

Singapore Economics League 2025

Answer key and worked solutions

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Question 1

PPCrazy! 1

Difficulty: Easy

Total Points : 9

Author: Ho Jon Yew

The Production Possibility Curve (PPC) is a concept used to illustrate possible output bundles, based on an economy's factors of production.

Figure 1 shows the PPC of Farm A for one harvest. Farm A has a resource constraint of 100 units of labour, which must be split between the production of either Apples or Pears.

Assume Apples and Pears are infinitely divisible. The sole factor of production in Farm A is labour.

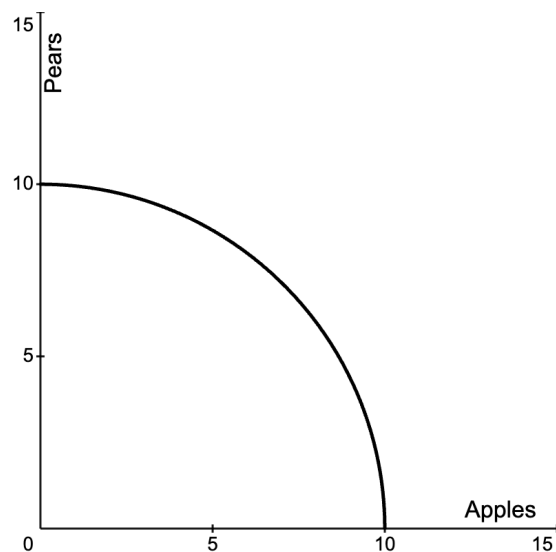


Figure 1

Question

Score

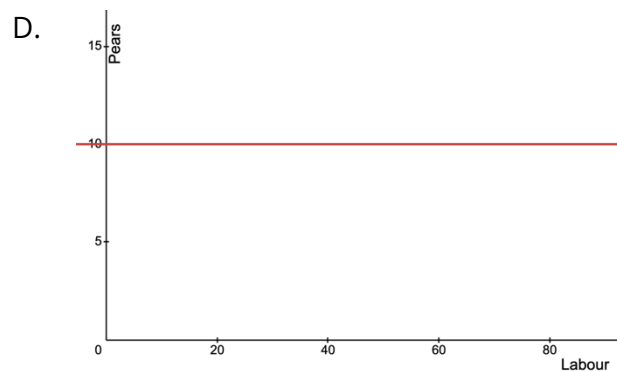
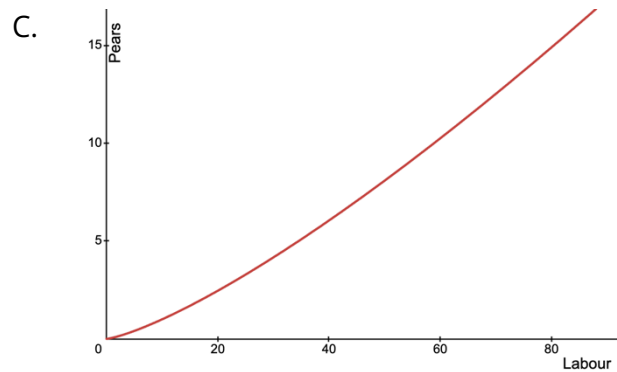
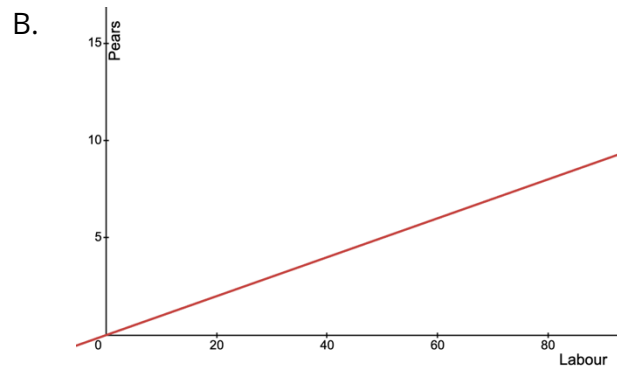
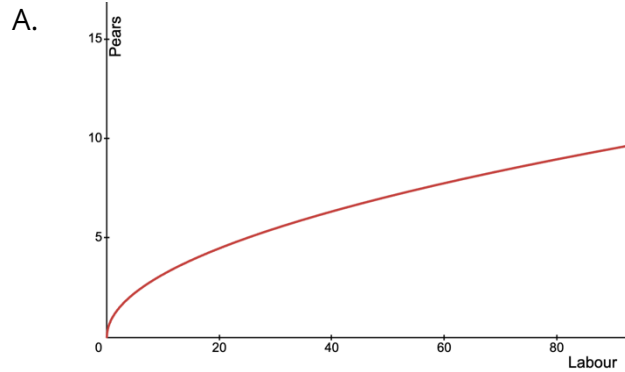
- i. Each statement regarding Farm A's PPC is either true or false. Select the correct options.
- A. Farm A can produce 12 apples in one harvest.
 - B. Farm A can produce both 10 apples and 10 pears in one harvest
 - C. Suppose Farm A is initially using 80 units of labour. It is possible for Farm A to produce more fruits.
 - D. Productive efficiency is achieved when Farm A produces 10 apples a harvest.

True False Set

(2)

Question 1

- ii. Which option shows the production function for pears in Farm A?
Assume that apples have a similar production function to pears.



MCQ

Question 1

- iii. Now, consider Farm B, which produces bananas (x_1) and grapes (x_2).
Farm B has the production functions:

$$x_1 = \sqrt{L_1}$$
$$x_2 = 0.05L_2$$

Further, Farm B's labour can be divided on the basis: $L_1 + L_2 \leq 400$

If Farm B produces 10 grapes a harvest, it can produce a maximum of q bananas. What is $\lfloor q \rfloor$, where $\lfloor \cdot \rfloor$ denotes the floor function?

Integer

(3)

- iv. Utility is given by the function: $U = x_1 + x_2$.

If Farm B produces on its Production Possibility Frontier, it must produce r bananas to maximise utility. What is $\lfloor r \rfloor$?

Integer

(2)

Question 1

Solution

Solution to (i)

Answer:

A	B	C	D
F	F	T	T

Explanation:

Option A is clearly false as the bundles that contain 12 apples lie outside the Production Possibility Frontier (PPF).

Option B is also false by similar reasoning

Option C is true as Farm A was initially only using 80 units of labour out of 100 units available. Farm A must be producing within its PPF, so production of fruits is not yet maximised.

Option D is true, as producing 10 apples requires the farm to exhaust all its labour, producing on the PPF.

Solution to (ii)

Answer:

A

Explanation:

Since the PPC is concave, we can conclude that there is **increasing opportunity costs** associated with producing larger numbers of pears. This is true if and only if labour obeys the **law of diminishing marginal returns**. In university textbooks, this is sometimes referred to as a decreasing marginal product of labour. The only production function that obeys this is option A.

Solution to (iii)

Answer:

14

Explanation:

Producing 10 grapes requires $10/0.05 = 200$ units of labour. We can allocate the remaining $400 - 200 = 200$ units of labour towards banana production.

$$X_1 = \sqrt{200} = 14.142. [q] = 14$$

Question 1

Solution to (iv)

Answer:

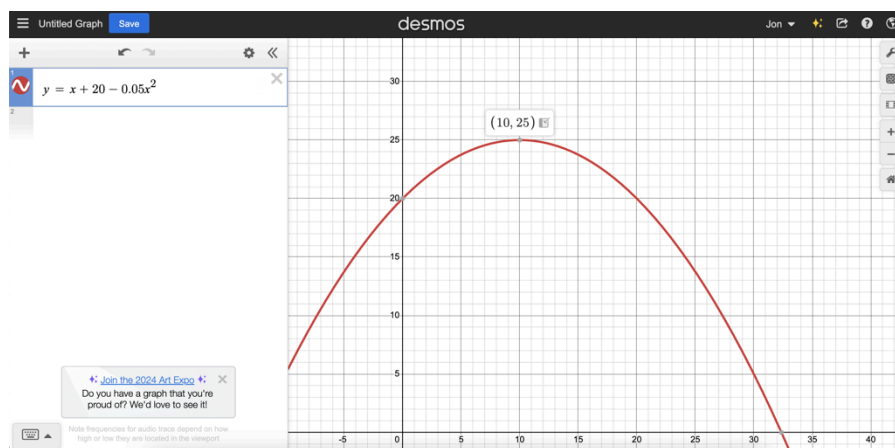
10

Explanation:

Observe that $x_1^2 = L_1$, and therefore

$$x_2 = 0.05L_2 = 0.05(400 - L_1) = 0.05(400 - x_1^2) = 20 - 0.05x_1^2.$$

Thus, we can rewrite the utility function as $U = x_1 + 20 - 0.05x_1^2$



The maximum value of U is 25, where $x_1 = 10$. This can be found via completing the square or a graphing calculator such as Desmos.

Question 2

The Little Mermaid

Difficulty: Easy

Total Points : 9

Author: Zonglun

In the classic fairy tale, the Little Mermaid (TLM) trades her voice to the Sea Witch for legs, hoping to win the Prince's love. We model her decision using utility theory:

- Utility Function: $U = x^5 + y^2$
 - x: Affection from the Prince (100 if loved, 0 otherwise).
 - y: Quality of her voice (100 if kept, 0 if traded).
- TLM is very naive about the world. She believes that:
 - If she trades her voice, the prince will certainly love her.
 - If she doesn't trade her voice, the prince will never love her.
- The reality is much more complex and written below:
 - If she trades her voice, there is only a mere 6% likelihood that the prince will love her.
 - If she doesn't trade her voice, there is also a 3% likelihood that the prince will love her.

Question

Score

- i. In the tale of TLM, TLM chooses to trade her voice for a pair of legs. From the perspective of TLM, is this behaviour rational and why?
- (a) It is rational. She should always aim to maximise x since it is of a higher order of magnitude.
 - (b) It is irrational. The actual expected utility for trading her voice is lower than the actual expected utility for not trading her voice.
 - (c) It is rational. To her best knowledge, her expected utility for trading her voice is higher than her expected utility for not trading her voice.
 - (d) It is irrational. She is facing informational failure as her knowledge is untrue.

MCQ

(3)

Question 2

- ii. Suppose in an alternate universe, there is a slightly nicer witch. In this universe, TLM is made an alternative offer and gains perfect information about the offer. All else equal, in this offer, she only has a 50% likelihood of losing her voice for choosing to gain a pair of legs. In this case, what is LJ ?

LJ denotes the floor function— LJ is the greatest integer number less than or equal to U .

Integer

(4)

- iii. Suppose you're still in the alternate universe. Using results from your calculations, will TLM choose to take up the offer? Will this choice be rational?

- (a) Yes. Rational.
- (b) Yes. Irrational.
- (c) No. Rational.
- (d) No. Irrational.

MCQ

(2)

Question 2

Solution

Solution to (i)

Answer: C

Explanation:

A is incorrect because the rational choice should be the option that maximises expected utility, which need not be maximising x.

B is incorrect because from the perspective of the decision-maker, it is fully rational to consider the information she knows, even if it is under informational failure.

C is correct because from the perspective of the decision-maker, the option that maximises her expected utility (derived using the information she has) is the rational choice. In this case, the rational choice for TLM is to trade her voice.

D is incorrect because from the perspective of the decision-maker, the option that maximises her expected utility (derived using the information she has) is the rational choice. In this case, the rational choice for TLM is to trade her voice.

Solution to (ii)

Answer: 10276

Explanation:

By taking up the offer,

$$x = 6$$

$$y = 40$$

Hence,

$$U = 6^5 + 50^2$$

$$U = 10276$$

Solution to (iii)

Answer: A

Explanation:

A is correct because it is both true and a rational choice.

The expected utility for not taking up the offer is given by

$$U = 3^5 + 100^2$$

$$U = 10243$$

Question 2

Since $10276 > 10243$, the expected utility of taking up the offer is greater than the expected utility of not taking up the offer.

Thus, is it both the case that TLM will take up the offer and the case that this choice is optimal.

Question 3

Mystery Index

Difficulty: Easy

Total Points : 3

Author: Jon Yew

H is a mystery economic index created by SEL problem setters. It is derived from data published by international organizations, such as the IMF. Economic Index H has been scaled to range from 0 to 200.

The value of economics index H for different countries is shown below: ($\pm 2\%$ accuracy)

Country 1	131.56
Country 2	96.30
Country 3	60.4

Additional information about Countries 1, 2, 3, & 4 is given below:

- Country 1 is the southernmost country in Africa.
- Country 2 is city state and international finance hub in Southeast Asia
- Country 3's central bank funds a famous prize in economics.
- Country 4 has the largest *gross* national debt of any country.

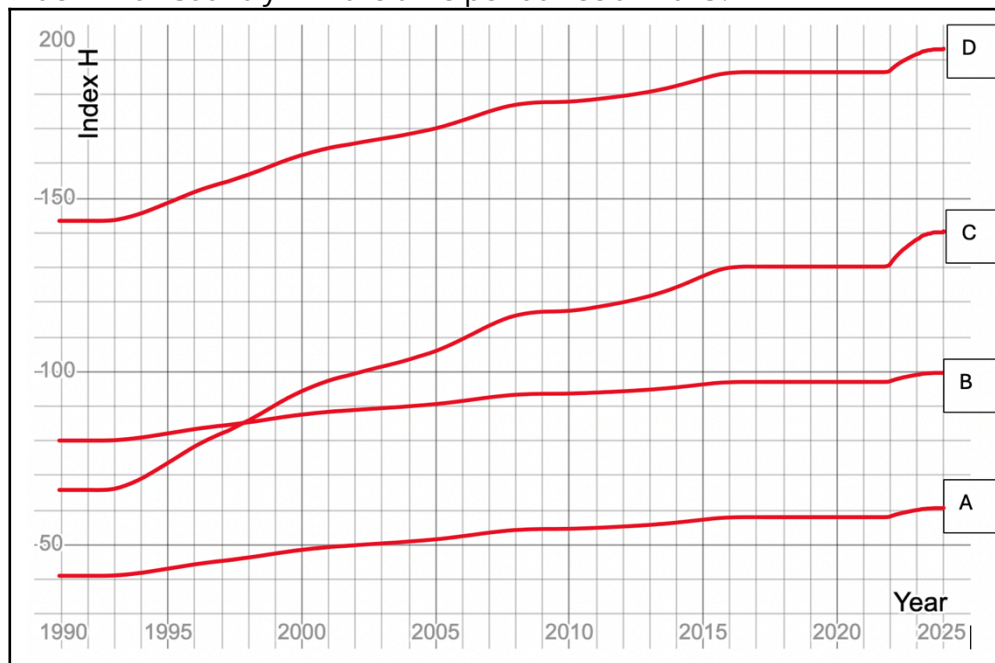
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Question 3

Question

Score

- i. Which line graph (in red) shows the approximate trend of economic index H for Country 4 in the time period 1990 - 2023?



MCQ

(3)

Question 3

Solution

Solution to (i)

Answer: B

Explanation:

First, derive the following:

Country 1 is South Africa.

Country 2 is Singapore.

Country 3 is Sweden.

Country 4 is the US.

Economic index H could represent data such as Nominal GDP, Unemployment rate, PPP, and more. Since H is on the scale 0-200, we can rescale H to a 0-100 scale to get a better idea of what it might represent:

	H divided by 2
South Africa	65.78
Singapore	48.15
Sweden	30.20

The above numbers mostly closely match these nation's GINI coefficients.

The level of income inequality in the US is most similar to Singapore's based off their 2023 GINI coefficient, so the best answer is B.

Question 4

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Music Theory

Difficulty: Easy

Total Points : 4

Author: Jon Yew jon.yew.ho@gmail.com

The domestic guitar market's demand function is shown in Figure 1.

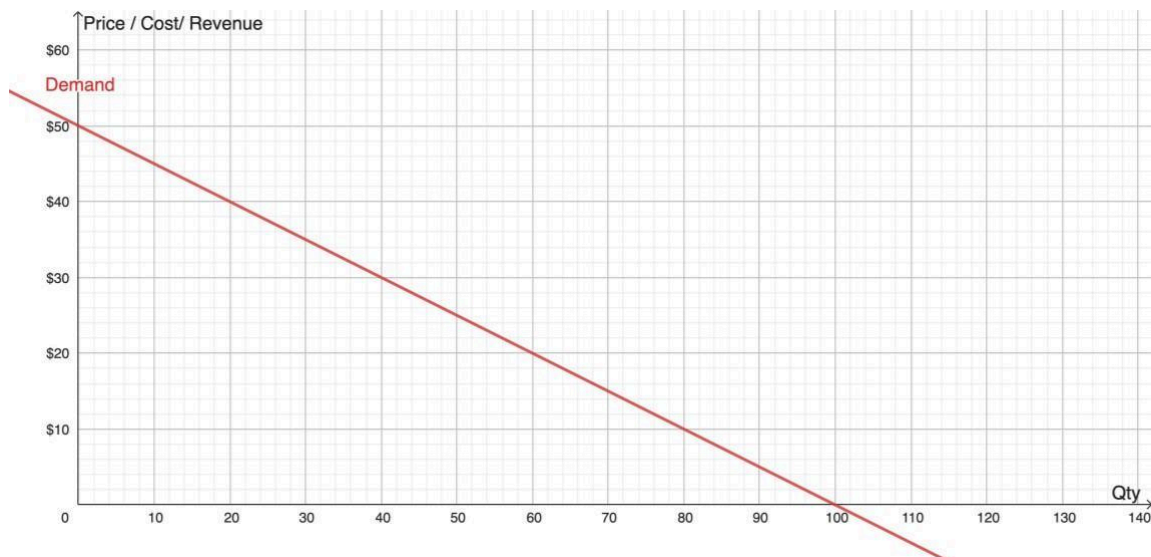


Figure 1

Brian's firm has a monopoly in the domestic market for guitars. Brian's firm has a cost function given by the equation: $TC=10Q+50$.

Question

Score

- i. What quantity of guitars should Brian's firm produce to maximize profit?

Integer

2

- ii. Piano Corp's total revenue (TR) and total cost (TC) curves are shown in Figure 2.

Question 4

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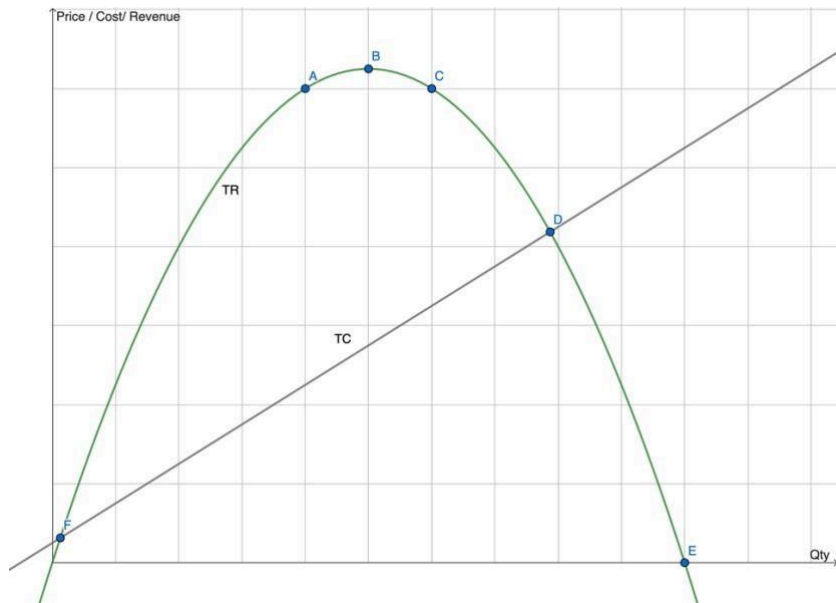


Figure 2

Which point along Piano Corp's TR curve is profit maximizing?

MCQ

2

Question 4

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Solution

Solution to (i)

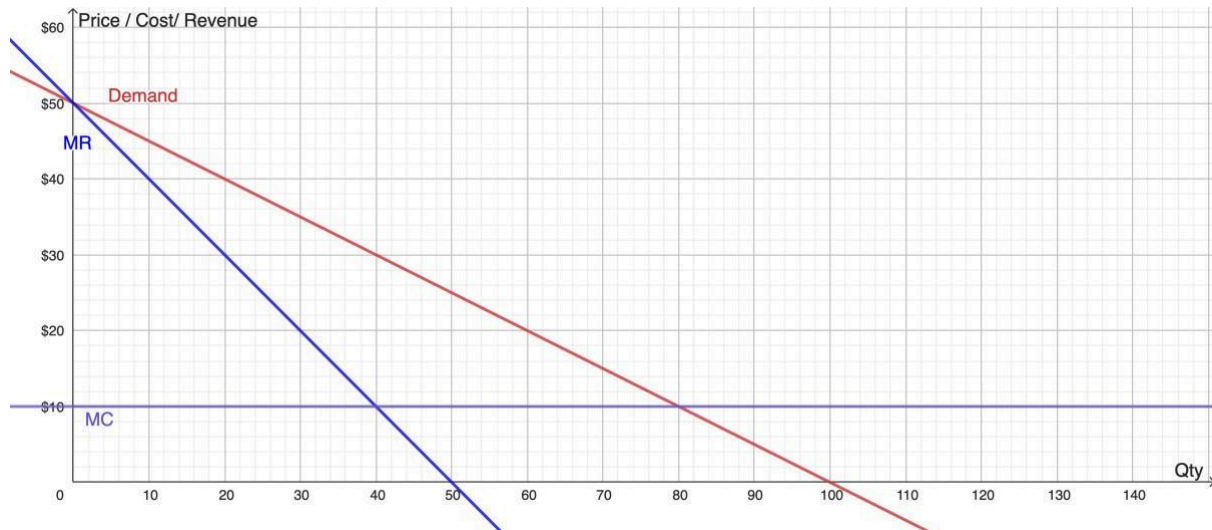
Answer: 40

Explanation:

If the market is a monopoly and demand is linear, the demand curve is also the average revenue (AR) curve.

Since the AR curve has intercepts (0, 50) and (0, 100), we know that the marginal revenue (MR) curve has intercepts (0, 50) and (0, 50) (this can be proven algebraically and also recalled from high school firm theory). Secondly, we can observe from the total cost equation $TC=10Q+50$ that the firm's marginal cost (MC) is 10 for all quantities produced.

We now have information on MC and MR, and we know that the firm's profit is maximised when $MC = MR$. Plotting MC against MR:



Equality is at Qty = 40.

Solution to (ii)

Answer: A

Explanation:

Profit is maximised when $MR = MC$. Furthermore, observe that MR and MC are the first derivatives of TR and TC respectively. The profit maximising Qty produced is thus the Qty

Question 4

Singapore Economics League **2025**

when the gradients of the TR and TC curves are the same. By observation, this condition only holds for point A.

Question 5

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A haul at the Farmers' Market

Difficulty: Easy

Total Points: 12

Author: Zonglun

On every other Saturday of the month, the quiet town of Peaceville has a Farmers' Market. With plentiful fresh fruits, vegetables, and meat, the Farmers' Market attracts almost the whole town.

There are 2 stalls in particular, right next to each other:

- A fruit store selling apples (A)
- A fruit store selling bananas (B)

Demand Functions:

- Apples: $D_A = 30p_B - 20p_A$
- Bananas: $D_B = 50p_A - 18p_B$

Initial Conditions (for the 1st iteration of the Farmers' Market):

- Apples: Price $p_A = \$2$, $Q_s = 100$
- Bananas: Price $p_B = \$3$, $Q_s = 200$

Question

Score

Question 5

Singapore Economics League 2025

- i. Not all the quantity supplied of Apples and Bananas sold out. Apparently, the store owners had set prices "by gut feel". Select why this may not be ideal for the store owners and why this occurs frequently in the real world.
- (a) Wrong prices will cause societal inefficiency, harming society at large, which causes the store owners to experience disutility. In the real world, the owners do not know the exact demand for their goods.
 - (b) Wrong prices may reduce the profits that the store owners can earn. In the real world, the owners do not know the exact demand for their goods.
 - (c) Wrong prices will cause societal inefficiency, harming society at large, which causes the store owners to experience disutility. In the real world, store owners may try to charge higher prices than market-clearing because this will increase profit. (2)
 - (d) Wrong prices may reduce the profits that the store owners can earn. In the real world, the owners do not know the exact demand for their goods. In the real world, store owners may try to charge higher prices than market-clearing because this will increase profit.

MCQ

- ii. Why is it that the demand function of Apples includes the price of Bananas?
- (a) They are produced using the same farmland.
 - (b) They are purchased by the same groups of people.
 - (c) They satisfy the same desires.
 - (d) They are sold next to each other.

Multi-Choice

(2)

- iii. Shortly before the 2nd iteration of the Farmers' Market, a prophet appeared and told the Banana owner the exact demand for his bananas. The apple store owner continues selling the same units of apples at the same price. Let the price that the Banana store owner will charge now to maximise profits be p_B , what is L_{p_B} ?

Question 5

Singapore Economics League **2025**

$\lfloor U \rfloor$ denotes the floor function— $\lfloor U \rfloor$ is the greatest integer number less than or equal to U .

Integer

(3)

- iv. Suppose that before the 3rd iteration of the Farmers' Market, the prophet also appeared and told the Apple owner the exact demand for his apples. The banana owner is made aware of this.

Also, the fixed quantity of apples and bananas has been lifted due to a change in the production process of both store owners. Now, they have an infinite supply of apples and bananas, but each unit of apples costs \$6 to produce and each unit of bananas costs \$8 to produce.

Let the quantity of bananas traded be Q_B .

What is $\lfloor Q_B \rfloor$?

Integer

(5)

Question 5

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Solution

Solution to (i)

Answer: B

Explanation:

The first part of A and C is wrong because in the assumptions of economics, producers are self-interested agents that do not care about their impact on society, only their profits.

The first part of B and D is correct because it is true that not maximising profits is a cause for concern for producers.

The second part of C and D is wrong because charging a price above market-clearing does not **always** mean higher profits. Also, it is explicitly stated in the question that the reason for the pricing was a “gut feeling”.

The second part of A and B is correct because, in reality, most producers do not know the true demand of their consumers.

Solution to (ii)

Answer: C

Explanation:

A is wrong because it describes goods that are competitive in supply. The costs of production of these goods are dependent on the production of the other, but we are focusing on the demand for these goods, which are not dependent on each other. B is wrong because even if the goods are purchased by the same groups of people, it doesn't mean their demand is related. For example, the same group of people (homemakers) probably purchase both utility and rice, but that doesn't mean that they will buy less rice because utility is cheaper.

C is correct. These goods are known as “Substitute Goods” because they satisfy the same needs and wants of people. Apples and Bananas are fruits, so most people can accept one as a replacement for the other, making them strong substitutes.

D is wrong. The fact that they're sold next to each other also doesn't mean their demand is related. For all we know, another store next to the banana store may be a firearm store, so do people buy fewer bananas if the firearms become cheaper? No.

Solution to (iii)

Answer: 2

Explanation:

Question 5

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Students should recall knowledge from the topic of Firm & Decisions. As we know that quantity supplied is fixed, Marginal Cost (MC) is 0.

$$D_B = 50p_A - 18p_B$$

$$D_B = 100 - 18p_B$$

$$\text{Marginal Revenue (MR)} = 100 - 36p_B$$

For maximum profit, production should be at $MR=MC$,

$$100 - 36p_B = 0 \quad p_B$$

$$= 2.78 \text{ (3sf)}$$

$$L_{p_B} = 2$$

Alternative solution:

$$\text{Profit} = D_B \cdot p_B - \text{Cost} = 100p_B - 18p_B^2 - 0 \quad d(\text{Profit})/d(p_B)$$

$$= 100 - 36p_B$$

$$\text{To maximise profit, } d(\text{Profit})/d(p_B) =$$

$$0 \text{ Therefore, } 100 - 36p_B = 0 \text{ The rest is}$$

the same.

Solution to (iv)

Answer: 194

Explanation:

Students should be able to pick up that there is now a Marginal Cost (MC) of production. Recall that both firms will still try to maximise their profits - let's work with unknown variables first and the answer should become salient very soon.

Students should first consider the production of Apples,

$$D_A = 30p_B - 20p_A$$

$$MR_A = 30p_B - 40p_A$$

$$MR_A = MC_A$$

$$30p_B - 40p_A = 6$$

$$p_A = 0.75p_B - 0.15$$

Now consider the production of Bananas,

$$D_B = 50p_A - 18p_B$$

$$MR_B = 50p_A - 36p_B$$

$$MR_B = MC_B$$

Question 5

Singapore Economics League **2025**

$$50p_A - 36p_B = 8$$

$$50(0.75p_B - 0.15) - 36p_B = 8$$
$$1.5p_B - 7.5$$
$$= 8$$

$$p_B = 31/3$$

Finally, to find the quantity of Bananas,

$$D_B = 50p_A - 18p_B$$

$$D_B = 50(0.75p_B - 0.15) - 18p_B$$

$$D_B = 19.5p_B - 7.5$$

$$D_B = 19.5(31/3) - 7.5$$

$$D_B = 194$$

Since the quantity supply is not capped, quantity traded = 194.

Question 6

Game On: Dominance & Reduction

Difficulty: Easy

Total Points: 12

Author: Theodore Chou theodorechousm128@gmail.com

In the realm of strategic interaction, players often choose from a range of fixed strategies with each yielding different outcomes depending on their opponent's choice. The matrix below captures such a scenario, with two players, Rowan and Colton, each selecting from four strategies.

While some of the strategy names (e.g. *Tit for Tat*, *Grim Trigger*) are inspired by classic Game Theory, do note that they have been assigned arbitrarily payoffs; players using the same named strategy may still experience differing payoffs.

Random, Grudger and Pavlov are arbitrary names for strategies too.

The game is presented in normal form, with Rowan's payoffs listed first and Colton's payoffs colour-coded in **blue** for ease of reference.

Rowan	Colton				
	Strategy	Tit for tat	Random	Grudger	Pavlov
	Tit for tat	1, 3	3, 1	0, 2	1, 1
	Always cooperate	1, 2	1, 2	2, 3	1, 1
	Always Defect	3, 2	2, 1	1, 3	0, 3
	Grim Trigger	2, 0	3, 0	1, 1	2, 2

Question

Score

- i. Select all the options that are applicable.

Rowan's strictly dominant strategy/strategies are:

- (a) Tit for tat
- (b) Always cooperate
- (c) Always defect
- (d) Grim trigger
- (e) None of the above

Question 6

MCQ Multi-select

(2)

- ii. Select all the options that are applicable.
Colton's strictly dominant strategy/strategies are:
- (a) Tit for tat
 - (b) Random
 - (c) Always defect
 - (d) Grim trigger
 - (e) None of the above

MCQ Multi-select

(2)

- iii. Use iterated deletion of dominated strategies to reduce the game as much as possible.

Formatting:

When typing out the payoffs, DO NOT use any spacings.

For Example: "1,3"  versus "1, 3" 

Name and write down the strategies for each player in the same order as they were originally in the normal form.

For Example: If you deleted the following strategies for Rowan: "Tit for tat" and "Always Cooperate", the first strategy under Rowan will be named: "Always Defect", followed by the strategy of "Grim Trigger".

NOTE: Answers that do not follow the required formatting (including consistent capitalisation and exact naming of strategies as shown in the game table at the beginning of the question) will be considered incorrect.

	Colton		
	Strategy	<insert Colton's strategy's name>	<insert Colton's strategy's name>
	<insert Rowan's strategy's name>	<payoffs>	<payoffs>
	<insert Rowan's strategy's name>	<payoffs>	<payoffs>

String Table

(8)

Question 6

Solution

Solution to (i)

Answer: (e)

Explanation:

Rowan does not have a strictly dominant strategy.

This is seen by how there is no one such row with all the payoffs of Rowan that are underlined (i.e. There's no strategy that strictly dominates another)

Here is the longer explanation:

A strictly dominant strategy is a strategy that is strictly better than any other strategy that can be played by the player under consideration.

Consider Rowan:

When Colton chooses Tit for Tat, Rowan's best response is Tit for tat (Payoff of $3 > 2 > 0$)

When Colton chooses Random, Rowan's best response is either Tit for tat OR Grim Trigger (both have a payoff of 3 and $3 > 2 > 1$)

When Colton chooses Grudger, Rowan's best response is Always cooperate (as $2 > 1 > 0$)

When Colton chooses Pavlov, Rowan's best response is Grim Trigger ($2 > 1 > 0$)

Hence, for Rowan, there is no one strategy that is always better than another strategy no matter what Colton plays. Hence, we conclude that Rowan's best responses are dependent on Colton's moves and thus, Rowan has no strictly dominant strategy.

Solution to (ii)

Answer: (e)

Explanation:

Same reasoning as for (i).

Solution to (iii)

Answer:

Explanation:

Question 6

Rowan	Colton				
	Strategy	Tit for tat	Random	Grudger	Pavlov
	Tit for tat	1, <u>3</u>	<u>3</u> , 1	0, <u>2</u>	1, <u>1</u>
	Always cooperate	1, <u>2</u>	1, <u>2</u>	<u>2</u> , <u>3</u>	1, <u>1</u>
	Always defect	<u>3</u> , <u>2</u>	2, 1	1, <u>3</u>	0, <u>3</u>
	Grim trigger	2, <u>0</u>	<u>3</u> , <u>0</u>	1, <u>1</u>	<u>2</u> , <u>2</u>

- Delete Colton's column of Random
⇒ It is strictly dominated by Grudger
- Delete Rowan's row of Tit for tat
⇒ It is weakly dominated by Grim Trigger
- Delete Colton's column of Tit for Tat
⇒ It is strictly dominated by Grudger
- Delete Rowan's row of Always defect
⇒ It is strictly dominated by Always cooperate

End Result:

Rowan	Colton		
	Strategy	Grudger	Pavlov
	Always cooperate	2, <u>3</u>	1, <u>1</u>
	Grim Trigger	1, <u>1</u>	<u>2</u> , <u>2</u>

Question 7

This mugger life is not 4 me

Difficulty: Easy

Total Points : 11

Author: Jon Yew jon.yew.ho@gmail.com

Its 11pm on a Sunday night, and the world is fast asleep. Except for you, staring blankly at a half completed 10m microeconomics essay. Your bloodstream has a 10% caffeine content, and your economics mid-year examination is tomorrow. What is the next step in answering market failure questions? You try to recall but draw a blank. All the words on the page seem to be jumbling together. Is my plushie in the corner moving? You can't help but laugh at the absurdity of it all...

Question

Score

- i. At 7pm, you were still fresh, and you breezed through your Anki definition cards in 15 minutes. 4 hours deep, and it's hard to tell what topic these lecture notes are on.

Match the following economics concepts being described:

Law of diminishing marginal returns	?	A) in assuming that more mugging = better grades
Capital Depreciation	?	B) of time expended with respect to knowledge gained
Perceived Marginal Private Benefit	?	C) of continued mugging remains positive
Logical fallacy	?	D) of your brain's ability to study meaningfully

Sort

2

Question 7

- ii. Jerome's promotional examinations are coming up, and he hopes to get as many 'A's as possible.
(Subjects which score 70 or higher are awarded an 'A')

Jerome takes the following subjects:

Level	Type	Name	Mid-year examination score M
H2	Science	Biology	65
H2	Science	Chemistry	62
H2	Science	Mathematics	61
H2	Arts	Economics	67
H1	Other	General Paper	71
H1	Other	Chinese Language	60

For each subject, the promotional exam score ' P ' depends on past performance, as well as knowledge gained: $P = K + M$

The time spent studying is converted to knowledge by the following formula:

$$K = \sqrt{T}$$

Jerome has a busy schedule as he plays on the Tennis team and is volunteering for his classmate's service-learning project. Thus, he only has 100 hours of uninterrupted study time before his exams, which he must divide between his subjects.

How many 'A's will Jerome receive by studying optimally?

Integer

3

Question 7

- iii. Which of the following describes the strategy that Jerome should use to maximise the number of A grades he achieves?

A)	Devote equal time to every subject
B)	The time allocated to each subject should be proportional to the square root of $M - K$ for that subject
C)	Devote more time to the lowest scoring subjects.
D)	Devote more time to the highest scoring subjects with scores < 70 .

MCQ

2

- iv. Suppose Jerome no longer wishes to maximise the number of 'A' grades. Instead, he wishes to achieve the highest *average* grade. Now, what is his ideal strategy?

A)	Devote equal time to every subject
B)	The time allocated to each subject should be proportional to the square root of $M - K$ for that subject
C)	Devote more time to the lowest scoring subjects.
D)	Devote more time to the highest scoring subjects with scores < 70 .

MCQ

2

- v. What is the highest average grade Jerome can achieve at his promotional examinations? Give your answer to 1 d.p.

Float

2

Question 7

Solution

Solution to (i)

Answer:

Law of diminishing marginal returns	B) of time expended with respect to knowledge gained
Capital Depreciation	D) of your brain's ability to study meaningfully
Perceived Marginal Private Benefit	C) of continued mugging remains > 0
Logical fallacy	A) in assuming that more mugging = better grades.

Solution to (ii)

Answer: 4

Explanation:

General Paper will score 71 points = A if he allocates no studying time to it, so Jerome should focus on his other subjects.

We need to get subjects to 70 points while conserving as many points as possible, so we consider those subjects nearest to the A grade.

Economics is 3 points off, so it requires 9 hours of study

Biology is 5 points off, so it requires 25 hours of study

Chemistry is 8 points off, so it requires 64 hours of study

Math is 9 points off, so it requires 81 hours of study

$9 + 25 + 64 = 98$ which is less than 100

$9 + 25 + 65 + 81 = 179 > 100$

If 98 hours are allocated to Economics, Biology, and Chemistry, another 3 'A's can be achieved, resulting in 4 'A's. It is not possible to get 5 'A's due to the time constraints faced.

Solution to (iii)

Answer: D

Explanation: see (ii)

Question 7

Solution to (iv)

Answer: A

Explanation: see (ii)

From the knowledge production function:

$$K = \sqrt{T}$$

We can see that the time spent studying has diminishing returns for each subject.

Let the average promotional exam grade be $\bar{P}$. Observe that since $\bar{P} = \bar{K} + \bar{M}$ and $\bar{M}$ is constant, $\bar{P}$ is maximised if and only if $\bar{K}$ is maximised. How do we maximise the average knowledge gained? We allocate an equal amount of time to each subject. This can be proven via contradiction as an exercise for the reader.

Solution to (v)

Answer: 68

Explanation:

$$\bar{M} = \frac{65 + 62 + 61 + 67 + 71 + 60}{6} = 64.33$$

$$\bar{K} = \sqrt{\frac{100}{6}} = 4.08$$

$$\bar{P} = \bar{K} + \bar{M} = 64.33 + 4.08 = 68.41 \sim 68.4$$

Question 8

tiktok vids pmo fr icl

Difficulty: Easy

Total Points : 6

Author: Jonas

TikTok and Instagram Reels continue to be dominant platforms for viral memes in 2025. Recently, slang-driven memes such as “ts,” “pmo,” and “icl” have gained massive popularity, spreading rapidly among youth. These memes evolve quickly, with countless users creating derivative versions that build on the transcendental vocabulary of the original — forming nascent and innovative sentences such as “icl u pmo n ts pmo sm lol ng! cn u b fr w me rn vro? 🍷🍷”.

These dynamics highlight several economic challenges on these platforms, shaped by **attention scarcity**, **behavioural incentives**, and **fast-changing user preferences**.

Economists studying TikTok and Instagram Reels in 2025 have identified multiple market failures and behavioural patterns shaping this meme economy.

Question

Score

- i. Which of the following best explains why meme creation on TikTok and Instagram Reels might not reach an efficient outcome even without classic externalities?
- A. Meme creation causes negative effects on viewers that reduce overall enjoyment.
 - B. People’s preferences for memes change rapidly, and memes compete based on how well they outperform others, leading to cycles of overproduction.
 - C. Memes are private goods with fixed tastes, so creators supply exactly what users want.
 - D. Meme creators always earn revenue proportional to meme quality, ensuring efficiency.

MCQ

(2)

Question 8

- ii. Users on TikTok and Instagram Reels often experience “*meme fatigue*” — a sense of boredom or overload caused by the constant stream of repetitive or derivative memes. A 2025 survey by Digital Youth Insights found that 68% of users said they were tired of seeing the same memes recycled repeatedly, leading some to skip large portions of their feeds.

Which of the following best describes the source of market failure in this scenario?

- A. Meme creators fail to consider how their memes reduce other users’ attention, causing too many low-quality memes.
- B. Viewers don’t invest enough effort to find good memes, so high-quality memes are underconsumed.
- C. Platform algorithms encourage creators to prioritize quantity over quality, which directly causes the inefficiency.
- D. Meme consumers want constant novelty, so creators produce memes rapidly, which is efficient.

MCQ

(2)

- iii. **True or false:**

- a. Making memes excludable through **paywalls** or **subscription models** would improve efficiency by aligning creator incentives with content quality.
- b. Implementing **algorithmic filters** that limit the frequency of similar memes appearing on user feeds can help reduce meme fatigue and improve overall user satisfaction.

True False

(2)

Question 8

Solution

Solution to (i)

Answer: B

Explanation:

Why B is correct:

- This captures the idea of positional goods and endogenous preferences, where value depends on relative standing and tastes evolve quickly, causing constant competition and overproduction even without classic externalities.
- A: Suggests negative effects reduce enjoyment, which implies an externality, but the question asks for explanation *without classic externalities*.
- C: Incorrect because memes are *not* private goods with fixed tastes; they are non-excludable and tastes evolve, so creators cannot simply match static demand.
- D: Incorrect as meme creators rarely earn revenue strictly proportional to quality; many create for attention or social capital, leading to inefficiencies.

Solution to (ii)

Answer: A

Explanation:

Why A is correct:

- This describes a **negative consumption externality** (attention pollution): creators produce excessive memes because they do not bear the cost imposed on others' limited attention.
- **B**: Suggests *underconsumption* of high-quality memes due to viewers' effort, but the problem is overproduction of low-quality memes, not underconsumption.
- **C**: While algorithms may influence behaviour, the root market failure lies in creators' incentives, not algorithm design itself; algorithms are a proximate cause, not the fundamental externality.
- **D**: Incorrect because it claims rapid meme production is efficient; in fact, it can cause overload and reduce overall welfare due to attention scarcity.

Question 8

Solution to (iii)

Answer: False, True

Explanation:

- a. While excludability can improve incentives in some cases, it does not *guarantee* higher efficiency. Many meme creators are motivated by social capital, not profit, and restricting access through paywalls can reduce audience reach, dampen virality, and exclude non-paying users. In some cases, excludability may even discourage innovation or distort content priorities, making outcomes less efficient.
- b. Algorithmic curation that controls content repetition can mitigate attention pollution and enhance user experience, reducing meme fatigue.

Question 9

Wordlenomics

Difficulty: Easy

Total Points : 4

Author: Jon Yew jon.yew.ho@gmail.com

Today you've decided to play Wordle, and find to your surprise that they've made it Economics Themed: (Fig. 1) You try out UTILITY and SURPLUS, but to no avail:

(Wordle rules: <https://en.wikipedia.org/wiki/Wordle#Gameplay>)

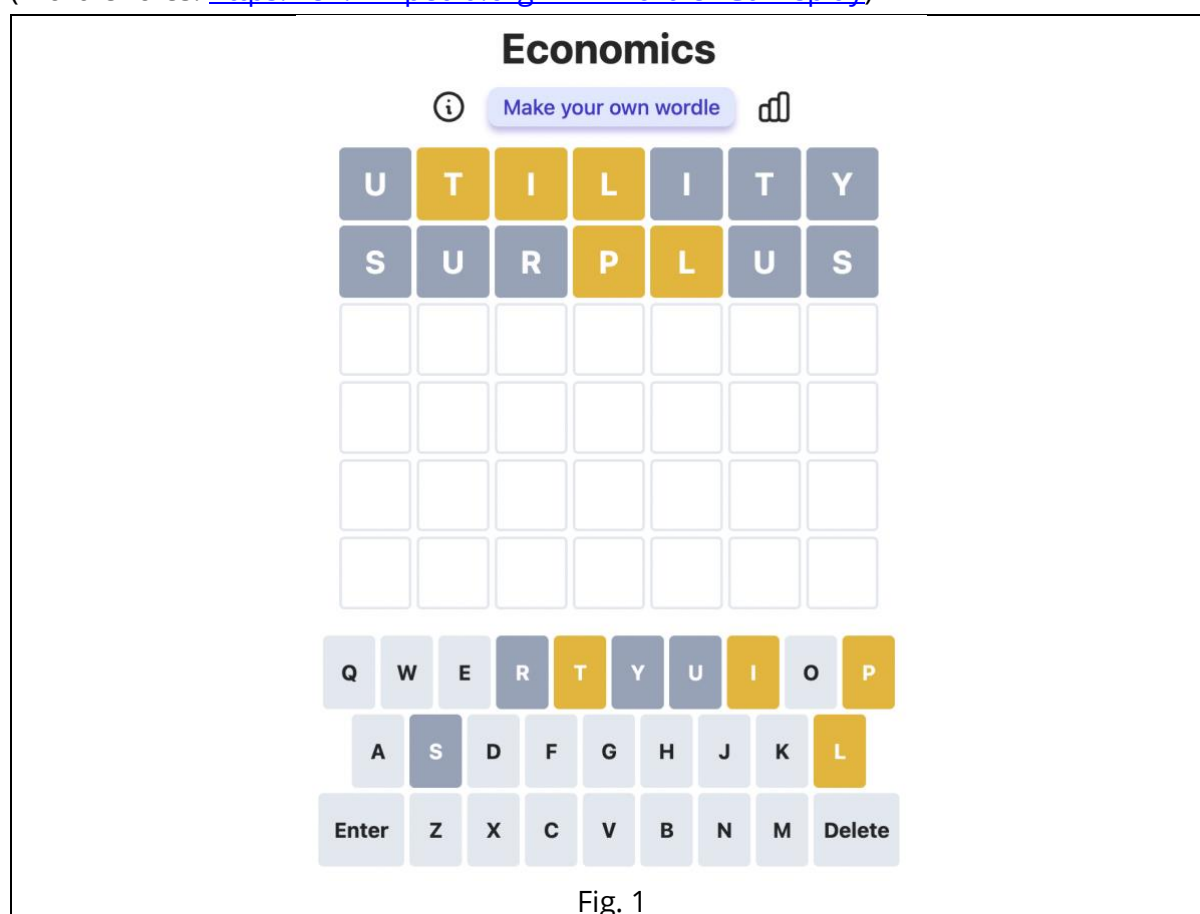


Fig. 1

Question

Score

i. What is the word?

Here's a hint:

XXXXXXX is an important input in the production of goods and services

String

2

Question 9

- ii. Match the economics concepts to their definitions

1) How well a firm/economy maximises output with given inputs.		A) Utility
2) That it is impossible to be fully satisfied		B) Surplus
3) The resource constraint on economic actors which limits their ability to satisfy unlimited wants		C) Budget
4) The value added		D) Efficiency
5) The revealed or normative objective which economic actors seek to maximize		E) Scarcity

Sort

2

Question 9

Solution

Solution to (i)

Answer: CAPITAL

Solution to (ii)

Answer:

1) How well a firm/economy maximises output with given inputs.	D) Efficiency
2) That it is impossible to be fully satisfied	E) Scarcity
3) The resource constraint on economic actors which limits their ability to satisfy unlimited wants	C) Budget
4) The value added	B) Surplus
5) The revealed or normative objective which economic actors seek to maximize	A) Utility

Question 10

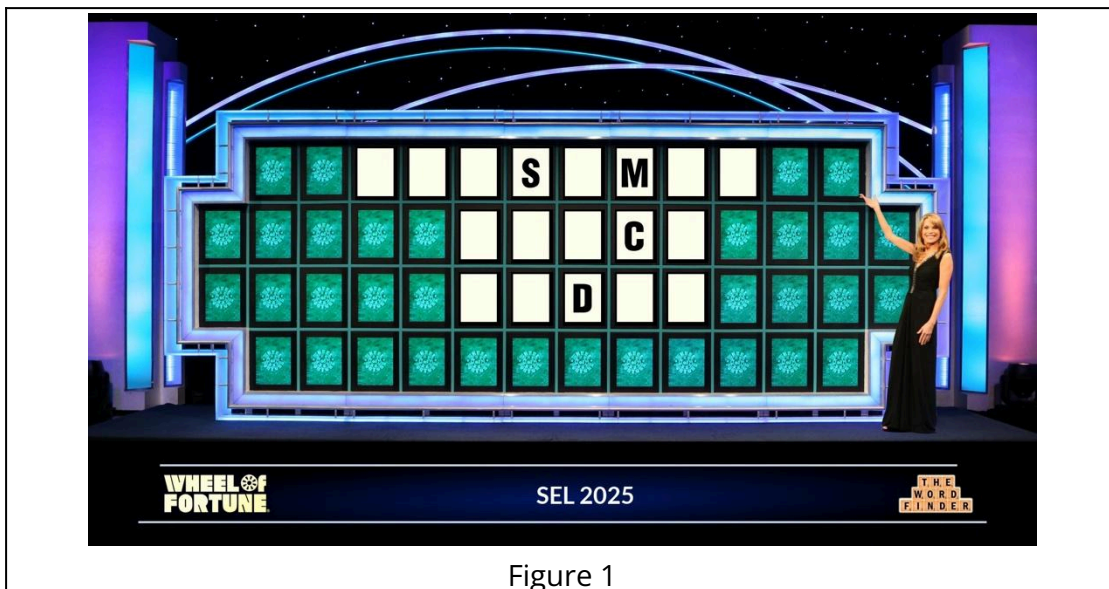
The Wheel of Fortune

Difficulty: Easy

Total Points : 8

Author: Jon Yew jon.yew.ho@gmail.com

You've done it. After all those trials and tribulations, you've made it to the final round of the Wheel of Fortune Singapore. Only 3 more questions lies between you and the grand prize. With the whole nation watching and 1 million SGD on the line, will you be the one to take it home?



Hints:

1. The War in Ukraine contributed to **its** increase in Singapore.
2. If **it** increases during a downturn, then the material standard of living may fall.
3. SingStat publishes **it**.

Question

Score

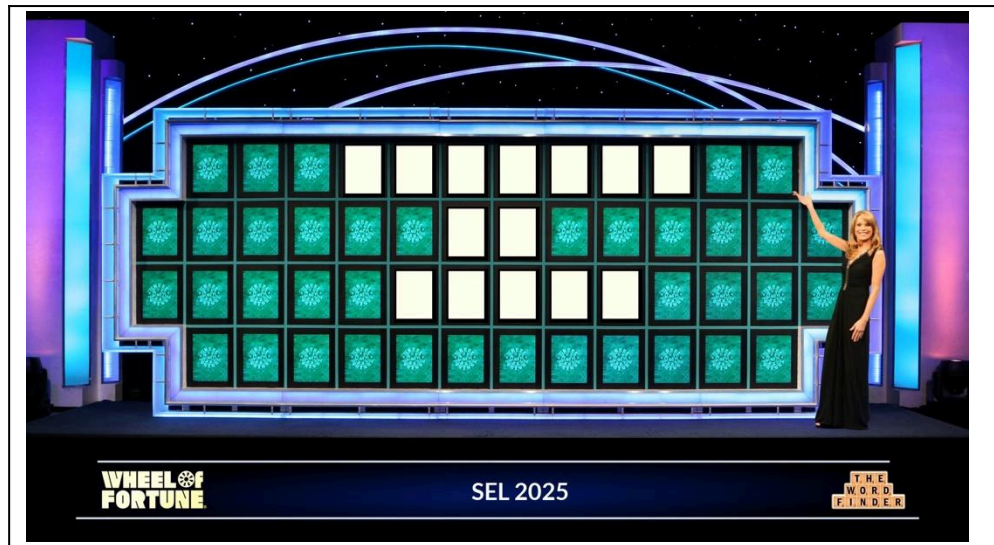
- i. What is the phrase? (Fig. 1)
Give your answer as the full string. Do not add additional whitespaces or double spaces to the end of the string or between words, as this may cause the correct answer to be registered as wrong.

String

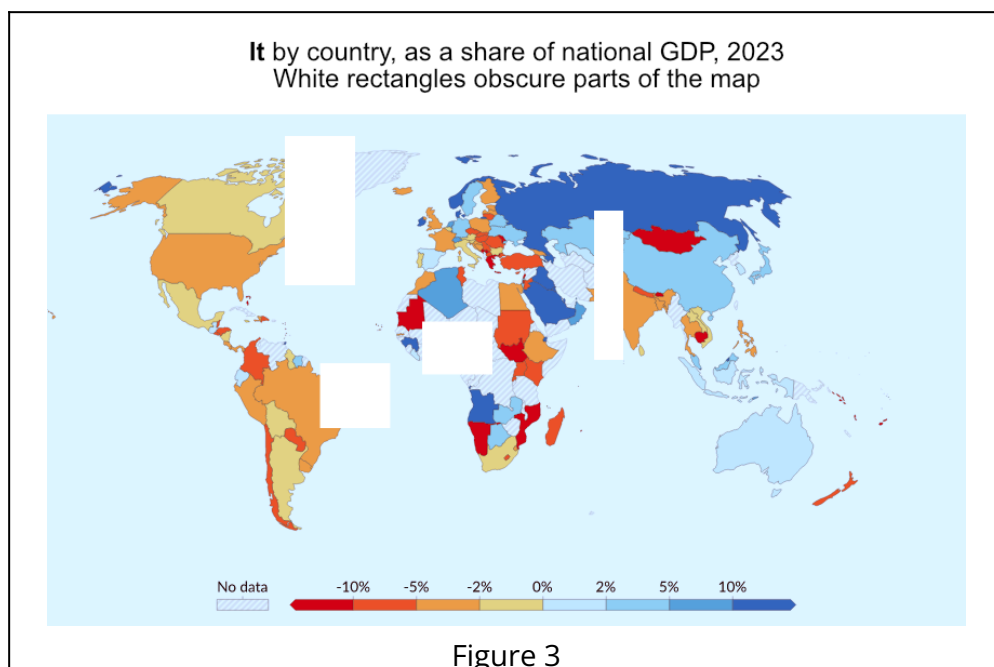
3

Question 10

- ii. Next question! What's the phrase? (Fig. 2)



Hint: (Fig. 3)



String

Question 10

- iii. Last question! What phrase (Fig. 4) illustrates the movement from C to E along the LRAC curve? (Fig. 5)

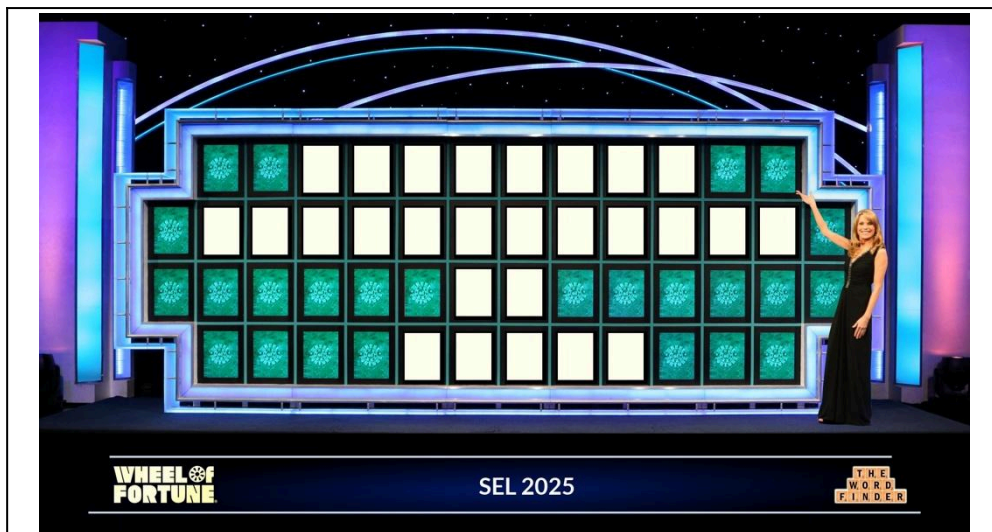


Figure 4

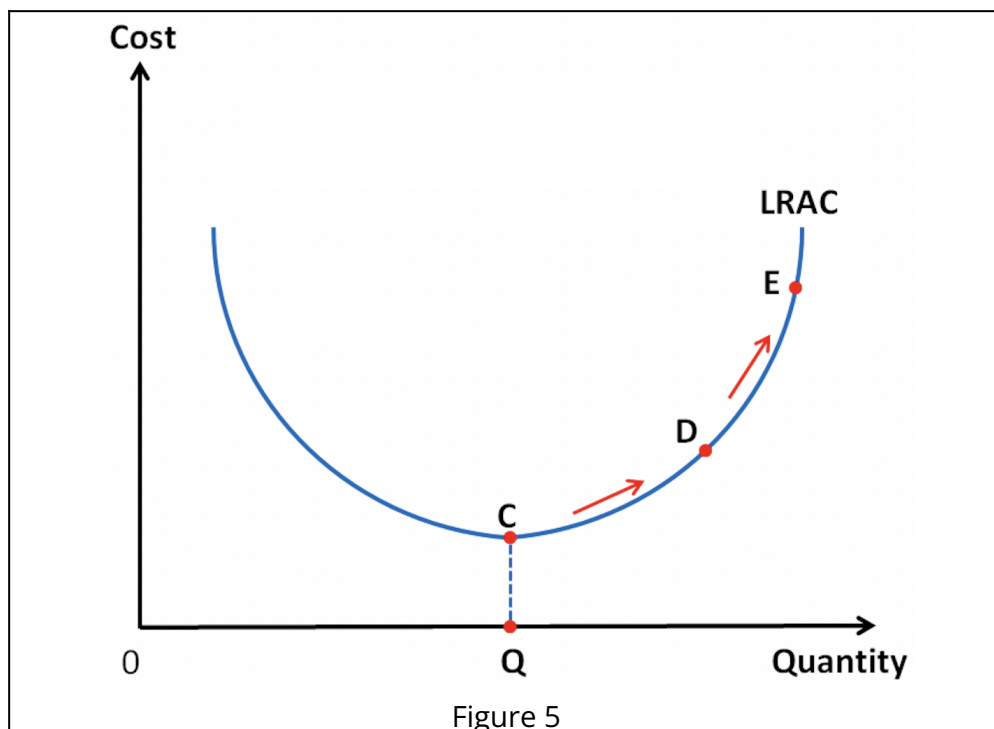


Figure 5

Question 10

Solution

Solution to (i)

Answer: CONSUMER PRICE INDEX

Explanation:

Hint 1: The war in Ukraine caused global economic uncertainty and a slowdown of Ukrainian grain exports. The average cost of imported goods rises resulting in inflation

Hint 2: Inflation during a downturn with stagnant wages implies lower purchasing power and correspondingly a fall in MSOL.

Solution to (ii)

Answer: BALANCE OF TRADE

Explanation: Let this concept be X. One key detail is that X is negative for the United States while positive for China, implying this is likely to be trade related. Additionally, X divided by GDP is the greatest for petrol states such as Russia and Saudi Arabia. We conclude that this is likely a phrase related to the current account and net exports.

Solution to (iii)

Answer: INTERNAL DISECONOMIES OF SCALE

Question 11

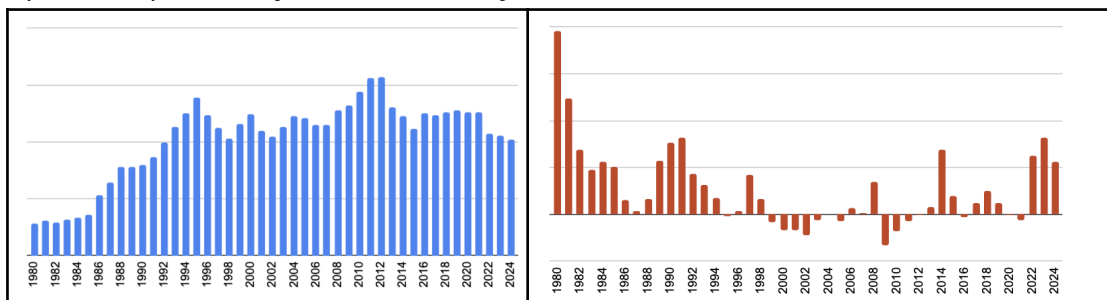
Mystery Country

Difficulty: Easy

Total Points : 4

Author: Yuxuan Zhao

The following graphs show the trends in GDP (current prices) and inflation rate, (compared to previous year) of a country from 1980 to 2024.



Can you guess which country it is?

Question

Score

- i. Give the name of this country

String

4

Question 11

Solution

Solution to (i)

Answer: Japan

Explanation:

Defining characteristics of the GDP graph

1. Upward trend in the 1980s
2. General stagnation from 1992 onwards, with significant downward trends from 1995-1998, 2012-2015, 2021-2024

Defining characteristics of the inflation graph

1. Highs: 1980-1985, 1989, 1997, 2008, 2014, 2022-2024
2. Lows: Most of the late 1990s, 2000s, 2010s

Key thought process

1. Dip in GDP in the late 1990s can be attributed to the 1997 Asian Financial Crisis
 - a. Other possibilities include: Russian Financial Crisis (1998), Ecuador economic crisis (1998-1999), Argentine great depression (1998-2002), Brazil financial crisis (1999). However, these countries all experienced significant economic growth in the 2000s, unlike the trend shown in the graph
2. The Asian Financial Crisis mainly affected the following regions: South Korea, Indonesia, Thailand, Hong Kong, Laos, Malaysia, Philippines, Brunei, mainland China, Japan, Singapore, Taiwan, Vietnam
3. The only country from the list above that has been struggling with stagnant economic growth and deflation since the 1990s is Japan

Long explanation

1980s: Japan experienced remarkable economic growth, driven by exuberance in the equities markets and skyrocketing real estate prices. However, this growth was largely unsustainable.

Question 11

1990s: The collapse of the asset price bubble resulted in a lengthy period of economic stagnation and deflation, known as Japan's "Lost Decade". In 1997, the Asian Financial Crisis (originating in Thailand) resulted in a significant fall in GDP. This was worsened by the increase in consumption tax rate from 3% to 5% which also contributed to the spike in inflation rate.

2000s-2010s: GDP growth remained sluggish, with demographic challenges like an ageing population and labour shortages dampening growth. Japan also struggled with deflation as a result. The 2014 inflation was again sparked by an increase in sales tax rate, from 5% to 8%. (Note: In 2008, though it appears that nominal GDP did not take a severe hit from the Global Financial Crisis, real GDP actually fell significantly, even more so than the US)

2020s: The Covid-19 pandemic had a significant impact on Japan's GDP and inflation rates, as Japan's economy contracted sharply while global commodity prices rose rapidly.

Question 11



Singapore Economics League **2025**

Question 12

Your unemployed friend on a Tuesday

Difficulty: Easy

Total Points : 10

Author: Jon Yew

Question

Score

- i. A quote from an economist: "if you pay people not to work and tax them when they do, don't be surprised if you get unemployment"

What type of unemployment is this?

A)	Structural unemployment
B)	Cyclical unemployment
C)	Frictional unemployment
D)	Voluntary unemployment

MCQ

2

- ii. Which of the following macroeconomic outcomes is least likely to arise, following a substantial rise in the unemployment rate during an economic downturn, in the United Kingdom?

A)	A fall in welfare expenditure
B)	A fall in consumer expenditure
C)	A fall in firm expenditure
D)	A fall in tax revenue

MCQ

2

Question 12

- iii. Country X has the following qualities:
- (a) A managed, free-float currency
 - (b) A long-term current account deficit
 - (c) Low unemployment

The government proposes several policies to reduce the deficit. Which policy is unlikely to increase unemployment, yet may cause inflationary effects?

A)	A lowering of the interest rate
B)	An increase of the income tax rate
C)	The implementation of moderate import tariffs (10%)
D)	An appreciation of the currency

MCQ

2

- iv. Every year, Singapore's Ministry of Education (MOE) carries out the Graduate Employment Survey to analyse the employment rates and income of college graduates.

The following joint probability distribution* is between *college graduation status* and *employment status* in Singapore:

	Employed (E = 1)	Unemployed (E = 0)	Total
College Graduate (G = 1)	W	X (0.08)	W + X
Non-graduate (G = 0)	Y	Z	Y + Z
Total	W + Y (0.17)	X + Z	W + X + Y + Z (=1.00)

The values of "Y" and "X+Z" are given.

A member of the population is randomly selected, and they report being unemployed. What is the probability that they did not graduate from college? Give your answer as to 3 d.p.

(For example, P = 0.123)

Float

4

Question 12

Solution

Solution to (i)

Answer: D

Explanation: None of A, B, or C fit the definition, so the best option is D

Solution to (ii)

Answer: A

Explanation: The UK has an extensive welfare program. More unemployed individuals means more people will apply for state handouts, and welfare expenditure will rise.

Solution to (iii)

Answer: A

Explanation: Lower interest rates will overheat the economy. Unemployment won't rise but there may be demand pull and import inflation.

Solution to (iv)

Answer: 0.904

$$P(G = 0 \mid E = 0) = 1 - P(G = 1 \mid E = 0) = 1 - P(G = 1 \text{ \& } E = 0) / (E = 0) = 1 - X / (X + Z) = 1 - (0.08/0.83) = 0.904$$

Question 13

The third certainty

Difficulty: Easy

Total Points : 10

Author: Jon Yew

Question

Score

- i. The following table shows the average amount of direct taxes paid by households in France during the 2023-2024 fiscal year:

	Bottom 25%	Second 25%	Third 25%	Top 25%
Income (Franc)	15 500	27 800	57 800	106 800
Direct Tax	2 300	3 500	10 700	25 000

Which of the following are both positive statements and true?

A)	France has a progressive tax regime
B)	Low-income households have a lesser tax burden
C)	Without taxation, there would be greater income inequality, ceteris paribus
D)	High-income households are paying too much tax
E)	High-income households pay a greater proportion of their income as tax
F)	France's tax regime is unfair

MCQ Multi Select

2

Question 13

- ii. Consider Country X; a diversified, open, and developed economy with a population of 11 million. Initially, the only form of taxation in Country X is a moderate, flat rate income tax.

Select the true statements.

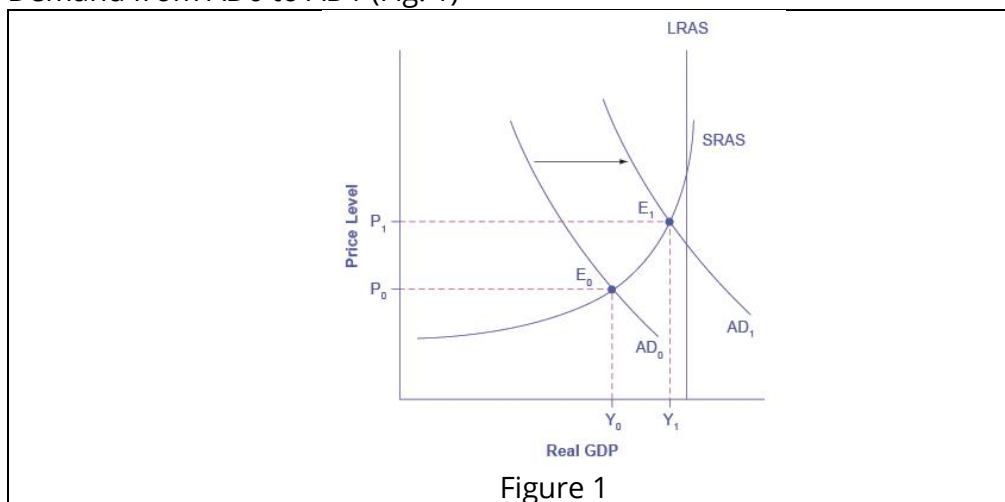
A)	Introducing a progressive tax will lower the GINI coefficient
B)	Introducing a Capital Gains Tax (CGT) on securities and property will lower the GINI coefficient
C)	A CGT on securities may reduce market liquidity. Thus, such taxes should apply to intraday stock traders while exempting long-term holders.
D)	Introducing a Goods and Service Tax (GST) will increase income inequality
E)	A measured tariff on specific imported goods can reduce unemployment in a chosen industry.

True False set

2

Question 13

- iii. Which change in tax policy most likely resulted in the shift in Aggregate Demand from AD₀ to AD₁ (Fig. 1)



A)	A reduction in GST
B)	A reduction in income tax
C)	A reduction in import tariffs
D)	A reduction in corporate taxes

MCQ

2

- iv. In the USA, companies can carry forward losses from previous years. These losses can be used to offset up to 75% of net annual profits, for an unlimited number of later years. The tax rate for companies in the USA is a flat 20% on net profit (losses are not taxed).

The following table shows the EBITDA of MegaCorp p.a.

	EBITDA (1000)	Year
	500	2022
	600	2023
		2024
Total	100	

What is the cumulative corporate tax paid by MegaCorp in the time period 2022 through 2024?

Integer

4

Question 13

Solution

Solution to (i)

Answer: A,B,C,E

Explanation: D and F are not positive statements, which can be observed from the phrases “too much” and “unfair”

Solution to (ii)

Answer: A, B, E

A)	Introducing a progressive tax will lower the GINI coefficient This is true. High income households are taxed a greater proportion of their income in a progressive tax regime.
B)	Introducing a Capital Gains Tax (CGT) on securities and property will lower the GINI coefficient This is true. Investing in capital is usually reserved for high income individuals with substantial disposable income, so a CGT will disproportionately affect them.
C)	A CGT on securities may reduce market liquidity. Thus, such taxes should apply to intraday stock traders while exempting long-term holders. This is false. The inverse is true, as taxing market makers reduces their willingness to make frequent trades. In Singapore, a CGT is levied on long term stock holders, however those who trade for a living have their capital gains taxed as income.
D)	Introducing a Goods and Service Tax (GST) will increase income inequality False. A GST does disproportionately affect low income households, however it does not directly change their income. Rather, it reduces their purchasing power.
E)	A measured tariff on specific imported goods can reduce unemployment in a chosen industry. This is true. Firms in labour-intensive industries in Country X have higher costs of production due to the higher reservation wage of workers, thus they may be

Question 13

	outcompeted by foreign manufacturers. A measured tariff can enable them to be competitive once more.
--	--

Solution to (iii)

Answer: B

Explanation: Lower income tax results in greater disposable income, so the willingness and ability of consumer to purchase goods and services will increase.

Solution to (iv)

Answer: 55

Income tax paid in 2022: **0** due to net losses

Income tax paid in 2023: **25**

Use 375 of the 1000 from 2022 losses as a net profit offset, resulting in a net profit of

$$500 - 375 = 125$$

$$20\% \times 125 = \mathbf{25}$$

Income tax paid in 2024: **30**

$$1000 - 375 = 625 \text{ remaining losses}$$

$$600 \times 0.75 = 450, \text{ the maximum amount of losses we can use as offset}$$

$$600 - 450 = 150$$

$$20\% \times 150 = \mathbf{30}$$

Sum over 3 years: **55**

Question 14

Multiplier effects

Difficulty: Easy

Total Points : 4

Author: Jon Yew

"In economics, the fiscal multiplier is the ratio of change in national income arising from a change in government spending. More generally, the exogenous spending multiplier is the ratio of change in national income arising from any autonomous change in spending." – Wikipedia, 2025

Question

Score

- i. What is the value of the government spending multiplier in this economy? The marginal propensities to save, withdraw, and tax are given in the table below:

MPS	0.1
MPW	0.4
MPT	0.15

Float

2

- ii. The marginal propensity to consume is the amount by which ____

A)	Consumption changes when total income increases by 1%
B)	Consumption changes when total income increases by 1 unit
C)	Consumption changes when disposable income increases by 1%
D)	Consumption changes when disposable income increases by 1 unit

MCQ

2

Question 14

Solution

Solution to (i)

Answer: 2.5

Explanation: Multiplier = $\frac{1}{MPW} = \frac{1}{0.4} = 2.5$

Solution to (ii)

Answer: D

Explanation:

This is a definitional question

Question 15

Cash, Cash, Baby

Difficulty: Easy

Total Points : 12

Author: Jon Yew

Question

Score

- i. Which statement about money is the most accurate?

A)	Deflation reduces the purchasing power of money
B)	Financial assets tend to be more liquid than physical assets
C)	A double coincidence of wants must be satisfied for money to act as a medium of exchange
D)	The supply of money must be perfectly elastic to act as a store of value

MCQ

2

- ii. What 4 letter word is used to describe money with no intrinsic value?

String

2

- iii. Wheel of fortune: discover the economic concept in Fig. 1

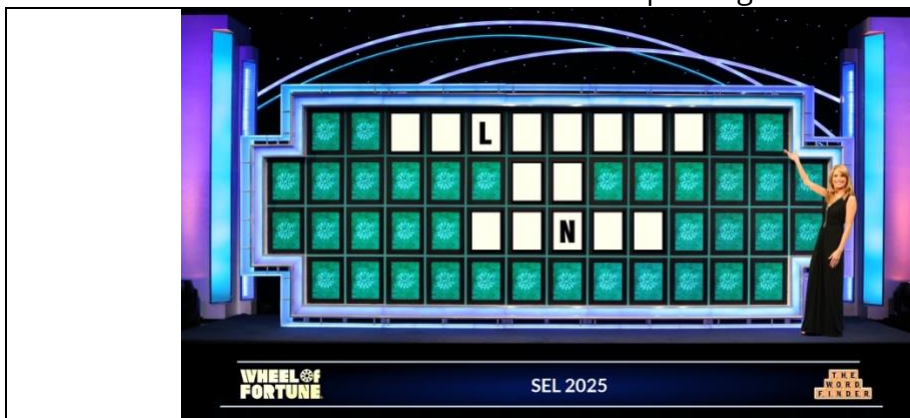


Figure 1

It rises with a positive economic outlook

It rises with a greater money supply

What is **it**?

String

3

Question 15

- iv. How might the Singapore reduce the nominal money supply?

A)	Sell bonds on the public market
B)	Buy bonds on the public market
C)	Collect more taxes
D)	None of the above

MCQ

2

- v. Which of the following will likely result in a 10% increase in nominal demand for money in a closed economy? Select all that apply

A)	An increase in the price level
B)	A decrease in the price level
C)	An increase in income tax
D)	A decrease in income tax
E)	An increase in the interest rate
F)	A decrease in the interest rate

MCQ Multi-select

3

Question 15

Solution

Solution to (i)

Answer: B

Explanation:

Solution to (ii)

Answer: FIAT

Solution to (iii)

Answer: Velocity of money

Solution to (iv)

Answer: B

Explanation: The public will purchase bonds on the public market in exchange for cash, which is removed from circulation and held as reserves.

Solution to (v)

Answer: A, D, and F

An increase in the price level means a greater amount of nominal money is needed to afford the same level of goods and services, so demand for money increases.

A decrease in income tax causes incomes to rise. Higher income individuals tend to demand more goods and services (consider lifestyle creep), so they seek more money to purchase these goods with.

A lower interest rate reduces the opportunity cost associated with holding cash as opposed to bonds, so demand for money will rise.

Question 16

Coin game

Difficulty: Medium

Total Points : 10

Author: Fan Yixiang

A and B are playing a game. A and B will both **choose** to show a side of a coin. Their payoff is shown in the table below, and the game will continue for many rounds.

	B		
		Head	Tail
	Head	-3,3	2,-2
	Tail	2,-2	-1,1

Let the probability for A and B to show the head of the coin be x and y , respectively.

Question

Score

- i. Let the range of values for which A will always win money regardless of B's actions be $m < x < n$. Find the sum of m and n .
Leave your answer accurate to 2 d.p.

Float

(4)

- ii. The payoff is now altered.

	B		
		Head	Tail
	Head	-3,2	2,-2
	Tail	2,-2	-1,1

Question 16



Singapore Economics League **2025**

Under mixed strategy nash equilibrium, it is given that the probability that exactly one head and one tail is shown is $11/24$. Thus, determine the value of the new payoff **Z**, as an integer.

<Integer>

(6)

Question 16

Solution

Solution to (i)

Answer:0.73

Explanation:

Expected payoff for A:

$$\begin{aligned} & -3xy - (1-x)(1-y) + 2x(1-y) + 2(1-x)y \\ & = -3xy - 1 + x + y - xy + 2x - 2xy + 2y - 2xy \\ & = -8xy + 3x + 3y - 1 \end{aligned}$$

For A to win money, expected payoff for A must > 0

$$-8xy + 3x + 3y - 1 > 0$$

$$(3-8y)x + 3y - 1 > 0$$

When y is greater than $\frac{3}{8}$, $(3-8y) < 0$, rearranging the inequality:

$$x < \frac{1-3y}{3-8y}$$

Since $\frac{1-3y}{3-8y}$ is a decreasing function when y is between $\frac{3}{8}$ and 1, sub $y=1$, $x < \frac{2}{5}$

When y is smaller than $\frac{3}{8}$, $(3-8y) > 0$, rearranging the inequality:

$$x > \frac{1-3y}{3-8y}$$

Since $\frac{1-3y}{3-8y}$ is a decreasing function when y is between 0 and $\frac{3}{8}$, sub $y=0$, $x > \frac{1}{3}$

Hence, as long as A maintains his probability of showing head to be between $\frac{1}{3}$ and $\frac{2}{5}$, A will win money in the long run with enough rounds of games no matter what B does as the expected payoff for A will always be positive

$$\frac{1}{3} + \frac{2}{5} = 0.33 + 0.4 = 0.73$$

Solution to (ii)

Answer:4 Explanation:

$$P(\text{A shows head}) \cdot P(\text{B shows tail}) + P(\text{A shows tail}) \cdot P(\text{B shows head}) = \frac{11}{24} x(1-y) + y(1-x) = \frac{11}{24} - (1)$$

In a mixed strategy nash equilibrium, each player must be **indifferent** to the strategies (their expected payoff for each strategy is equal given other player's strategy)

Question 16

Expected payoff for A when A shows head: $-3y+2(1-y)=-5y+2$

Expected payoff for A when A shows tail: $2y-1(1-y)=3y-1$ To

ensure indifference of A:

$$3y-1=-5y+2 \quad - (2)$$

Expected payoff for B when B shows head: $zx-2(1-x)=(z+2)x-2$

Expected payoff for B when B shows tail: $-2x+1(1-x)=-3x+1$ To

ensure indifference of B:

$$(z+2)x-2=-3x+1 \quad - (3)$$

Solving (2), $y=\frac{3}{8}$ Sub $y=\frac{3}{8}$ into (1), $x=\frac{1}{3}$

The mixed strategy Nash equilibrium is where A shows head $\frac{1}{3}$ of the time and B shows head $\frac{3}{8}$ of the time.

Sub $x=\frac{1}{3}$ into (3), $z=4$

Question 17

Willy Wonka and the Chocolate Factory

Difficulty: Medium

Total Points : 9

Author: Yuxuan Zhao



Willy Wonka plans to open a chocolate factory in Singapore, catering to 3 distinct customer groups:

1. Children who love chocolate but have limited pocket money, willing to pay \$1 per chocolate bar
2. Teenagers who have more pocket money, willing to pay \$4 per chocolate bar
3. Adults who have the greatest purchasing power but have less of a sweet tooth, willing to pay \$2 per chocolate bar

He estimates that the market demand curve can be represented by the following equation: $P = 5 - 0.025Q$. Each chocolate bar costs \$0.50 to produce.

Question

Score

- i. Willy Wonka holds a monopoly over the sales of chocolate in Singapore. He can choose to adopt 2 different pricing strategies—uniform pricing or first-degree price discrimination. What is the increase in profits that he can gain by adopting the latter? Assume he is able to prevent resale across customer groups. Give your answer to the nearest cent.

Float

5

- ii. Setting up a chocolate factory in Singapore requires a \$1000 initial investment. Calculate the Net Present Value of this investment, given that the cash flow in Year 1 is equal to the profits under uniform pricing calculated in (a), and increases by 10% every year over a period of 10 years. Assume a discount rate of 8%. Round your answer to the nearest integer.

Integer

4

Question 17

Solution

Solution to (i)

$$\text{Total Revenue} = Q(5 - 0.025Q) = 5Q - 0.025Q^2$$

$$\text{Marginal Revenue} = 5 - 0.05Q$$

When uniform pricing is adopted,

Willy Wonka produces up to the point where $MR = MC$, i.e. $5 - 0.05Q = 0.50$

$$\text{Solving, } Q = 90, P = \$2.75$$

$$\text{Profits} = (P - MC) \times Q = (2.75 - 0.5)(90) = \$202.50$$

When first-degree price discrimination is practised, Willy Wonka charges consumers the maximum price that they are willing to pay.

For children, $P = \$1 \rightarrow Q = 160$ For teenagers, $P = \$4 \rightarrow Q = 40$

For adults, $P = \$2 \rightarrow Q = 120$

$$\text{Profits} = 0.5(160) + 3.5(40) + 1.5(120) = \$400$$

$$\text{Increase in profits} = 400 - 202.50 = \underline{\underline{\$197.50}}$$

Solution to (ii)

Answer: 1039

$$NPV = -1000 + \sum_{n=0}^9 \frac{202.50 \times (1.1)^n}{(1 + 0.08)^{n+1}} = 1039$$

Question 18

PPCrazy! 2

Difficulty: Medium

Total Points : 4

Author: Jon Yew

Figure 1 shows the PPC of Farm A for one harvest. Farm A has a resource constraint of 100 units of labour, which must be split between the production of either Apples or Pears.

Assume Apples and Pears are infinitely divisible. The sole factor of production in Farm A is labour.

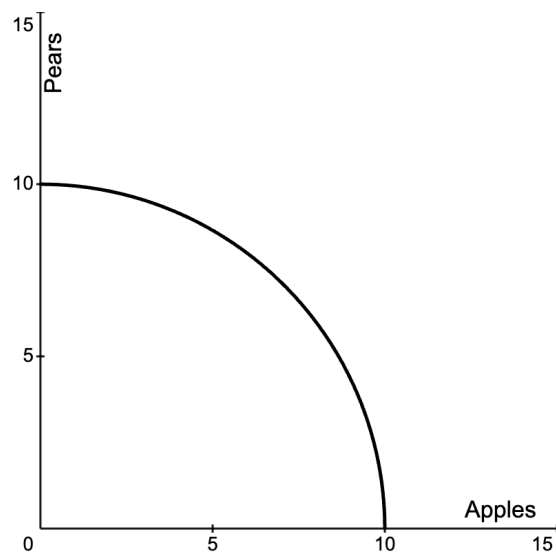


Figure 1

Question

Score

- i. Now, It is also given that the graph of Farm A's PPC (as seen in Fig 1) is exactly the arc of a circle centred at (0,0), when plotted on a graph with equal x and y spacing.

After each harvest, apples and pears are sold at the farmers market at the following rates:

6\$/apple

7\$/pear

(4)

Question 18

The cost of labour is 0.5\$ per unit, and Farm A does not incur any other costs. Given the above information, what is the maximum profit Farm A can make in a single harvest? Give your answer to the nearest integer.

Integer

(4)

Question 18

Solution

Solution to (i)

Answer:

42

Explanation:

Part 1: Setting up

First, let the quantity produced of pears and apples be Q_p and Q_A respectively. The question tells us that the PPF is the arc of a circle, and we know that circles have formulas of the form: $x^2 + y^2 = r^2$. Additionally, the PPF in Fig. 1 has Q_A on the x axis, Q_p on the y axis, and a radius of 10. We can thus form the equation $Q_A^2 + Q_p^2 = 100$ (*).

Based on the market prices for pears and apples, we can form the equation for total revenue as $TR = 6Q_A + 7Q_p$ (**).

For cost, we can assume that profit is maximised by using all factors of production, so all 100 units of labour will be used, and therefore total cost is $0.5\$ \times 100 = \$50$.

Part 2: Solving for maximum profit

Rearranging (*), we get: $Q_A = \sqrt{100 - Q_p^2}$.

Substituting this into (**) gives $TR = 6\sqrt{100 - Q_p^2} + 7Q_p$.

Finally, profit $P = TR - TC = 6\sqrt{100 - Q_p^2} + 7Q_p - 50$.

Plotting this equation in Desmos gives us a profit of 42.195 at the maximum point:

Question 19

Flood protection

Difficulty: Medium

Total Points : 16

Author: Fan Yixiang

Flood protection is considered as a public good due to its non-excludable and non-rivalrous nature. It reduces the loss to a country in the event of an actual flood.

The government of Indonesia is deciding on how much to spend on flood protection. The probability of a flood happening during time period t_0 is $P(n)$. If this flood occurs, Indonesia incurs a loss of 1000. However, spending N on flood protection will reduce these losses by $70\ln\left(\frac{N}{20} + 1\right)$.

Assume that:

1. Flood will occur either once or never, during t_0 .
2. The implemented flood protection will depreciate and become ineffective after t_0 .

(For Question parts ii., iii., & iv., round your answer **down** to the nearest whole number)

<u>Question</u>	<u>Score</u>
i. What is the minimum value of $P(n)$ required to justify Indonesia spending 100 units on flood protection? Give your answer to 2 d.p. <i>Float</i>	6
ii. When $P(n) = 0.60$, determine the optimal value of N . <i>Integer</i>	4
iii. When $P(n) = 0.20$, determine the optimal value of N . <i>Integer</i>	3
iv. Flood protection also offers positive externalities such as increased property values and preservation of ecosystems even if flood does not occur during t_0 . The positive externality due to flood protection is $\frac{20N}{30+N}$. When $P(n) = 0.20$, determine the new optimal value of N when accounting for positive externalities. <i>Integer</i>	3

Question 19

Solution

Solution to (i)

Answer: 0.80

Explanation:

Loss to Indonesia	Flood occurs $P(n)$	Flood does not occur $1 - P(n)$
Flood protection provided	$1000 + N - Y$	N
Flood protection not provided	1000	0

Loss to Indonesia when flood protection is not provided: $1000 \cdot P(n)$

Loss to Indonesia when flood protection is provided: $(1000 + N - Y) \cdot P(n) + N \cdot (1 - P(n))$

Sub $N=100$, for at least 100 units of flood protection to be provided, the loss to X when flood protection is not provided must be greater than when 100 units of flood protection is provided.

$$1000 \cdot P(n) > (1000 + 100 - Y) \cdot P(n) + 100 \cdot (1 - P(n)), \text{ where } Y = 70(\ln(100/20 + 1)) = 125$$

$$1000 \cdot P(n) > 975 \cdot P(n) + (1 - P(n)) \cdot 100$$

$$1000 \cdot P(n) > 875 \cdot P(n) + 100$$

Solving the inequality:

$$P(n) > 100/125$$

$$P(n) > 0.8$$

Solution to (ii)

Answer: 22

Explanation:

Sub $P(n)=0.60$,

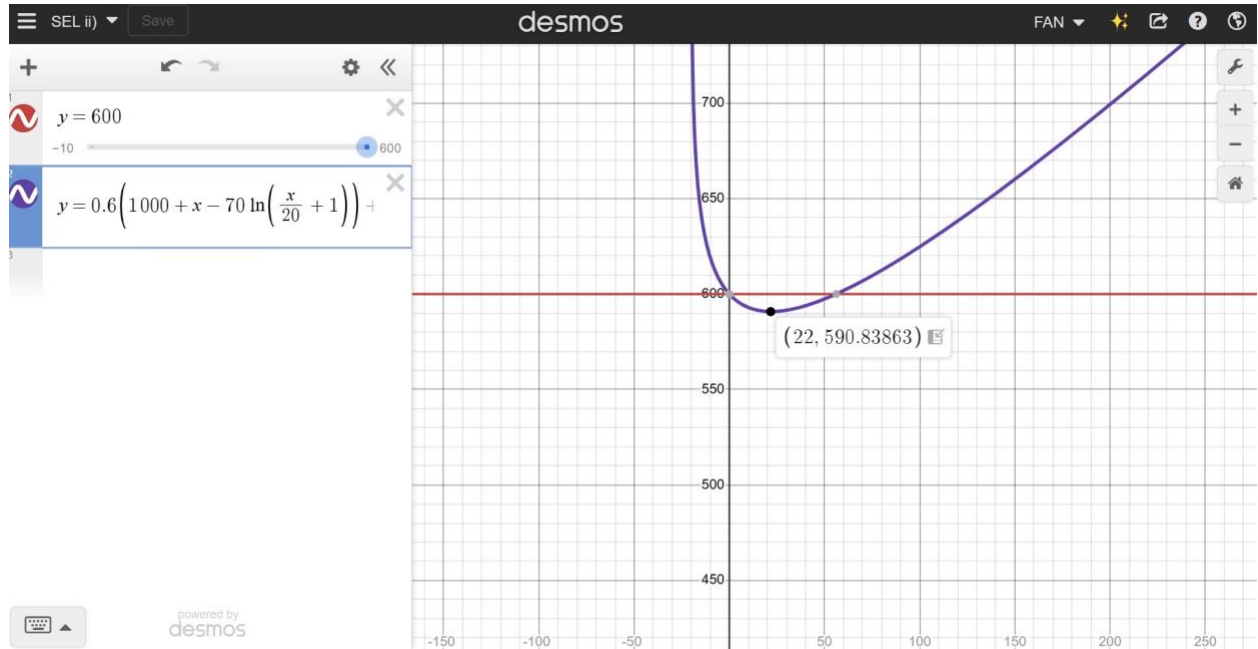
Indonesia's loss if flood protection is not provided: 600

Question 19

Indonesia's loss if flood protection is provided:

$$0.6(1000 + N - 70 \ln(\frac{N}{20} + 1)) + 0.4N$$

Using desmos:



The optimal value of N is 22.

Solution to (iii)

Answer: 0

Explanation:

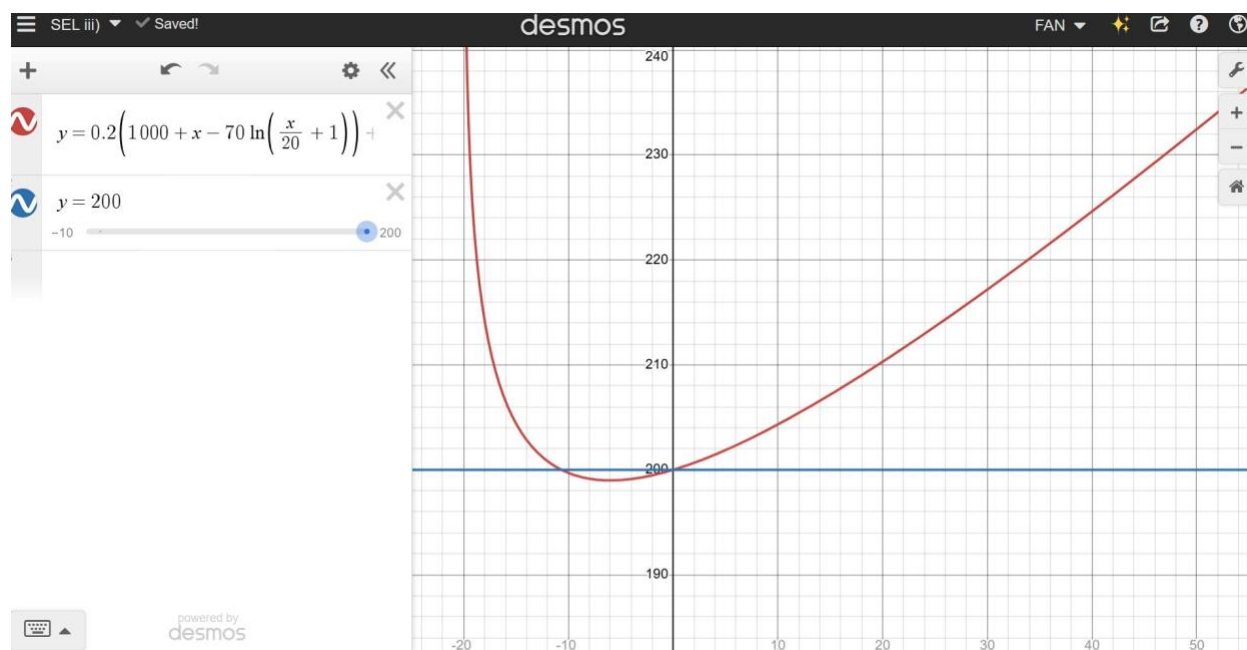
Indonesia's loss if flood protection is not provided: 200

Indonesia's loss if flood protection is provided:

$$0.2(1000 + N - 70 \ln(\frac{N}{20} + 1)) + 0.8N$$

Using desmos:

Question 19



From the graph, the loss to country X as long as flood protection is provided is always greater than 200.

The optimal value of N is 0.

Solution to (iv)

Answer: 6

Explanation:

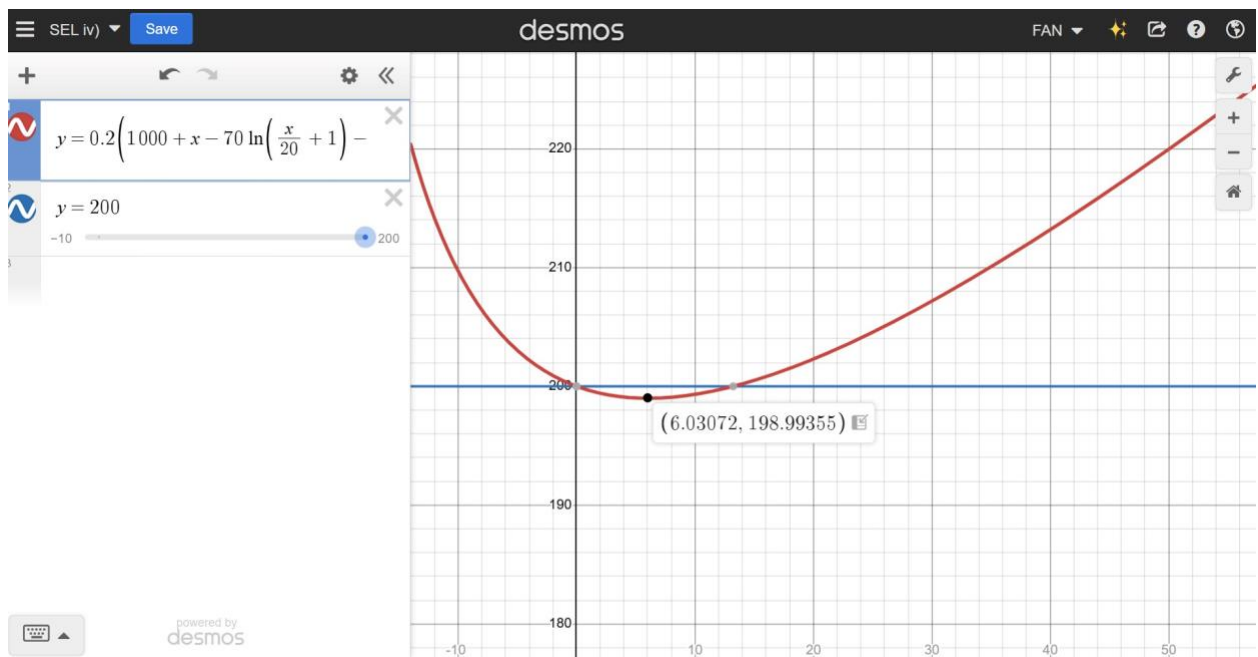
Sub $P(n)=0.20$

Country X's loss if flood protection is not provided: 200
Country X's loss if flood protection is provided:

$$0.2\left(1000 + N - 70 \ln\left(\frac{N}{20} + 1\right) - \frac{20N}{30 + N}\right) + (0.8)\left(N - \frac{20N}{30 + N}\right)$$

Using desmos

Question 19



The new optimal value of N is 6.

Question 20

Spongebob's new job

Difficulty: Medium

Total Points : 10

Author: Jonas

Spongebob Squarepants has recently been promoted to the head chef at the Krusty Krab. To sustain the Krusty Krab, Spongebob must ensure the restaurant is profitable. And since Mr Krabs (the owner) is extremely greedy, it is in Spongebob's interest to maximise the restaurant's profits in order to remain employed.

After a consultation with Squidward (the financial advisor), Spongebob finds that:

- The cost function of the Krusty Krab is given by $TC(Q) = 10Q + 0.5Q^2$
- The price function of the Krusty Krab is given by $P(Q) = 70 - 0.25Q$

Question

Score

- i. Determine, on Spongebob's behalf, the number of Krabby Patties the Krusty Krab should produce to maximise profits.

Integer

4

- ii. Recently however, Plankton, the owner of the restaurant Chum Bucket, successfully entered the market for Krabby Patties. Bikini Bottom (where Spongebob Squarepants lives) now has 2 restaurants that sell Krabby Patties: the Krusty Krab and the Chum Bucket.

Given this situation, Spongebob must prepare to increase the Krusty Krab's production of Krabby Patties to continue to maximise profits. Spongebob knows that the Chum Bucket spends \$50 to produce one Krabby Patty. It is also known that the market's new demand function is given by $Q = 500 - P$.

Determine, on Spongebob's behalf, how many more Krabby Patties the Krusty Krab will need to produce in the long run. Assume that both restaurants are competing in a Cournot-Nash equilibrium, where each firm independently chooses its output to maximize profit while considering the other firm's output.

Integer

6

Question 20

Solution

Solution to (i)

Answer: 40

Explanation:

Differentiating $TC(Q) = 10Q + 0.5Q^2$, we obtain $MC(Q) = 10 + Q$

Revenue = PQ , thus $TR(Q) = 70Q - 0.25Q^2$

Differentiating, we obtain $MR(Q) = 70 - 0.5Q$

At profit maximizing output $MC = MR$, $10 + Q = 70 - 0.5Q$

Thus, $Q = 40$

Solution to (ii)

Answer: 66

Explanation:

By manipulating the market demand function, we obtain $P = 500 - Q_1 - Q_2$, since Q comprises of Q_1 (Krusty Krab's output) and Q_2 (Chum Bucket's output)

$\pi(Q_1) = TR - TC = Q_1(500 - Q_1 - Q_2) - (10Q_1 + 0.5Q_1^2) = 490Q_1 - 1.5Q_1^2 - Q_1Q_2$

Differentiating wrt Q_1 , we find that $\pi'(Q_1) = 490 - 3Q_1 - Q_2$

When profit is maximized, i.e. $\pi'(Q_1) = 0$, $Q_2 = 490 - 3Q_1$

$\pi(Q_2) = TR - MC * Q_2 = Q_2(500 - Q_1 - Q_2) - 50Q_2 = 450Q_2 - Q_2^2 - Q_1Q_2$

Differentiating wrt Q_2 , we find that $\pi'(Q_2) = 450 - Q_1 - 2Q_2$

When profit is maximized, i.e. $\pi'(Q_2) = 0$, $Q_2 = 225 - 0.5Q_1$

Substituting $Q_2 = 490 - 3Q_1$ into $Q_2 = 225 - 0.5Q_1$, $Q_1 = 106$

Additional Krabby Patties produced = $Q_1 - Q = 106 - 40 = 66$

Question 21

Duopoly Games

Difficulty: Medium

Total Points : 13

Author: Yuxuan Zhao

Pingo and Ringo are both manufacturers of soft drinks in the small town of Fizzville.

Question

Score

- i. It is given that Pingo is more efficient, incurring Marginal Cost of 5, while Ringo incurs a Marginal Cost of 10. Assume that the relationship between price of soft drinks (P) and quantity of soft drinks demanded (Q) is $P = 25 - Q$. Assume products are homogenous.

Pingo and Ringo compete by simultaneously choosing how much soft drinks to supply. What will Pingo and Ringo's respective profits be if they behave strategically?

A)	Pingo's profit =
B)	Ringo's profit =

Integer set

5

- ii. Now, Pingo and Ringo undergo innovation and product differentiation, such that they both incur a new Marginal Cost of 8. The new demand equations are $Q_p = 44 - 2P_p + P_r$ and $Q_r = 44 - 2P_r + P_p$. Calculate Pingo and Ringo's respective profits when they undergo price competition.

A)	Pingo's profit =
B)	Ringo's profit =

Integer set

4

- iii. Pingo and Ringo decide to collude to maximise joint profits. Calculate the new joint profits Pingo and Ringo receive.

Integer

4

Question 21

Solution

Solution to (i)

Answer:

A) 69, B) 11

Explanation:

Assume Pingo sells Q_P and Ringo sells Q_R units of soft drinks.

$$\text{Pingo's profits} = (P - MC)(Q) = (25 - Q_P - Q_R - 5)(Q_P)$$

$$\text{FOC: } 20 - 2Q_P - Q_R = 0 \rightarrow 2Q_P + Q_R = 20$$

$$\text{Ringo's profits} = (P - MC)(Q) - FC = (25 - Q_P - Q_R - 10)(Q_R)$$

$$\text{FOC: } 15 - 2Q_R - Q_P = 0 \rightarrow 2Q_R + Q_P = 15$$

$$\text{Solving, } Q_R + Q_P = 35/3 \rightarrow Q_P = 25/3, Q_R = 10/3$$

$$\text{Pingo's profits} = (20 - 35/3)(25/3) = 69$$

$$\text{Ringo's profits} = (15 - 35/3)(10/3) = 11$$

Solution to (ii)

Answer:

A) 288, B) 288

Explanation:

$$\text{Pingo's profits} = (P - MC)(Q) = (P_P - 8)(44 - 2P_P + P_R)$$

$$\text{FOC: } (44 - 2P_P + P_R) - 2(P_P - 8) = 0 \rightarrow P_P = (60 + P_R)/4$$

$$\text{Similarly, } P_R = (60 + P_P)/4$$

Solving at Nash Equilibrium,

$$(60 + P_R)/4 = (60 + P_P)/4 \rightarrow P_P = P_R = 20$$

$$\text{Pingo's profits} = \text{Ringo's profits} = (20 - 8)(44 - 40 + 20) = 288$$

Solution to (iii)

Answer: 648

Explanation:

$$\text{Joint profits} = (P_P - 8)(44 - 2P_P + P_R) + (P_R - 8)(44 - 2P_R + P_P)$$

$$\text{FOC}_P: (44 - 2P_P + P_R) - 2(P_P - 8) + (P_R - 8) = 0 \rightarrow 52 - 4P_P + 2P_R = 0$$

$$\text{Similarly, } 52 - 4P_R + 2P_P = 0$$

$$\text{Solving, } P_P = P_R = 26$$

$$\text{Joint profits} = (26 - 8)(44 - 52 + 26) * 2 = 648$$

Question 22

Hanging on to Losses: A Prospect Theory Dilemma

Difficulty: Medium

Total Points: 11

Author: Theodore Chou *theodorechousm128@gmail.com*

Suppose that Mr K buys 1000 shares in a software company at \$25/share. The company is currently attracting considerable media attention for its new accounting software, a highly touted product that is expected to become the industry standard, with considerable improvements in both efficiency and ease of use.

Mr K is an accountant who also has considerable expertise in evaluating accounting software options. He read all of the software company's advance information on the new package and carried out his own extensive research prior to buying the shares. Within 2 weeks of his purchase, the shares are up to \$30 and Mr K is tempted to sell them. He decides to hold on, however, as the industry excitement about the new software is increasing as the release date approaches. The shares continue to appreciate until there begin to be whispers about a serious bug in the software. In the weeks coming up to the release date, the company's share price becomes increasingly volatile, as rumours and counter-rumours abound. The company's share price falls below \$40 and then below \$25. Occasionally, some positive stories on social media cause brief bounces in the price, but Mr K is becoming increasingly pessimistic about the product. The shares are currently trading at \$20.

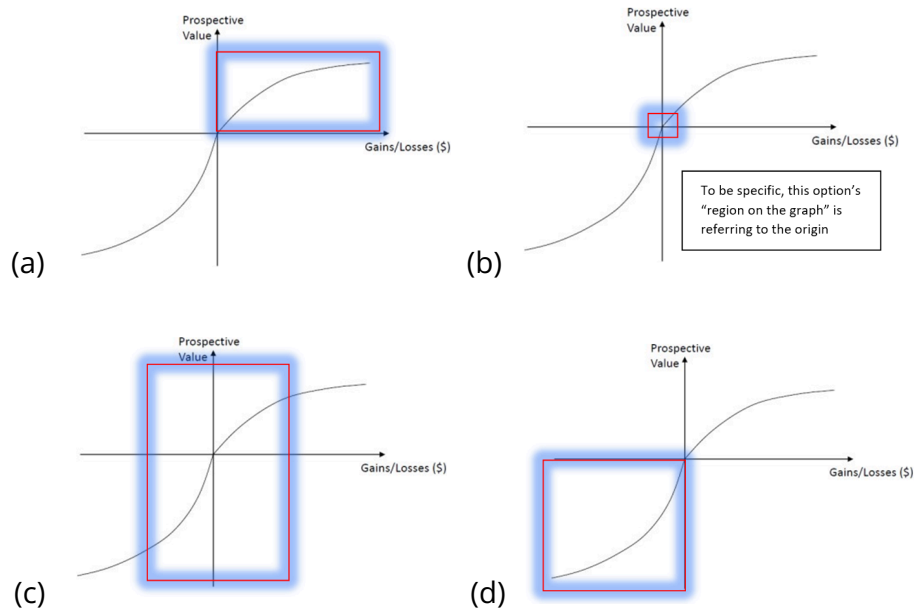
Although Mr K now believes that the product will fail, he decides to hold onto the shares in the hope that a new rumour will bounce the price back up to \$25 so that he can sell.

Question

Score

- i. Which region of the Prospect Theory graph is Mr K currently at?

Question 22



MCQ

(3)

- ii. Which Prospect Theory feature best explains Mr K's behaviour during the time that he owned these shares?
- (a) Risk aversion over gains
 - (b) Loss aversion
 - (c) Risk seeking over losses
 - (d) Changing reference points

MCQ

(2)

- iii. Select whether it is True or False based on Prospect Theory and/or Behavioural Finance.
- A. Mr K's refusal to sell at \$20 despite believing the product will fail is consistent with the disposition effect.
 - B. If the shares had briefly hit \$26, Mr K would almost certainly have sold – this reflects framing by the reference point.
 - C. Mr K's extensive research before investing completely rules out any bias in his current decision-making.
 - D. Prospect Theory assumes that losses loom larger than equivalent gains.

Question 22

True/False Set

(2)

- iv. Select 2 features of Prospect Theory that best explain Mr K's refusal to sell the stock when it dropped below his purchase price.
- A. Sunk cost fallacy
 - B. Mental accounting
 - C. Risk-seeking in the loss domain
 - D. Regret minimisation
 - E. Hyperbolic discounting

MCQ Multi-select

(2)

Question 22

Solution

Solution to (i)

Answer: D

Explanation:

While the question did not mention what the reference point should be, participants should be expected to identify that the reference point should be taken as that of the price Mr K bought the shares at originally (\$25/share). Thus, the origin of the graph denotes that very price.

By logic, numbers to the left of the origin must be less than 25. Since the share price is currently \$20/share, Mr K is currently at the region to the left of the origin/reference point. Hence (d) is the answer.

Participants should not try to argue that option (c) should also be valid. While (c) does have a portion of the “losses” region of the graph that is included in the answer, it also includes a part of the “gains” region. It is only partially correct. The Academics Team could also argue against those presenting the aforementioned argument that the loss of \$5 may happen to fall outside the range of the “losses” indicated by the blue box for option (c). Hence, the best answer is (d).

Solution to (ii)

Answer: B

Explanation:

Risk aversion over gains is the tendency to sell a position that has made money, rather than hold onto it for potential future gains. Mr K does not sell his shares when they are doing well. Hence, (a) is not the answer.

Risk seeking over losses is the tendency to hold onto losing positions, in the hope that the price will go back up to the original purchase price. That is what Mr K is doing here. Hence, (b) is the answer.

Loss aversion is how the pain of a loss is twice that of a similar sized gain. Mr K is not considering losses here. Not applicable. (c) is not the answer.

Changing reference points was not mentioned as something that Mr K did.

Question 22

Hence, that is not applicable. (d) is not the answer.

Solution to (iii)

Answer:

True

True

False

True

Explanation:

Statement	Answer	Explanation
Mr K's refusal to sell at \$20 despite believing the product will fail is consistent with the disposition effect.	True	The disposition effect is the tendency to hold on to losing investments too long and sell winning ones too early. Mr K clings to the losing stock hoping it recovers.
If the shares had briefly hit \$26, Mr K would almost certainly have sold – this reflects framing by the reference point.	True	The \$25 purchase price becomes Mr K's reference point, and selling above it feels like a gain. Behaviour is framed around this point, not absolute value.
Mr K's extensive research before investing completely rules out any bias in his current decision-making.	False	Research reduces initial error, but cognitive biases like loss aversion and regret aversion can still distort decisions even with good information.
Prospect Theory assumes that losses loom larger than equivalent gains.	True	This is central to Prospect Theory: losses are psychologically more painful than equal-sized gains are pleasurable.

Question 22

Solution to (iv)

Answer:

Risk-seeking in the loss domain

AND

Regret minimisation

Explanation:

Option	Correct?	Explanation
Sunk cost fallacy	✗	This refers to justifying future investment based on past costs. Mr K isn't pouring more money in. He's holding due to expected recovery, not because of sunk costs.
Mental accounting	✗	Mental accounting is about treating money differently depending on its source or category. It doesn't directly explain Mr K's refusal to sell at a loss.
Risk-seeking in the loss domain	✓	This is directly from Prospect Theory: when facing a loss, people take bigger risks in hopes of recovery. Mr K holds hoping for a bounce back to break even.
Regret minimisation	✓	Mr K likely fears the regret of selling at a loss and seeing the price bounce back later. This emotional bias explains part of his reluctance to sell.
Hyperbolic discounting	✗	This concerns time preference and impulsive behaviour. Not applicable

Question 22

		here. Mr K's problem is loss-related, not impatience-related.
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Question 23

Understanding the Coase Theorem

Difficulty: Medium

Total Points: 4

Author: Yixiang *fanyixiang2006@gmail.com*

The Coase Theorem states that, under certain conditions, bargaining between parties can lead to a socially optimal and efficient outcome in the presence of disputes over property rights and externalities.

Question

Score

- i. What are the conditions of coase theorem?
- (a) Externalities are negative
 - (b) Low or zero transaction cost
 - (c) Well-defined property rights
 - (d) Property rights must be assigned to the party affected by the externality
 - (e) The outcome is beneficial for the bargaining parties

MCQ multi-select

(2)

- ii. Consider this scenario:
There is a river with a factory located upstream and fishermen situated downstream. The factory's waste disposal pollutes the river, causing damage to the fishermen's operations and reducing their profits. For each unit of production, the factory earns a **revenue of 400** but generates waste that results in **250 in damages** to the downstream fishermen.

Units of production	Revenue of factory	Private cost of production	Damage to fishermen
1	400	100	250
2	800	200	500

Question 23

3	1200	550	750
4	1600	1000	1000
5	2000	1600	1250

Assuming at most 5 units can be produced everyday, no fixed cost and property right of the river is under the factory, what is/are the **possible** outcomes under coase theorem? Everyday,

- (a) Fishermen pay 650 to factory and factory agrees to stop all production
- (b) Fishermen pay 500 to factory to stop production, and deducts 100 for every unit produced
- (c) Fishermen pay 2000 to factory to stop production, and deducts 100 for every unit produced
- (d) Fishermen does not pay any amount to factory to reduce their production

MCQ multi-select

(2)

Question 23

Solution

Solution to (i)

Answer: b,c

Explanation:

- (a) Coase theorem does not always mean negative externality. Coase theorem can be applied when inefficiencies arise and it can be due to positive externality
- (b) Low or (preferably) zero transaction cost is required to ensure the outcome is socially efficient
- (c) Well-defined property rights ensure clear and effective negotiation
- (d) Property rights can belong to any party initially. The outcome will remain the same through negotiation under Coase theorem
- (e) Coase theorem ensures a socially efficient outcome, and does not guarantee that the outcome is optimal or efficient **for a single party**. One party may be worse off due to Coase theorem - in making the society better off

Solution to (ii)

Answer: b,c

Explanation:

Calculate the socially efficient outcome

Units of production	Revenue of factory	Private cost of production	Damage to fishermen	Net social benefit (revenue of factory - total cost of factory)
1	400	100	250	50
2	800	200	500	100
3	1200	550	750	-100

Question 23

4	1600	1000	1000	-400
5	2000	1600	1250	-850

2 units of production per day is the socially efficient outcome as it produces the highest net social benefit. As such, **negotiations between the factory and farmers should lead to this outcome. Both option B and C lead to 2 units of production per day.**

Option B

Units of production	Revenue of factory	Private cost of production	Pay from fishermen	Profit of factory
0	0	0	600	600
1	400	100	500	800
2	800	200	400	1000
3	1200	550	300	950
4	1600	1000	200	800
5	2000	1600	100	500

Option C

Units of production	Revenue of factory	Private cost of production	Pay from fishermen	Profit of factory
0	0	0	2000	2000
1	400	100	1900	2200
2	800	200	1800	2400
3	1200	550	1700	2350
4	1600	1000	1600	2200
5	2000	1600	1500	1900

Under option C, the fishermen are very worse off and are paying unnecessarily high to the factory. However, it is still a socially efficient outcome. Hence it is possible under

Question 23

coase theorem as **negotiations between parties do lead to a socially efficient outcome**, even though it is not efficient for one certain party(fishermen).

Question 24

The Coconut Cart Pricing Competition

Difficulty: Medium

Total Points: 10

Author: Theodore Chou *theodorechousm128@gmail.com*

Two carts selling coconut milk (from the coconut) are located at points 0 and 1, 1 mile apart on the beach in Rio de Janeiro. (They are the only two coconut-milk carts on the beach.) The carts – Cart 0 and Cart 1 – charge prices p_0 and p_1 , respectively, for each coconut.



One thousand beachgoers buy coconut milk, and these customers are uniformly distributed along the beach between carts 0 and 1. Each beachgoer will purchase one coconut milk in the course of her day at the beach, and in addition to the price, each will incur a transport cost of $0.5 \times D^2$, where D is the distance (in miles) from her beach blanket to the coconut milk cart. In this system, Cart 0 sells to all the beachgoers located between 0 and x , and Cart 1 sells to all the beachgoers located between x and 1, where x is the location of the beach goer who pays the same total price whether she goes to Cart 0 or Cart 1.

Location x is then defined by the expression.

$$p_0 + 0.5x^2 = p_1 + 0.5(1 - x)^2$$

Each cart will set its prices to maximise its profit, Π , which is determined by revenue (the cart's price times its number of customers) and cost (each cart incurs a cost of \$0.25 per coconut times the number of coconuts sold).

Question 24

Question

Score

- i. Recall that Cart 0 gets the customers between 0 and x , or just x , while Cart 1 gets the customers between x and 1, or $1 - x$. That is, Cart 0 sells to x customers, where x is measured in thousands, and Cart 1 sells to $(1 - x)$

The number of customers served by Cart 0 is $ap_0 + bp_1 + c$

The number of customers served by Cart 1 is $dp_0 + ep_1 + f$

$$a, b, c, d, e, f \in \mathbb{R}$$

Give the values of real numbers a, b, c, d, e , and f in their simplest decimal form.

Correct formatting of numbers	Incorrect formatting
1.5, -0.3, 3.11	+1.5, -3/10, 3.110

A)	a
B)	b
C)	c
D)	d
E)	e
F)	f

String set

(3)

- ii. Each cart has a best response rule as a function of its rival's price.

Best response rule for Cart 0: $p_0 = \alpha p_1 + \beta$

Best response rule for Cart 1: $p_1 = \gamma p_0 + \lambda$

Give the values of real numbers α , β , γ , and λ in their simplest decimal form.

A)	α
B)	β
C)	γ
D)	λ

String set

(5)

- iii. The Nash equilibrium price for the coconut milk on the beach can be represented as $(a/b, c/d)$ where a, b, c, d are real integers and a/b and c/d represent the prices that Cart 0 and Cart 1 set respectively.

Give the value of $\frac{a}{b} \times \frac{c}{d}$

Float

(2)

Question 24

Solution

Solution to (i)

Answer:

A)	a	-1
B)	b	1
C)	c	0.5
D)	d	1
E)	e	-1
F)	f	0.5

Number of customers served by Cart 0 = $-p_0 + p_1 + 0.5$

Number of customers served by Cart 1 = $p_0 - p_1 + 0.5$

Explanation:

$$p_0 + 0.5x^2 = p_1 + 0.5(1 - x)^2$$

$$p_0 + 0.5x^2 = p_1 + 0.5(1 - 2x + x^2)$$

$$p_0 + 0.5x^2 = p_1 + 0.5 - x + 0.5x^2$$

$$x = p_1 - p_0 + 0.5$$

Number of customers served by Cart 0 = $-p_0 + p_1 + 0.5$

$$1 - x = 1 - (p_1 - p_0 + 0.5)$$

$$1 - x = 0.5 - p_1 + p_0$$

$$1 - x = p_0 - p_1 + 0.5$$

Number of customers served by Cart 1 = $p_0 - p_1 + 0.5$

The number of customers served by Cart 0 is $ap_0 + bp_1 + c$

The number of customers served by Cart 1 is $dp_0 + ep_1 + f$

A)	a	-1
B)	b	1
C)	c	0.5
D)	d	1
E)	e	-1
F)	f	0.5

Question 24

Solution to (ii)

Answer:

A)	α	0.5
B)	β	0.375
C)	γ	0.5
D)	λ	0.375

$$p_0 = 0.5p_1 + 0.375$$

$$p_1 = 0.5p_0 + 0.375$$

Explanation:

The best response rules can only be determined from the payoffs for each of the Carts. Hence, we find the profit functions first.

Profit function of Cart 0, π_0 = Total Revenue – Total Costs

$$\begin{aligned} &= \text{Price} \times \text{Quantity} - \text{Marginal Costs} \times \text{Quantity} \\ &= p_0 (-p_0 + p_1 + 0.5) - 0.25 (-p_0 + p_1 + 0.5) \\ &= -p_0^2 + p_0 p_1 + 0.5 p_0 - 0.25 p_0 + 0.25 p_1 - 0.125 \\ &= -p_0^2 + (0.75 + p_1) p_0 - 0.25 p_1 - 0.125 \end{aligned}$$

Profit function of Cart 1, π_1 = Total Revenue – Total Costs

$$\begin{aligned} &= \text{Price} \times \text{Quantity} - \text{Marginal Costs} \times \text{Quantity} \\ &= p_1 (p_0 - p_1 + 0.5) - 0.25 (p_0 - p_1 + 0.5) \\ &= -p_1^2 + (0.75 + p_0) p_1 - 0.25 p_0 - 0.125 \end{aligned}$$

The best response rule can be found by finding the First Order Condition (FOC) for each player's payoffs.

⇒ This entails differentiating the payoffs of Cart 0 and Cart 1 with respect to p_0 and p_1 respectively, before equating the two to 0 respectively.

Best response rule for Cart 0:

$$-2p_0 + (0.75 + p_1) = 0$$

$$p_0 = \frac{0.75}{2} + \frac{1}{2} p_1$$

$$p_0 = \frac{1}{2} p_1 + \frac{3}{8}$$

$$p_0 = 0.5p_1 + 0.375 \text{ ----- BR1}$$

Since the payoffs for each player is symmetrical,
Therefore, the best response rule for Cart 1 is:

Question 24

$$p_1 = \frac{1}{2}p_0 + \frac{3}{8}$$

$$p_1 = 0.5p_0 + 0.375 \text{ ----- BR2}$$

Solution to (iii)

Answer: 0.5625

NE: $(\frac{3}{4}, \frac{3}{4})$

Explanation:

To find the Nash equilibrium, we find the intersection of the best response curves by equating **BR0** to **BR1**.

This is due to how the intersection point will allow us to determine the values of p_0 and p_1 that are mutual best responses for each player, thus ensuring that there will be no gains from deviating from that price, allowing for us to determine the Nash equilibrium.

Sub **BR0** into **BR1**:

$$p_1 = \frac{1}{2}\left(\frac{1}{2}p_1 + \frac{3}{8}\right) + \frac{3}{8}$$

$$p_1 = \frac{1}{4}p_1 + \frac{3}{16} + \frac{3}{8}$$

$$\frac{3}{4}p_1 = \frac{9}{16}$$

$$p_1 = \frac{3}{4}$$

Sub $p_1 = \frac{3}{4}$ into **BR0**:

$$p_0 = \frac{1}{2}\left(\frac{3}{4}\right) + \frac{3}{8}$$

$$= \frac{3}{8} + \frac{3}{8}$$

$$= \frac{3}{4}$$

Therefore, the Nash equilibrium is $(\frac{3}{4}, \frac{3}{4})$.

$$\frac{a}{b} \times \frac{c}{d} = \frac{3^2}{4} = 0.5625$$

Question 25

Lemons, Luck, and Leverage

Difficulty: Moderate

Total Points: 9

Author: Theodore Chou *theodorechousm128@gmail.com*

You're in the market for a used car and spot a listing for your preferred model. The owner invites offers rather than naming a price. After a rough inspection, you estimate that the car could be worth anywhere from \$1000 to \$5000, uniformly distributed.

As a former mechanic, you have a personal edge: when you own the car, you can work on it and increase its value by exactly one-third of its true worth.

However, the seller knows the exact condition and value of the car, and will only accept your offer if it exceeds the car's true value.

<u>Question</u>	<u>Score</u>
i. What is your expected profit if you offer \$3000? <i>Round your answer to the nearest integer.</i> <i>Integer</i>	(3)
ii. Indicate True/False to the following statements: a) If your offer is accepted, the car is likely to be of lower-than-average quality. b) Your mechanical skills give you a competitive edge, but they do not eliminate the adverse selection problem. c) The seller's informational advantage is irrelevant because the car value is uniformly distributed. <i>True/False</i>	(2)
iii. What is the highest offer that you can make without losing money on the deal? <i>Round your answer to the nearest integer</i> <i>Integer</i>	(2)

Question 25

- iv. What economic concept best explains why your offer is only accepted when the car's value is low?
- (a) Winner's Curse
 - (b) Moral Hazard
 - (c) Signalling
 - (d) Risk Aversion
- (2)

MCQ

Question 25

Solution

Solution to (i)

Answer: -333

Explanation:

It is important to realise that the current owner knows the exact value of the car and thus, will only accept your offer if it exceeds that value.

$$\begin{aligned}\text{Average value of car} &= (1000 + 5000) / 2 \\ &= 3000\end{aligned}$$

Since the values from 1000 to 3000 are equally likely, assuming that your offer was accepted,

$$\begin{aligned}\text{Expected value of the car to the owner} &= (1000 + 3000) / 2 \\ &= 2000\end{aligned}$$

$$\begin{aligned}\text{On average, the value of the car to you} &= 2000 (4/3) \\ &= 2666.67 \text{ (rounded to 2 d.p.)}\end{aligned}$$

$$\begin{aligned}\text{Expected profit} &= 2666.67 - 3000 \\ &= -333 \text{ (rounded down to the nearest cent)}\end{aligned}$$

Solution to (ii)

Answer:

True

True

False

Explanation:

Statement	Answer	Explanation
The car is likely lower-than-average in value if your offer is accepted.	True	The seller knows the true value and only accepts if it's less than your offer.
Your mechanical skills give you a competitive edge,	True	You can boost value after purchase, but can't stop

Question 25

but they don't eliminate adverse selection.		sellers from only selling you bad cars.
The seller's informational advantage is irrelevant because value is uniformly distributed.	False	The uniform distribution doesn't remove the asymmetric information — the seller still knows more than you.

Solution to (iii)

Answer: 2000

Explanation:

Let \$B be the amount that you offered.

The current owner will sell you his car if its value to him is between \$1,000 and B.

Expected value of the car = $(B + 1000)/2$

$$= B/2 + 500$$

Expected value of the car to you = $(4/3)(B/2 + 500)$

$$= 2B/3 + 2000/3$$

Expected profit = $(2B/3 + 2000/3) - B$

$$= 2000/3 - B/3$$

If you are not going to lose money,

$$\Rightarrow 2000/3 - B/3 = 0$$

$$\Rightarrow B = 2000$$

Solution to (iv)

Answer: (a)

Explanation:

Option	Concept	Relevant Here?	Why/Why Not
A	Winner's Curse	 Yes	You overpay when you win due to asymmetric info
B	Moral Hazard	 No	No change in

Question 25

			behaviour after the sale
C	Signalling	✗ No	Seller isn't revealing private info
D	Risk Aversion	✗ No	Problem is selection bias, not risk preference

Question 26

Bluffing in the Dark

Difficulty: Hard

Total Points: 21

Author: Theodore Chou *theodorechousm128@gmail.com*

Felix and Oscar are playing a simplified version of poker. Each makes an initial bet of \$8. Then, each separately draws a card, which may be High (H) or Low (L), with equal probabilities. Each sees his own card but not that of the other.

Then, Felix decides whether to Pass (P) or to Raise (R) (bet an additional \$4). If he chooses to Pass, the two cards are revealed and compared. If the outcomes are different, the one who has the High card collects the whole pot. The pot has \$16, of which the winner himself contributed \$8, so his winnings are \$8. The loser's payoff is $-\$8$. If the outcomes are the same, the pot is split equally and each gets his \$8 back (payoff of 0).

If Felix chooses Raise, then Oscar has to decide whether to Fold (F) (concede) or See (S) (match with his own addition \$4). If Oscar chooses Fold, then Felix collects the pot irrespective of the cards. If Oscar chooses See, then the cards are revealed and compared. The procedure at that point is the same as that in the preceding paragraph, but the pot is now bigger.

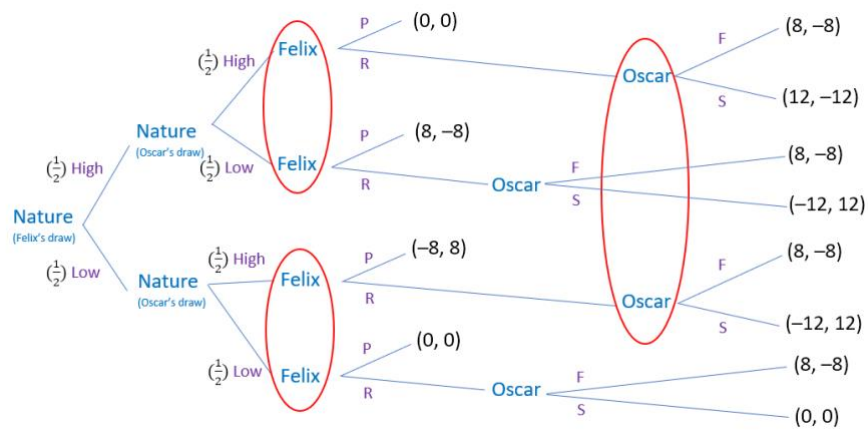
Question

Score

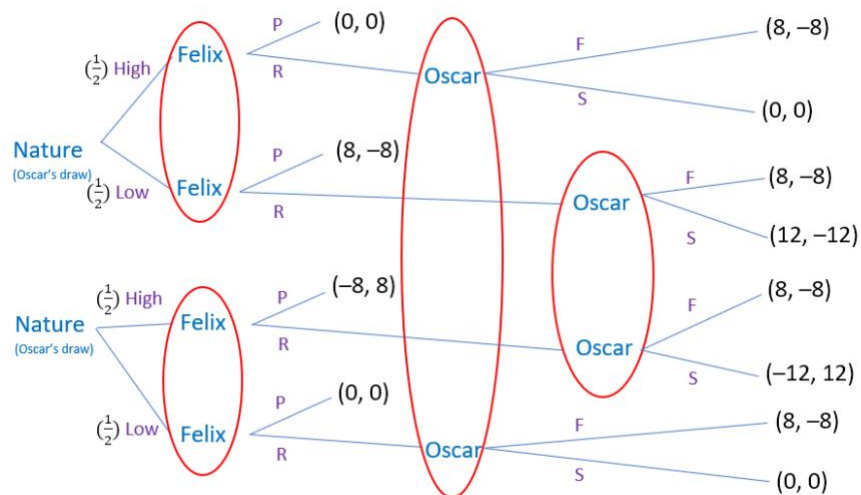
- i. Which of the following is an accurate depiction of the game tree to this game?

Tip: The red circles represent the uncertainty that the players have regarding where they are in the game at that moment.

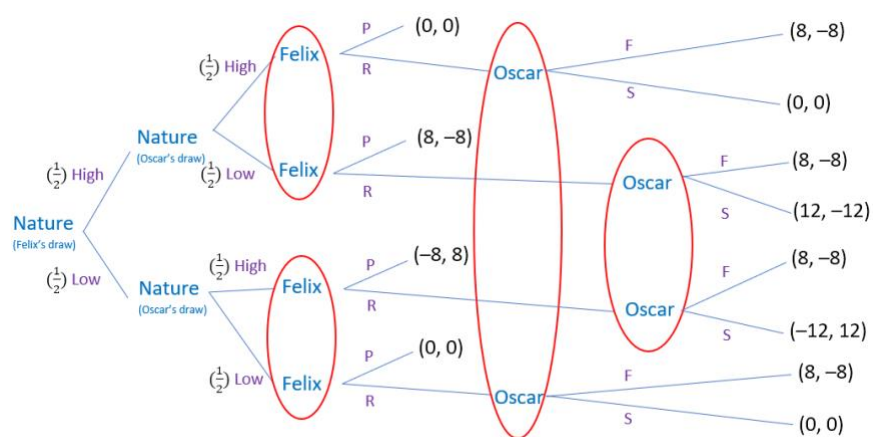
Question 26



(a)

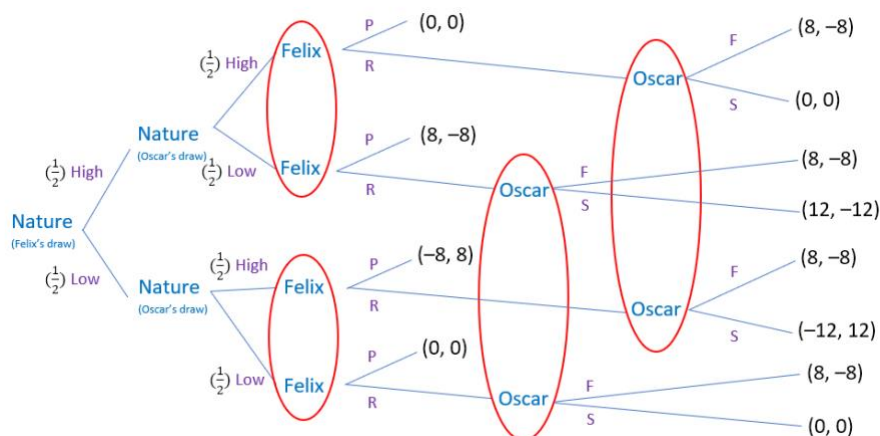


(b)



(c)

Question 26



(d)

MCQ

(3)

ii. If the game is instead written in normal form, Felix has four strategies:

- (1) Pass always (PP for short)
- (2) Raise always (RR)
- (3) Raise if his own card is High and Pass if it is Low (RP)
- (4) The other way round (PR)

Similarly, Oscar has four strategies:

- (1) Fold always (FF)
- (2) See always (SS)
- (3) See if his own card is High and Fold if it is Low (SF)
- (4) The other way round (FS)

Fill up the table's payoffs for Felix and Oscar

Example of how to write a payoff is: -1,0

Where the integers are separated by a comma (with no spacing) and -1 is the payoff to Felix and 0 is the payoff to Oscar.

	Oscar: FF	Oscar: SS	Oscar: SF	Oscar: FS
Felix: PP				
Felix: RR				
Felix: RP				
Felix: PR				

String Table

(7)

Question 26

- iii. Eliminate the strictly and weakly dominated strategies.

Which of the following sets of strategies are left in the simplified payoff matrix?

- (a) Felix: RP, Felix: PR, Oscar: SS, Oscar: FS
- (b) Felix: RR, Felix: RP, Oscar: SS, Oscar: SF
- (c) Felix: PR, Felix: RR, Oscar: FF, Oscar: FS
- (d) Felix: PP, Felix: RR, Oscar: SF, Oscar: FS

MCQ

(2)

- iv. Find the mixed strategy equilibrium in the remaining table.

*Formatting of the answer – Enter your answers in fractions (e.g. 0.125 as 1/8), NO spaces and in this format (with the **same brackets**):*

For example, if you selected option (a) for (iii), the probabilities will be in this order:



where a, b, c, d, e, f, g, h are real integers.

Sample answer: $(\{2/3, 1/2\}, \{1/3, 1/4\})$

String

(5)

Question 26

- v. What is the expected payoff to Felix in the equilibrium?

Formatting: Express your answer in decimal form.

Float

(2)

- vi. Why does Felix use a mixed strategy in equilibrium, instead of always Raising with a High card and Passing with a Low card?

- (a) To manipulate Oscar's expectations and increase his own payoffs by occasionally revealing his card type.
- (b) To prevent Oscar from learning his card type and responding in a way that reduces Felix's expected gain.
- (c) To increase the overall uncertainty in the game by making Oscar's own card more unpredictable.
- (d) To confuse Oscar about Felix's payoffs and discourage Oscar from folding too early.

MCQ

(2)

Question 26

Solution

Solution to (i)

Answer: (d)

Explanation:

When Oscar draws a card, he does not know what card Felix has. Hence, Felix has circles in the game tree.

The same logic applies.

Calculate the payoffs accordingly.

Solution to (ii)

Answer:

	Oscar: FF	Oscar: SS	Oscar: SF	Oscar: FS
Felix: PP	0, 0	0, 0	0, 0	0, 0
Felix: RR	8, -8	0, 0	1, -1	7, -7
Felix: RP	2, -2	1, -1	0, 0	3, -3
Felix: PR	6, -6	-1, 1	1, -1	4, -4

Explanation:

$$EU_{\text{Felix}}(\text{PP} | \text{FF}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0) \\ = 0$$

$$EU_{\text{Oscar}}(\text{FF} | \text{PP}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0) \\ = 0$$

$$EU_{\text{Felix}}(\text{PP} | \text{SS}) = 0$$

$$EU_{\text{Oscar}}(\text{SS} | \text{PP}) = 0$$

$$EU_{\text{Felix}}(\text{RR} | \text{FF}) = \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) \\ = 8$$

$$EU_{\text{Oscar}}(\text{FF} | \text{RR}) = \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) \\ = -8$$

$$EU_{\text{Felix}}(\text{RR} | \text{SS}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (0) \\ = 0$$

$$EU_{\text{Oscar}}(\text{SS} | \text{RR}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

Question 26

$$= 0$$

$$EU_{\text{Felix}}(\text{RR} | \text{SF}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (8)$$

$$= 1$$

$$EU_{\text{Oscar}}(\text{SF} | \text{RR}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (-8)$$

$$= -1$$

$$EU_{\text{Felix}}(\text{RR} | \text{FS}) = \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 7$$

$$EU_{\text{Oscar}}(\text{FS} | \text{RR}) = \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= -7$$

$$EU_{\text{Felix}}(\text{RP} | \text{FF}) = \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 2$$

$$EU_{\text{Oscar}}(\text{FF} | \text{RP}) = \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= -2$$

$$EU_{\text{Felix}}(\text{RP} | \text{SS}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 1$$

$$EU_{\text{Oscar}}(\text{SS} | \text{RP}) = \frac{1}{2} \left(\frac{1}{2} \right) (0) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= -1$$

$$EU_{\text{Felix}}(\text{RP} | \text{SF}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 0$$

$$EU_{\text{Oscar}}(\text{SF} | \text{RP}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 0$$

$$EU_{\text{Felix}}(\text{RP} | \text{FS}) = \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + 0$$

$$= 3$$

$$EU_{\text{Oscar}}(\text{FS} | \text{RP}) = \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + 0$$

$$= -3$$

$$EU_{\text{Felix}}(\text{PR} | \text{FF}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (8)$$

$$= 6$$

$$EU_{\text{Oscar}}(\text{FF} | \text{PR}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (-8)$$

$$= -6$$

$$EU_{\text{Felix}}(\text{PR} | \text{SS}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= -1$$

$$EU_{\text{Oscar}}(\text{SS} | \text{PR}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (0)$$

$$= 1$$

Question 26

$$EU_{\text{Felix}}(\text{PR} | \text{SF}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (-12) + \frac{1}{2} \left(\frac{1}{2} \right) (8) \\ = 1$$

$$EU_{\text{Oscar}}(\text{SF} | \text{PR}) = 0 + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (12) + \frac{1}{2} \left(\frac{1}{2} \right) (-8) \\ = -1$$

$$EU_{\text{Felix}}(\text{PR} | \text{FS}) = 0 + 2 + \frac{1}{2} \left(\frac{1}{2} \right) (8) + \frac{1}{2} \left(\frac{1}{2} \right) (0) \\ = 4$$

$$EU_{\text{Oscar}}(\text{FS} | \text{PR}) = 0 - 2 + \frac{1}{2} \left(\frac{1}{2} \right) (-8) + \frac{1}{2} \left(\frac{1}{2} \right) (0) \\ = -4$$

Solution to (iii)

Answer: (b)

Explanation:

This was the original table:

	Oscar: FF	Oscar: SS	Oscar: SF	Oscar: FS
Felix: PP	0, 0	0, 0	0, 0	0, 0
Felix: RR	8, -8	0, 0	1, -1	7, -7
Felix: RP	2, -2	1, -1	0, 0	3, -3
Felix: PR	6, -6	-1, 1	1, -1	4, -4

Since Felix's PP is weakly dominated by Felix's RR, we eliminate Felix's PP strategy

	Oscar: FF	Oscar: SS	Oscar: SF	Oscar: FS
~~Felix: PP~~	~~0, 0~~	~~0, 0~~	~~0, 0~~	~~0, 0~~
Felix: RR	8, -8	0, 0	1, -1	7, -7
Felix: RP	2, -2	1, -1	0, 0	3, -3
Felix: PR	6, -6	-1, 1	1, -1	4, -4

Since Felix's PR is weakly dominated by Felix's RR, we eliminate Felix's PR

	Oscar: FF	Oscar: SS	Oscar: SF	Oscar: FS
~~Felix: PP~~	~~0, 0~~	~~0, 0~~	~~0, 0~~	~~0, 0~~
Felix: RR	8, -8	0, 0	1, -1	7, -7
Felix: RP	2, -2	1, -1	0, 0	3, -3
~~Felix: PR~~	~~6, -6~~	~~-1, 1~~	~~1, -1~~	~~4, -4~~

Question 26

Since Oscar's FF is strictly dominated by Oscar's SS, we eliminate Oscar's FF strategy.

	~~Oscar: FF~~	Oscar: SS	Oscar: SF	Oscar: FS
~~Felix: PP~~	~~0, 0~~	~~0, 0~~	~~0, 0~~	~~0, 0~~
Felix: RR	<del>8, ~~8~~</del>	0, 0	1, -1	7, -7
Felix: RP	<del>2, ~~2~~</del>	1, -1	0, 0	3, -3
~~Felix: PR~~	<del>6, ~~6~~</del>	~~-1, 1~~	<del>1, ~~1~~</del>	<del>4, ~~4~~</del>

Since Oscar's FS is strictly dominated by Oscar's SF (or SS), we eliminate Oscar's FS strategy.

	~~Oscar: FF~~	Oscar: SS	Oscar: SF	~~Oscar: FS~~
~~Felix: PP~~	~~0, 0~~	~~0, 0~~	~~0, 0~~	~~0, 0~~
Felix: RR	<del>8, ~~8~~</del>	0, 0	1, -1	<del>7, ~~7~~</del>
Felix: RP	<del>2, ~~2~~</del>	1, -1	0, 0	<del>3, ~~3~~</del>
~~Felix: PR~~	<del>6, ~~6~~</del>	~~-1, 1~~	<del>1, ~~1~~</del>	<del>4, ~~4~~</del>

End result:

	Oscar: SS	Oscar: SF
Felix: RR	0, 0	1, -1
Felix: RP	1, -1	0, 0

Solution to (iv)

Answer: $(\{\frac{1}{2}, \frac{1}{2}\}, \{\frac{1}{2}, \frac{1}{2}\})$

Explanation:

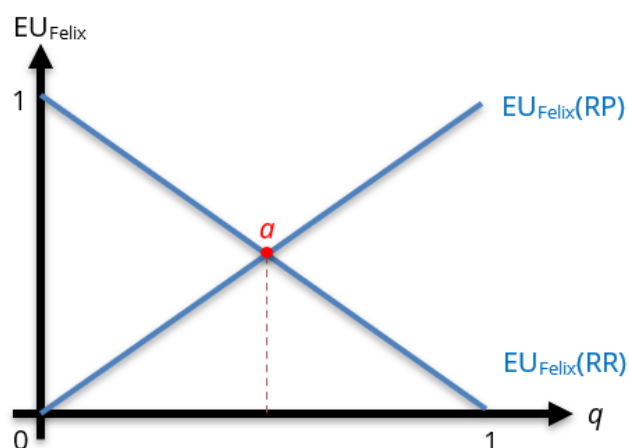
Let Felix (Player 1) and Oscar (Player 2) play RR, RP, SS and SF with probabilities p , $(1 - p)$, q and $(1 - q)$ respectively.

For there to be a mixed strategy equilibrium, the current player must be indifferent between the strategies used in support of the mixed strategy equilibrium.

$$\begin{aligned} EU_{\text{Felix}}(\text{RR}) &= 0q + (1 - q) \\ &= 1 - q \end{aligned}$$

$$\begin{aligned} EU_{\text{Felix}}(\text{RP}) &= q + 0 \\ &= q \end{aligned}$$

Question 26



When $EU_{\text{Felix}}(\text{RR}) = EU_{\text{Felix}}(\text{RP})$,

$$1 - q = q$$

$$2q = 1$$

$$q = \frac{1}{2}$$

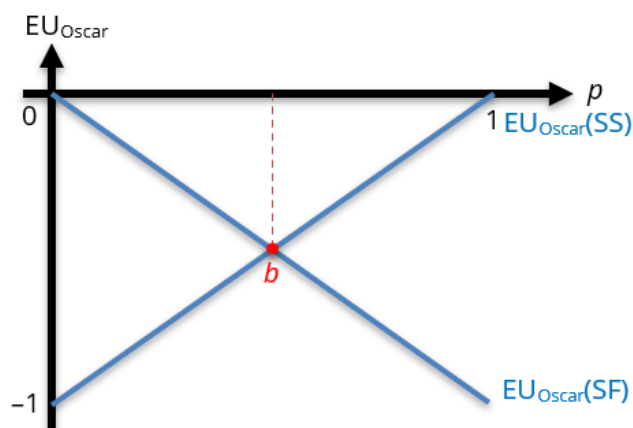
At point "a", when Player 2 mixes between his strategies with $q = \frac{1}{2}$, Player 1 is indifferent between RP.

Hence, a mixed strategy Nash equilibrium is possible.

$$EU_{\text{Oscar}}(\text{SS}) = 0 + (-1)(1 - p)$$

$$= p - 1$$

$$EU_{\text{Oscar}}(\text{SF}) = -p$$



Question 26

When $EU_{\text{Oscar}}(\text{SS}) = EU_{\text{Oscar}}(\text{SF})$,

$$p - 1 = -p$$

$$2p = 1$$

$$p = \frac{1}{2}$$

At point “b”, Player 1 mixes between RR and RP with $p = \frac{1}{2}$ and Player 2 is indifferent between SS and SF.

Hence, the mixed strategy is $(\{\frac{1}{2}, \frac{1}{2}\}, \{\frac{1}{2}, \frac{1}{2}\})$ since the conditions required for a mixed strategy Nash equilibrium to exist have been met.

Solution to (v):

Answer: 0.5

Explanation:

Focus on Felix’s payoffs:

$$\begin{aligned}\text{Expected payoff} &= \frac{1}{2}(\frac{1}{2} \cdot 0 + \frac{1}{2} \cdot 1) + \frac{1}{2}(\frac{1}{2} \cdot 1 + \frac{1}{2} \cdot 0) \\ &= 0.5\end{aligned}$$

Solution to (vi):

Answer: (b)

Explanation:

A: Incorrect

It sounds close, but the flaw is in “occasionally revealing” his type. Felix wants to conceal, not reveal, his card. If he’s predictable, Oscar will exploit that. Bluffing (Raising even with a Low card) hides his type — that is the goal of mixing.

B: Correct

This captures the essence: Felix mixes to jam the signal, making it hard for Oscar to figure out whether he has a High or Low card. If Oscar could deduce Felix’s type, he could adjust and reduce Felix’s gains. Mixing protects Felix from this.

C: Incorrect

Question 26

Felix's strategy doesn't affect Oscar's card, which is drawn independently. This answer misleads by shifting the uncertainty to the wrong place. The uncertainty is about Felix's type, not Oscar's.

D: Incorrect

Felix doesn't want to confuse Oscar about payoffs (those are known). The issue is about information, not payoff confusion. Also, discouraging Oscar from folding would be bad when Felix is bluffing. Felix wants Oscar to fold sometimes.

Question 27

Is it too Matcha

Difficulty: Hard

Total Points : 8

Author: Jon Yew

During her JC1 school holidays, Mei Li decides to open her own Matcha Store; **Mei Li's Matcha Madness (MMM)**. Mei Li opens two branches, one in Singapore and one in Kuala Lumpur. MMM's marginal cost is 5 MYR. Over a few months, Mei Li decides to experiment by varying the price of Matcha every week. Her sales are as follows:

Price (MYR)	Q in SG	Q in KL
10	130	31
11	106	27
12	105	31
14	100	24
15	60	24
16	70	25
17	65	18
18	60	23
20	48	21
22	28	18
24	16	18
25	2	14
26	1	10
30	0	9



Assumptions:

1. Mei Li makes strategic business decisions
2. Matcha and Cash are both infinitely divisible

Question

Score

- i. By estimating the **Inverse Demand Function(s)** facing MMM, suggest the price Mei Li should set for each market. Round your answers to the nearest integer

A) Price in Singapore P_S

B) Price in Kuala Lumpur P_K

Integer Set

3

Question 27

- ii. One day, Antitrust laws are introduced which mandate that the same price for matcha at in Singapore and Kuala Lumpur. What is Mei Li's decrease in profit? Give your answer to 3s.f.

Float

3

- iii. Antitrust laws remain in place. One month, an inflationary spiral causes the cost of inputs to go up, and Mei Li is forced to adjust her pricing. Nevertheless, her profits sink to \$ 290.85 by the end of the month. What was is the new constant marginal cost that MMM is facing?

Integer

2

Question 27

Solution

Solution to (i)

Answer: A) 16, B) 21

Explanation:

The question specified inverse demand curves, whereby Price is expressed as a function of Quantity Demanded. Thus, we do linear regression using price as the dependent variable (y) and Quantity as the independent variable (x)

Using least squares regression:

$$P_s = -0.13764Q + 26.34783$$

$$P_k = -0.84307Q + 36.2157$$

$$R_s = P_s Q - TC = -0.13764Q^2 + 26.34783Q - 5Q, \text{ which is maximised when } Q = 77.54951$$

$$R_k = P_k Q - TC = -0.84307Q^2 + 36.2157Q - 5Q, \text{ which is maximised when } Q = 18.51311$$

$$P_s = -0.13764(77.54951) + 26.34783 = 15.6739154436 = 16$$

$$P_k = -0.84307(18.51311) + 36.2157 = 20.6078523523 = 21$$

Solution to (ii)

Answer: 24.8

Explanation:

Combined profit before antitrust laws: $\pi_s + \pi_k = 827.75691 + 288.94989 = 1116.7068$
(Maximum profit can be found via either calculus or plotting profit in G.C.)

Combined Profit with identical pricing: $\pi_c =$

$$\text{unit profit} \times \text{total quantity} = (p - 5) \left(\frac{26.34783 - p}{0.13764} + \frac{36.2157 - p}{0.84307} \right)$$

Plot π_c against p to find that maximum π_c is 1091.88426

The decrease in profit is $1116.7068 - 1091.88426 = 24.82254$

Question 27

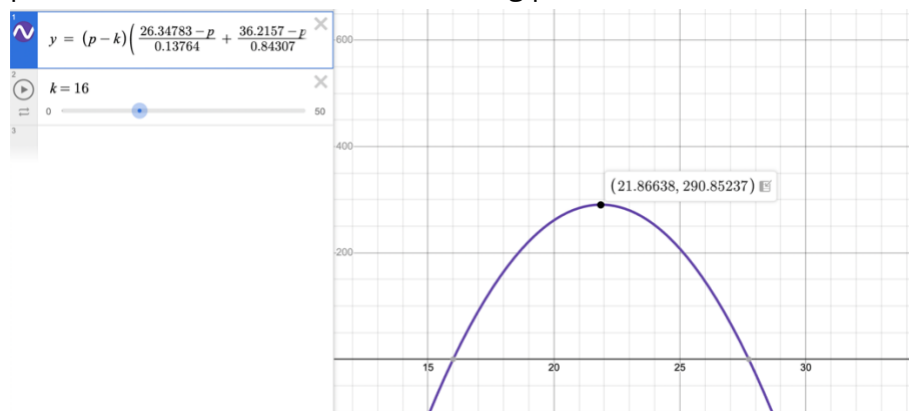
Solution to (iii)

Answer: 16

Explanation:

Let the new MC be K

Plot $\pi = (p - K)\left(\frac{26.34783 - p}{0.13764} + \frac{36.2157 - p}{0.84307}\right)$ in a G.C, and vary K while observing the turning point. The π coordinate of the turning point is 290.85 when K = 16



Question 28

AGI inbound

Difficulty: Hard

Total Points : 9

Author: Jon Yew

Question

Score

- i. The labour market for economists used to be governed by traditional labour dynamics:

$$S(w) = -60 + 5w$$

$$D(w) = 1200 - 10w$$

One day, ClosedAI introduces an AI agent adept at performing the work of economists at scale. Industry sources soon reveal that the supply of AI agents is of the form $A(w) = -K + \frac{K}{13.5}w$, for some unknown integer K .

2 years after the entry of these AI agents, quantitative analysis by research journals indicate that the surplus earned by human workers was reduced by 8163.9. The labour ministry estimated that the unemployment rate of fresh graduate economists rose from ~7.2% to ~20.6%, despite demand behaviour from employers remaining invariant.

What is the decrease in labour supplied by economists following the introduction of AI agents?

Integer

5

- ii. Which of the following statements are true?

A) The reservation wage for AI agents is less than that of human economists	True/false
B) Societal welfare decreased following the introduction of AI agents	True/false
C) All human economists became unemployed following the introduction of AI agents	True/false
D) The wages of economists fell by more than 20%	True/false
E) There is a deadweight loss following the introduction of AI agents.	True/false

True False Set

4

Question 28

Question 28

Solution

Solution to (i)

Answer: 141

Explanation:

The new supply of labour is $N(w) = S(w) + A(w) = -60 + 5y - K + \frac{K}{13.5}y$

Plot $S(w)$, $D(w)$, and $N(w)$ with a graphing calculator, and plot the initial and final worker surplus. The worker surplus is the area above $S(w)$ but below the equilibrium wage.

GeoGebra:



The desired final worker surplus is $12960 - 8163.9 = 4796.1$

Do guess and check by varying K until the surplus is equal to the above value, which occurs when $K = 135$

From the plot of the relevant equations, we can see that the labour supplied by human economists fell from 360 to 219, a reduction of 141.

Solution to (ii)

Answer:

A	B	C	D	E
F	F	F	T	F

Explanation:

A) The reservation wage for AI agents is less than that of human economists	This is false. The reservation wage for AI is 13, which is more than the reservation wage for humans of 12
B) Societal welfare decreased following the introduction of AI agents	False. The increase in employer surplus was more than the decrease in worker surplus. This can be confirmed

Question 28

	graphically.
C) All human economists became unemployed following the introduction of AI agents	False. There is some amount of labour supplied by human economists still
D) The wages of economists fell by more than 20%	This is true. The initial and final wages were 84 and 55.8 respectively, indicating a wage fall of 33%
E) There is a deadweight loss following the introduction of AI agents.	False. There is no difference between MSB and MPB, and no difference between MSC and MPC

Question 29

Chinese Cars

Difficulty: Hard

Total Points : 12

Author: Jon Yew

According to many sources, Chinese automakers are growing dominant in global markets through a combination of low price and high quality, particularly with Electric Vehicles (EVs) (Fig. 1)

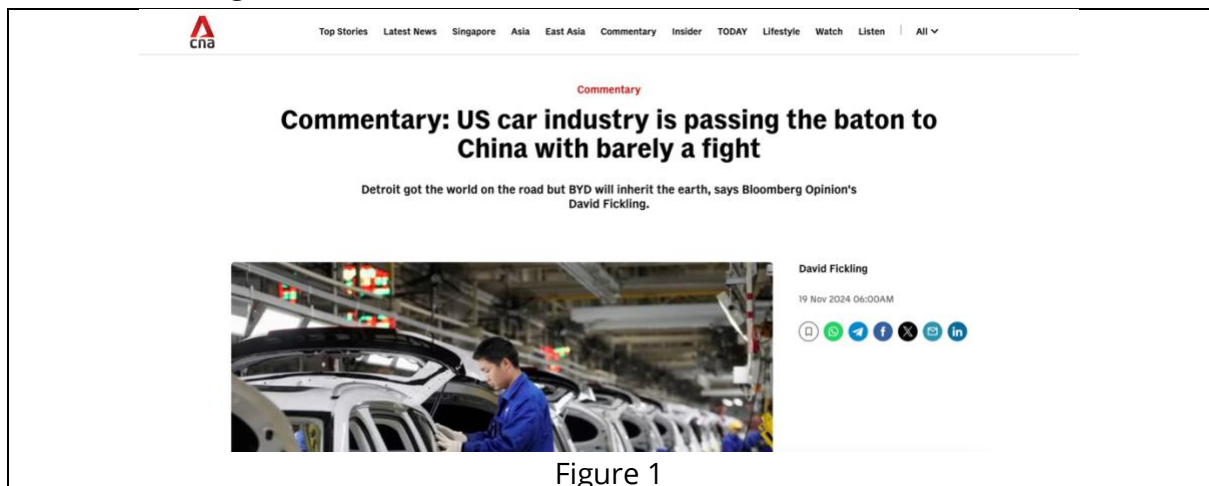


Figure 1

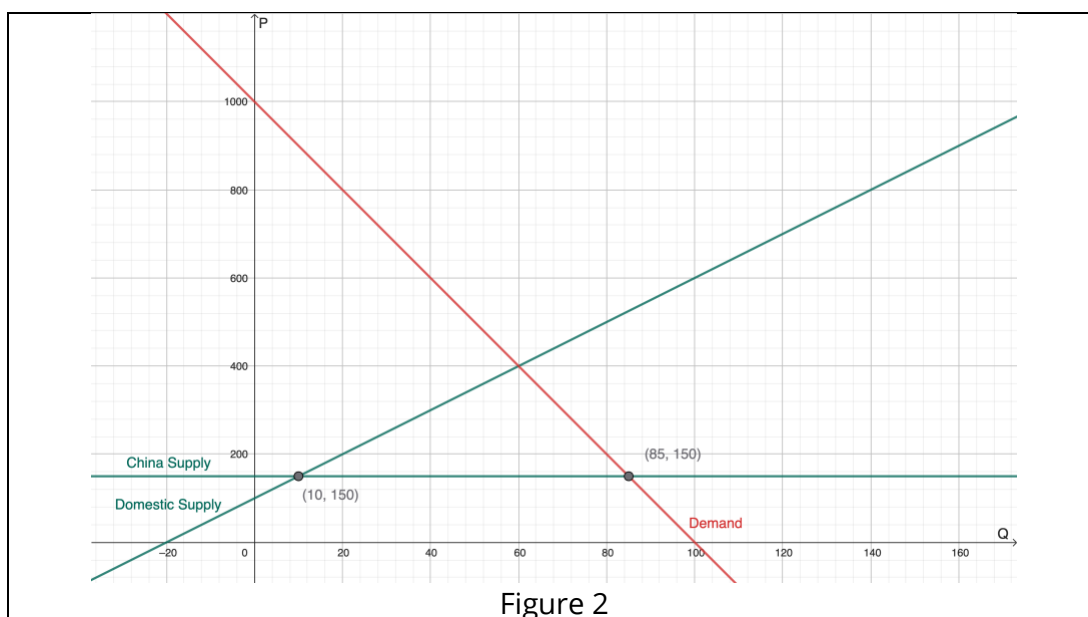
To protect their domestic industries from being outbid, some nations such as the USA have implemented import controls on Chinese vehicles.

Question

Score

- i. A simplified model of the market for cars in the USA is shown in Fig. 2

Question 29



Domestic firms such as General Motors and Cadillac contribute to the domestic supply. Chinese firms such as BYD also export their vehicles to the USA. Due to China's substantial industrial capacity, their imported supply is modelled as perfectly elastic supply. Consumers always prefer cheaper cars. However, if two cars have the same price, they will choose the domestically produced car out of patriotism.

What is the minimum tariff T which should be applied on Chinese EVs, in order to:

A) price Chinese EVs out of the domestic market?	
B) Increase the quantity of American cars sold by 200%?	
C) Generate tax revenue of 4080?	

Question 29

- ii. During t_0 , there are no tariffs.

During t_1 , a new US Presidency is elected, bringing with him a new trade policy. The US Government imposes a unit tariff of $T = I$ onto imported Chinese Cars as a protectionist measure under the Trump administration. The administration requests a meeting with Chinese leadership, hoping to use tariffs as a negotiation tool. However, the Trump administration's demands are rebuked.

During t_2 , the US government raises tariffs on Chinese cars even further, to $T = I + 75$.

The change in producer surplus and consumer surplus at equilibrium from t_1 to t_2 is ΔPS and ΔCS respectively. It is given that

$$\left| \frac{\Delta CS}{\Delta PS} \right| = \frac{14}{33}$$

Determine the value of I
(I is an integer)

Integer

Question 29

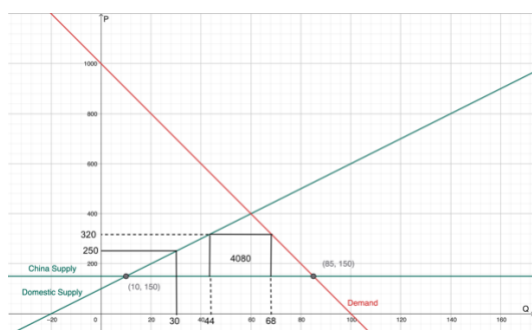
Solution

Solution to (i)

Answer:

A) price Chinese EVs out of the domestic market?	250
B) Increase the quantity of American cars sold by 200%?	100
C) Generate tax revenue of 4080?	170

Explanation: Deriving equation is a possible technique, though it is unnecessary. We can perform geometric techniques on the graph provided to glean the necessary information:



Chinese EVs are priced out with a tariff of 250, as they will now cost 400 per unit, so the whole demand will be taken up by domestic manufacturers.

To increase the Q_s of American cars from 10 to 30, we can extrapolate from the graph that the post-tariff price of Chinese cars must be 250, implying a tariff of $250 - 150 = 100$.

Generating tax revenue requires some guesswork, however it can be found relatively quickly to occur when the post-tariff price of Chinese cars is 320.

Solution to (ii)

Answer: 70

Explanation:

This question can be solved via programming, algebra, or graphing techniques. In all 3 cases, the equations of the Demand and Supply curve must be derived from information in Fig. 2.

Question 29

The demand curve passes through (0, 1000) and (100, 0), so we can solve the equation of the demand curve to be: $q = -\frac{1}{10}p + 100$. Similarly, the supply curve passes through (-20, 0) and (10, 150); we solve the equation of the supply curve to be $p = 100 + 5q$.

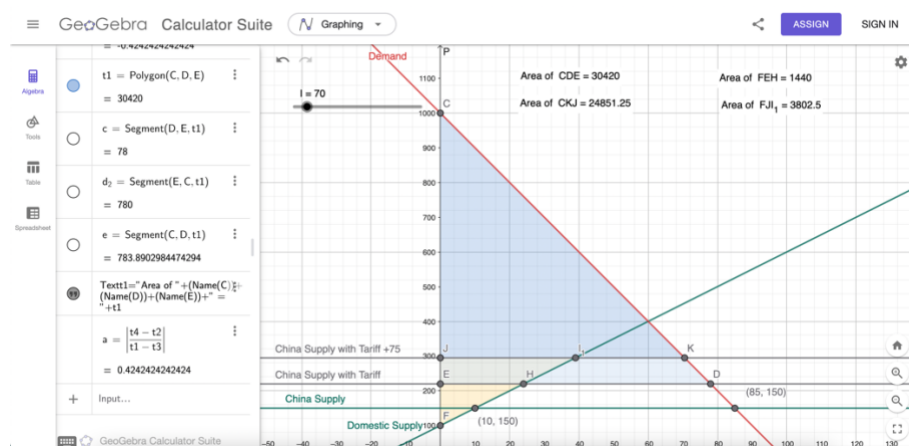
Graphical method:

Next, plot demand, supply, and the import supply $p = 150$ in a graphing calculator.

The import supply with the initial tariff is $p = 150 + I$, and the import supply with the hiked tariff is $p = 150 + I + 75$.

From here, the change in producer and consumer surplus ΔPS and ΔCS can be determined from the relevant areas on the graph. GeoGebra is a particularly useful tool here, as it allows you to observe how the value of specified areas change as certain values change.

Here is example of a GeoGebra setup that can solve for the answer:



We modify the value of I until it gives us $\left| \frac{\Delta CS}{\Delta PS} \right| = \frac{14}{33}$, which occurs when $I = 70$

Question 30

Milk Teanomics

Difficulty: Hard

Total Points : 16

Author: Jon Yew

Amy and Bob are friends at Toa Payoh Junior College. They both enjoy sandwiches (x) and milk tea (y).

They decide that trading between each other may help them to maximise their individual utility.

Amy and Bob each have utility functions of the form: $U = px^qy^{1-q}$, for some $p \in \mathbb{R}^+$, $q \in (0, 1)$

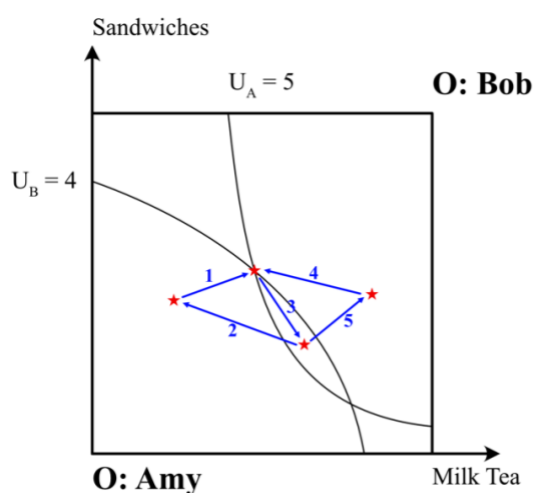


Figure 1

Figure 1 shows Amy and Bob's Edgeworth box, with 4 possible endowments of goods denoted by the red stars. Their indifference curves passing through one of the endowment points are also shown. Starting from one of the 4 possible initial endowments, Bob and Amy can choose to Barter with each other. For simplicity, let's restrict our analysis to the trades 1, 2, 3, 4 and 5 (denoted by the blue arrows in Fig. 1).

Question

Score

- i. Which trades will both Amy and Bob agree to? List only those trades which can be guaranteed based on the available information. Concatenate your answer as an integer with digits that strictly increase from left to right. For example, if you think both Amy and Bob will agree to trades 2, 4, and 5, input your answer as 245.

Integer

3

Question 30

- ii. What proportion of Amy's income will she spend on Milk Tea?
Sandwiches and Milk tea have fixed prices of 3\$ and 5\$ respectively.
Assume $q = 0.34$

Float

4

- iii. What is the Quantity of Milk Tea demanded by Amy with an income of 100\$? Round your answer to the nearest integer

Integer

2

Question 30

iv. **Bonus question 1: Carrot Farming**

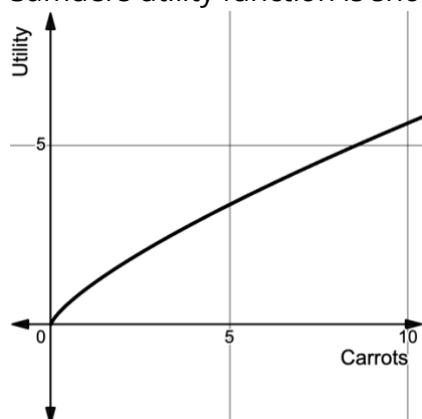
Samuel the rabbit loves carrots, so he decides to plant some carrots on $t = 0$ (Monday).

The carrots will sprout during time periods $t = 1, 2, 3$, and the world ends after Friday. After harvesting his carrots for the day, Samuel can choose to eat some or all of his carrots, and store the rest in his fridge to eat later. Samuel's fridge is very good and keeps his carrots fresh.

Harvest:

t	day	Harvest of carrots H_t
1	Tuesday	11
2	Wednesday	7
3	Thursday	2
4	Friday	0

Samuel's utility function is shown below:



Samuel does not discount future consumption of carrots
Samuel can see the future

What is the optimal number of carrots that Samuel should eat on Wednesday?

Integer

Question 30

i. **Bonus Question 2: Corporate Finance**

Let the interest rate on government securities be r .

CapitoLand is a real estate firm specialising in shopping malls. CapitoLand wishes to build a *new shopping mall*, *Waffle's Place*, which requires an initial capital investment of X \$. It is also given that $r = 5\%$.

CapitoLand makes several estimations to derive the return on investment provided by building Waffle's Place:

First, CapitoLand estimates that the mall will create an annual income 500 000\$ in the first year, from rent. The mall is in an area of growing traffic, so the income from the location is expected to increase by 3% into perpetuity.

Second, they assume that the investment in Waffle's Place is considered to be equally risky to the stock market. The stock market has an average annual rate of return of 11%.

Assume that CapitoLand's Board of Directors will approve any project with a positive net present value. What is the largest initial capital investment X \$, that the Board will still be willing to approve to build Waffles' Place?

Integer

(5)

Question 30

Solution

Solution to (i)

Answer: 3

This is the only trade that represents a pareto improvement.

Solution to (ii)

Answer: 0.66

Define the budget line as $m = xp_x + yp_y$

Using the utility function, find the Marginal Rate of Substitution of x and y and determine the tangency condition, which can then be substituted into the budget line.

After simplification, you should have: $m(1 - q) = yp_y$

This implies the proportion of income spent on Milk Tea (y) is $(1 - q) = 0.66$

Solution to (iii)

Answer: 13

Substitute the relevant values of m, q, and p_y into $m(1 - q) = yp_y$.

This should yield $y = 13.3 \sim 13$

Solution to (iv)

Answer: 5

Samuel's utility function is strictly concave. Thus, Samuel should avoid extreme values of carrot consumption. Utility is maximised when Samuel eats the same number of carrots each day. $20/4 = 5$.

Solution to (v)

Answer: 6 250 000

Explanation:

Let Net Present Value (NPV) of the investment be 0.

This problem is equivalent to the issue of pricing a perpetuity. This perpetuity pays 500 000 in the first year, with the payment increasing by 3% every year.

Question 30

$$\begin{aligned} PV &= \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \dots \\ &= \frac{C_1}{1+r} + \frac{C_1(1+g)}{(1+r)^2} + \frac{C_1(1+g)^2}{(1+r)^3} + \dots \end{aligned}$$

Fortunately, there is a simple formula for the sum of this geometric series.⁶ If we assume that r is greater than g , our clumsy-looking calculation simplifies to

$$\text{Present value of growing perpetuity} = \frac{C_1}{r-g}$$

Excerpt from *Principles of Corporate Finance* (Ch 2: How to Calculate Present Values)

From the formulas for the geometric series, we can derive that: $PV = \frac{R_1}{i-g}$, where R_1 is the return in Year 1, i is the interest rate, and g is the growth rate.

From “- investment in Waffle’s Place is considered to be equally risky to the stock market. The stock market has an average annual rate of return of 11%.”, we can see that this perpetuity is **not risk free**, with $i = 11\%$.

$$PV = \frac{500\,000}{0.11-0.03} = 6\,250\,000.$$

The Net Present Value of this investment is zero when the cost of investment is exactly equal to the present value, so the maximum X is 6.25M\$

Question 31

Secrets for Sale: A Wuxia Tale of Economic Leverage

Difficulty: Hard

Total Points : 15

Author: Jonas (kaifejo@gmail.com)

In *Jin Yong's* world of *Wuxia*, the *Beggars' Sect* serves as politically neutral brokers of information, maintaining their influence through impartiality and amassing profits.

Suppose the *Beggars' Sect* acquired the locations of N rare Origin Energy Pills, where information on the location of each pill can be sold to either the *Emei Clan* (E) or the *Wudang Clan* (W) for a price P_E or P_W , respectively.

The *Beggars' Sect* derives utility from two sources:

1. **Monetary income** (M): The sect values the *taels* (currency) received from selling the locations of the pills. Selling x pills at the best expected price ($P = \max(P_E, P_W)$) generates income:

$$M = x \cdot P.$$

2. **Leverage** (L): The sect also derives utility from political leverage gained by retaining the information on the locations of the pills. Retaining $y = N - x$ pills provides leverage proportional to the number of pills retained:

$$L = k \cdot y$$

where k is the leverage per pill and $k \in \mathbb{R}^+$.

The total utility of the *Beggars' Sect* is described by the utility function:

$$U(M, L) = M^a L^b$$

where $a, b > 0$ and $a + b = 1$.

The total number of pills is fixed: $x + y = N$.

Question 31

You are given that:

- $P = 6000$ (price per pill)
- $a = 0.4$ (weight on monetary income)
- $b = 0.6$ (weight on leverage)
- $k = 100$ (leverage per pill)
- $N = 10$ (total number of pills)

<u>Question</u>	<u>Score</u>
i. Determine how many pills (x^*) the Beggars' Sect should sell to maximize their utility $U(M, L)$. <i>Integer</i>	(6)
ii. Suppose the Beggars' Sect is risk averse. The utility from income is now: $U(M, L) = \ln M + c \cdot L$ where c is the preference for leverage and $c > 0$. a. Determine the % change of x when k, the leverage per pill, increases by 50%. Give your answer in 4 significant figures. <i>Float</i>	(6)
b. Suppose $c = 2$. Determine the minimum price P_{min} at which the sect would sell all N pills. <i>Integer</i>	(3)

Question 31

Solution

Solution to (i)

Answer: 4

Explanation:

1. Substitute $M = x \cdot P$ and $L = k \cdot N - x$ into $U(M, L) = M^a L^b$ to obtain
$$U(M, L) = (x \cdot P)^a (k \cdot (N - x))^b$$
2. To maximise $U(x)$, take the derivative wrt x to obtain
$$\frac{dU}{dx} = a \cdot P \cdot (x \cdot P)^{a-1} \cdot (k \cdot (N - x))^b - (x \cdot P)^a \cdot k \cdot (k \cdot (N - x))^{b-1} = 0$$
3. Factoring out common terms, we get $\frac{a}{x} - \frac{b}{N-x} = 0$
4. Rearranging and substituting in x^* , we get $\frac{a}{b} = \frac{x^*}{N-x^*}$, and hence,
$$x^* = \frac{a}{a+b} \cdot N = a \cdot N$$
5. Substituting in values of a and N , we obtain $x^* = 4$.

Solution to (ii)(a)

Answer: -33.33

Explanation:

1. Substitute M and L into the utility equation, giving
$$U(x) = \ln \ln (x \cdot P) + c \cdot k(N - x).$$
2. Similarly, take the derivative wrt x to obtain $\frac{dx}{dU} = \frac{1}{x} \cdot P - c \cdot k = 0$.
3. Factoring out common terms, we obtain $x^* = \frac{P}{c \cdot k}$
4. Let $k' = 1.5k$, therefore $x'^* = \frac{P}{c \cdot 1.5k} = \frac{P}{c \cdot k} \cdot \frac{2}{3}$
5. X decreased by 33.33%

Question 31

Solution to (ii)(b)

Answer: 2000

Explanation:

1. Since $x^* = \frac{P}{c \cdot k}$, then $P = x \cdot c \cdot k$
2. When $x^* = N$, $P = N \cdot c \cdot k = 10 \cdot 2 \cdot 100 = 2000$

Question 32

Circular Flow

Difficulty: Hard

Total Points : 11

Author: Ho Jon Yew

Preamble:

We learnt in Macroeconomics that: $Y = C + I + G + X - M$ for open economies. In this question, we will introduce some of the mathematical theory underlying simple macroeconomic models, to explore what insights we can derive from them.

Let's begin by modelling a simple closed economy. We start with the equation:

$$Y = C + I + G$$

whereby Consumption is given by

$$C = c_0 + c_1 Y_D$$

and observes the conditions: $c_0 \geq 0, c_1 \in (0, 1)$.

Also, disposable income $Y_D = Y - T$, where T is taxes. In this model, Income and Government spending are exogenous factors, while Taxation is endogenously dependent on income:

$$T = t_0 + t_1 Y, \quad t_1 \in (0, 1)$$

For the purposes of part (i) and (ii), it is given that $c_1 = 0.8$ and $t_1 = 0.14$

Question

Score

- i. By deriving an equation for the *fiscal multiplier**, determine the numerical value of the Marginal Propensity to Consume (MPC) of this economy.

*Ratio of change in National Income arising from a change in Government Spending.

Float

7

Question 32

- ii. It is now given that the government is fiscally prudent, and always balances the budget: $G = T$. New technology is created, causing Investment to increase by 20 units. What is the corresponding increase in National Income at the new equilibrium? Give your answer to 2 d.p.

Float

4

Question 32

Solution

Solution to (i)

Answer: 0.688

Explanation:

$$\begin{aligned} Y &= C + I + G \quad \text{substitute} \\ &= C_0 + C_1 Y_D + I + G \quad \text{substitute again} \\ &= C_0 + C_1 (Y - T) + I + G \quad \text{and again} \\ &= C_0 + C_1 (Y - (t_0 + t_1 Y)) + I + G \\ &= C_0 + C_1 (1 - t_1) Y - C_1 t_0 + I + G \\ [1 - C_1 (1 - t_1)] Y &= C_0 - C_1 t_0 + I + G \quad \text{rearrange} \\ Y &= \frac{1}{1 - C_1 (1 - t_1)} (C_0 - C_1 t_0 + I + G) \\ \text{diff. } Y \text{ w.r.t } G \text{ to find fiscal multiplier } \frac{\Delta Y}{\Delta G} \\ \frac{\Delta Y}{\Delta G} &= \frac{1}{1 - C_1 (1 - t_1)} = \frac{1}{1 - MPC} \quad \text{from macroeconomics} \\ \text{so } MPC &= C_1 (1 - t_1) = 0.8(1 - 0.14) = 0.688 \end{aligned}$$

Solution to (ii)

Answer: 116.28

Explanation:

$$\begin{aligned} \text{From (i), } Y &= C_0 + C_1 (Y - T) + I + G \\ &= C_0 + C_1 (Y - T) + I + T \\ \text{substitution: } Y(1 - C_1) &= C_0 + (t_0 + t_1 Y)(1 - C_1) + I \\ \text{manipulate: } Y(1 - t_1)(1 - C_1) &= C_0 + I + t_0(1 - C_1) \\ Y &= \frac{1}{(1 - t_1)(1 - C_1)} (I + C_0 + t_0 - t_0 C_1) \\ \text{diff } Y \text{ w.r.t } I \\ \frac{\Delta Y}{\Delta I} &= \frac{1}{(1 - t_1)(1 - C_1)} = \frac{1}{(1 - 0.14)(1 - 0.8)} = \frac{250}{43} = \frac{\Delta Y}{\Delta I} \\ \text{sub } \Delta I &= 20 \\ \Delta Y &= \frac{250}{43} \times (\Delta I = 20) = 116.28 \\ \text{Essentially the same process as part (i)} \end{aligned}$$

Question 33

IS LM

Difficulty: Hard

Total Points : 10

Author: Fan Yixiang fanyixiang2006@Gmail.com

In a closed economy, the equilibrium between interest rate and output (GDP) can be modelled by the IS-LM model, where the IS curve stands for investment saving and the LM curve stands for liquidity-preference money supply.

Question

Score

- I. If the central bank decides to increase the money supply, what will happen to the model?
- A. LM curve shifts left, interest rate increases and GDP decreases
 - B. LM curve shifts right, interest rate decreases and GDP increases
 - C. IS curve shifts left, interest rate decreases and GDP decreases
 - D. IS curve shifts right, interest rate increases and GDP increases

<MCQ>

(2)

- II. In a liquidity trap, which of the following statements are true
- A. The LM curve is horizontal
 - B. The IS curve is vertical
 - C. An increasing in investment is ineffective in increasing the output
 - D. An increasing in money supply is ineffective in increasing the output

<MCQ multi-select>

(2)

Question 33

- III. The LM curve represents the combinations of interest rate and output where **money supply equals money demand**. The IS curve represents the combinations of interest rate and output where **total spending=total output**.

In a closed economy, the following information is given:

$$C=200+0.75(Y-T)$$

$$I=300-25i$$

$$G=250$$

$$T=200$$

$$M=1000$$

$$P=2$$

where C, I, G, T, M, P indicate consumption function, investment function, government spending, tax, quantity of money and price level respectively.

$$\text{Real money demand}=0.25Y-20i$$

Y is the national income while i is the interest rate.

By deriving the equation of the IS and LM curve, calculate the equilibrium interest rate and national income. Round off your answers to the nearest integer.

(For eg, if you think the equilibrium interest rate is 4.1 and national income is 100.8, give your answer as: 4, followed by 101.

<Integer set>

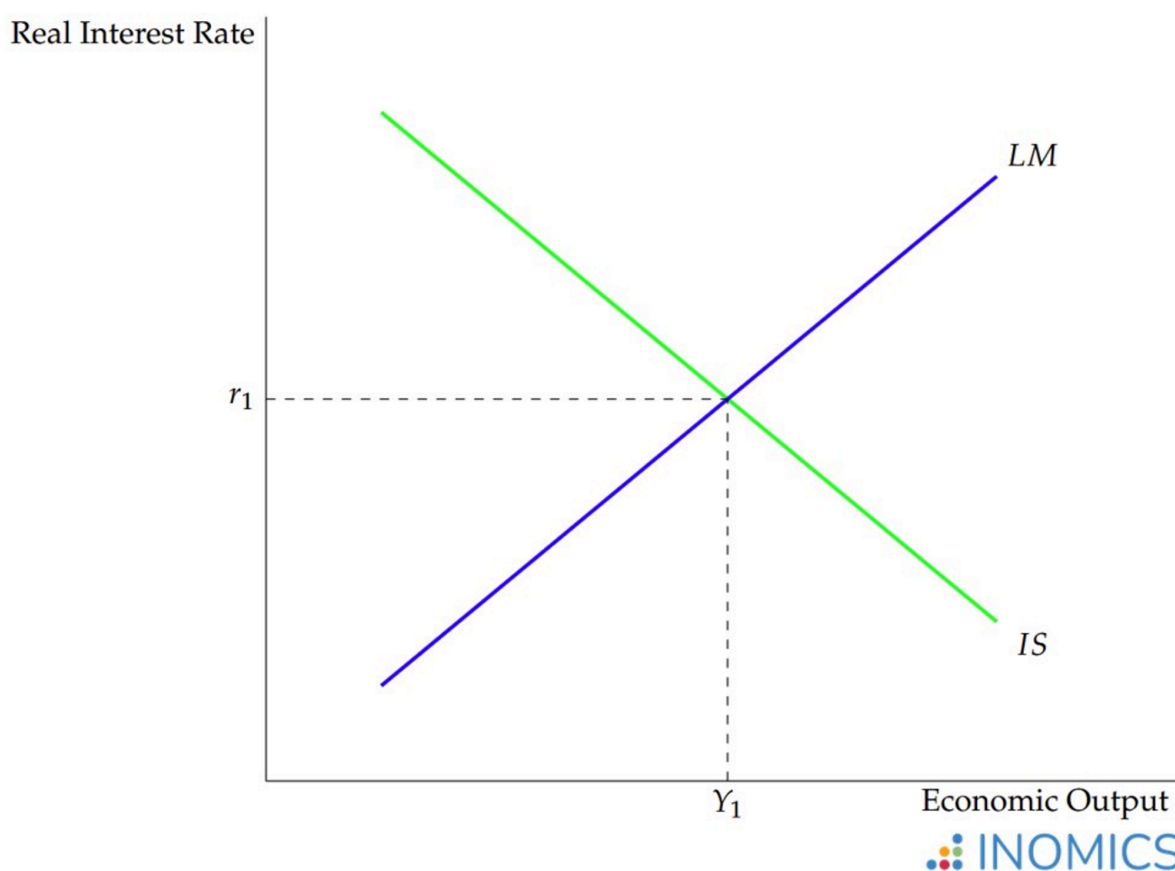
(6)

Question 33

Solution

In the IS-LM model, the output/GDP is placed at the horizontal axis while interest rate is placed at the vertical axis.

Figure 1: The IS-LM Model at Equilibrium

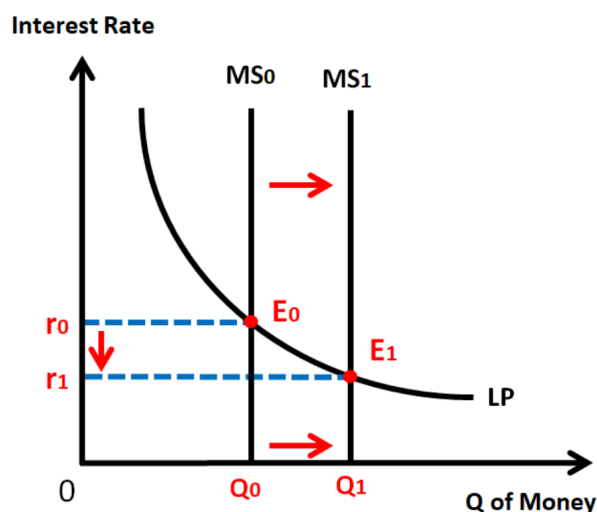


Solution to (i)

Answer: B

Explanation: The LM curve shows the combination of interest rate and output where the money supply=money demand.

Question 33



From this graph of money market equilibrium, a rise in money supply (rightwards shift) leads to a **lower interest rate and higher output** to ensure the new equilibrium where money supply=money demand. This is reflected by a **rightward shift of the LM curve**.

Solution to (ii)

Answer: A, D

Explanation:

Liquidity traps refer to a situation where interest rate is very low and increases in money supply has no effect on the interest rate.

The LM curve becomes horizontal with a fixed interest rate. Under this circumstance, any changes in money supply will not affect the interest rate and the output.

However, an increase in investment means that at any interest rate, there is a higher aggregate demand and output. This is represented by a rightwards shift of the IS curve along a horizontal LM, increasing the output.

Hence option A and D are correct.

Solution to (iii)

Answer: 2,2178

Explanation:

The IS curve is defined by $Y = C + I + G$, in which total output(income)=total spending in the economy.

Substituting the values: $Y = 200 + 0.75(Y - 200) + (300 - 25i) + 250$.

After simplification, IS curve: $Y = 2400 - 100i$

The LM curve's equation is under the condition that money supply=money demand.

Money supply is derived by quantity of money/price level.

Question 33

Money supply = $M/P = 1000/2 = 500$

Money demand = $0.25Y - 20i$

Hence, LM curve: $500 = 0.25Y - 20i$, $Y = 2000 + 80i$

The equilibrium national income(Y) and interest rate(i) is the intersection between the IS and LM curve.

Solving the two simultaneous equation:

(1): $Y = 2400 - 100i$

(2): $Y = 2000 + 80i$

$i = 2.22$ and $Y = 2177.8$

Rounding off to the nearest integer, the answer is [2, 2178]

Question 34

Pretty Shoes

Difficulty: Hard

Total Points : 12

Author: Li Zonglun

Everyone likes having nice, matching pairs of shoes. But people on Earth-1357 have it pretty hard when it comes to getting matching shoes... Most people there have a significantly larger left foot, thanks to a peculiar evolutionary development. So, unfortunately for them, their left shoes typically cost quite a bit more than their right shoes.

Left shoes and right shoes are perfect complements in a 1:1 fixed ratio. A single shoe for either foot allows the consumer to derive 0 utility, and only with both shoes do consumers derive utility.

Suppose that the market sells Left Shoes (L) and Right Shoes (R) separately.

The marginal cost of Left Shoes $MC_L = 0.6q$

The marginal cost of Right Shoes $MC_R = 0.3q$

There are 100 identical consumers in this market, each with \$3500. They are happy to buy as many pair of shoes as possible.

Suppose that the markets for L and R are both perfectly competitive, meaning that the price is equal to marginal cost.

Question

Score

- i. How many pairs of shoes will each consumer purchase?
Integer (3)
- ii. Due to a sudden genetic mutation, all consumers' left and right feet both grew even larger. Now, the Left Shoes have $MC_L = lq$ and Right Shoes have $MC_R = rq$
It is known that the total number of shoes sold had fallen by 15% (rounded to the nearest tenth), and the money spent on the shoes has remained exactly the same as (i).
What is $(l+r)$? Give your answer in 3 significant figures (s.f.s) (3)

Question 34

Float

- iii. Shoe Inc. decided to buy out all smaller firms on the market, making the shoe market a monopoly. Shoe Inc. still faces the same cost structure as before in (ii) [please use the final 3sf answer found in (ii)], with no fixed costs. The monopoly has decided to bundle the shoes together, selling them as one item.

Now, suppose that the demand is linear

What will be the selling price of said bundle?

Integer

(3)

- iv. Continuing from (iii), now the demand for shoes follows a linear pattern.

Demand = $10 - p/10$

Do keep in mind that quantities can only exist as integers!

What is the new selling price of said bundle?

Integer

(3)

Question 34

Solution

Solution to (i)

Answer: 6

Explanation:

The marginal cost of Left Shoes $MC_L = 0.6q$

The marginal cost of Right Shoes $MC_R = 0.3q$

There are 100 identical consumers in this market, each with \$3500. They are happy to buy as many pair of shoes as possible.

Therefore, total price = $0.6(100q) + 0.3(100q) = 90q = 3500/q$

$q^2 = 3500/90$

$q = 6.2361 = 6$ (rounded down)

Total money spent per person = $6 \times 0.9(600) = 3240$

Solution to (ii)

Answer: 1.30

Explanation:

Total quantity traded = $6 \times 0.8 \times 100 = 510 = 500$ (since each person can only buy an integer pairs of shoes)

$(1+r) \times 500 \times 5 = 3240$

$1+r = 1.296 = 1.30$ (3sf)

Solution to (iii)

Answer: 3500

Explanation:

This is a slight trick question. There is no need for any calculations.

As consumers only have a total of \$3500 to spend, but is willing to spend it all no matter the pairs of shoes they can get, the way to earn the most is to sell each pair at \$3500.

This allows the maximum revenue (\$3500/person) as well as the minimum cost (only one pair of shoes must be created per person)

Solution to (iv)

Answer: 60

Explanation:

Question 34

$$\text{Demand} = 10 - p/10$$

We understand that $AR = \text{Demand}$,

Rewrite the Demand in terms of quantity to obtain $p = 100 - 10q$

$MR = 100 - 20q$ (since MR is given by AR with twice gradient)

To maximise profit, $MR = MC$

$$100 - 20q = 1.30q$$

$$q = 4.6948 = 4 \text{ (rounded down)}$$

$$p = 60$$

Question 35

Savings and capitals

Difficulty: Hard

Total Points : 10

Author: Fan Yixiang fanyixiang2006@gmail.com

The Solow growth model shows us how saving, population growth, capital and technological growth affect an economy's output and growth. In the model, it assumes that **people save a fraction s of their income as investment and consume the rest of their income.** s is the saving rate and is a number between 0 and 1.

Question

Score

- i. In a particular closed economy where government spending is omitted, the national income Y , is given by 200 while the investment I , is given by 60. Calculate the saving rate s of the economy. Leave your answer in 2 decimal places

<Float>

(2)

- ii. In another closed economy where government spending is omitted, the production function is given by

$$Y = K^{\frac{1}{2}} * L^{\frac{1}{2}}$$

Where Y is the national output, K is the national capital's stock and L is the labour force.

The economy's saving rate is 0.4 per year and the savings is invested into capital stock. However, 10% of the economy's capital stock depreciates per year. At the start of the 1st year, units of capital per worker is 4. Calculate the units of capital per worker of the economy in the 3rd year. Give your answer to 4 decimal places.

<Float>

(5)

- iii. In the solow model, there is an important concept called the steady state of an economy, where the capital stock reaches an equilibrium. Calculate the units of capital per worker of the **economy in part ii in steady state.**

<Integer>

(3)

Question 35

Solution

Solution to (i)

Answer: 0.30

Explanation:

Since it is a closed economy, government spending and net exports are omitted. Using the national income formula:

National income = consumption + investment

$$Y = C + I$$

$$C = 140$$

A fraction of $(1-s)$ of the income is consumed in the economy, hence

$$C = (1-s) \cdot Y$$

By substituting the value of $C=140$ and $Y=200$, $s=0.3$

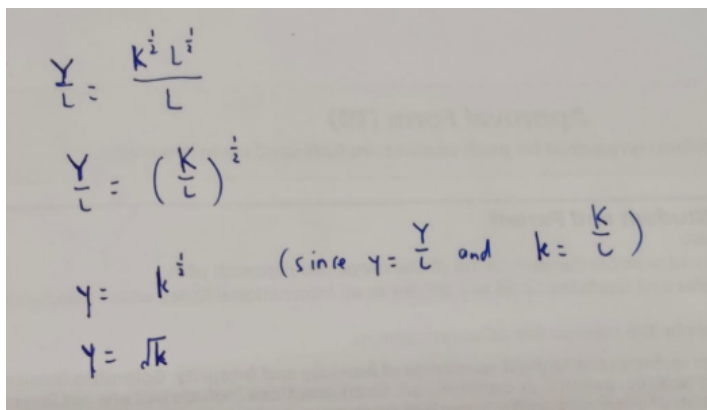
Solution to (ii)

Answer: 4.799

Explanation:

The production function given is on a national scale and we need to derive the per-worker production function. Let **y** be the output per worker and **k** be units of capital per worker

Dividing both sides by labour force L :



Handwritten derivation of the per-worker production function:

$$\frac{Y}{L} = \frac{K^{\frac{1}{2}} L^{\frac{1}{2}}}{L}$$
$$\frac{Y}{L} = \left(\frac{K}{L} \right)^{\frac{1}{2}}$$
$$y = k^{\frac{1}{2}} \quad \left(\text{since } y = \frac{Y}{L} \text{ and } k = \frac{K}{L} \right)$$
$$y = \sqrt{k}$$

Question 35

Substitute $k=4$, the output per worker y is 2.

Using the saving rate of 0.4, 40 percent of the output is saved and invested as capital

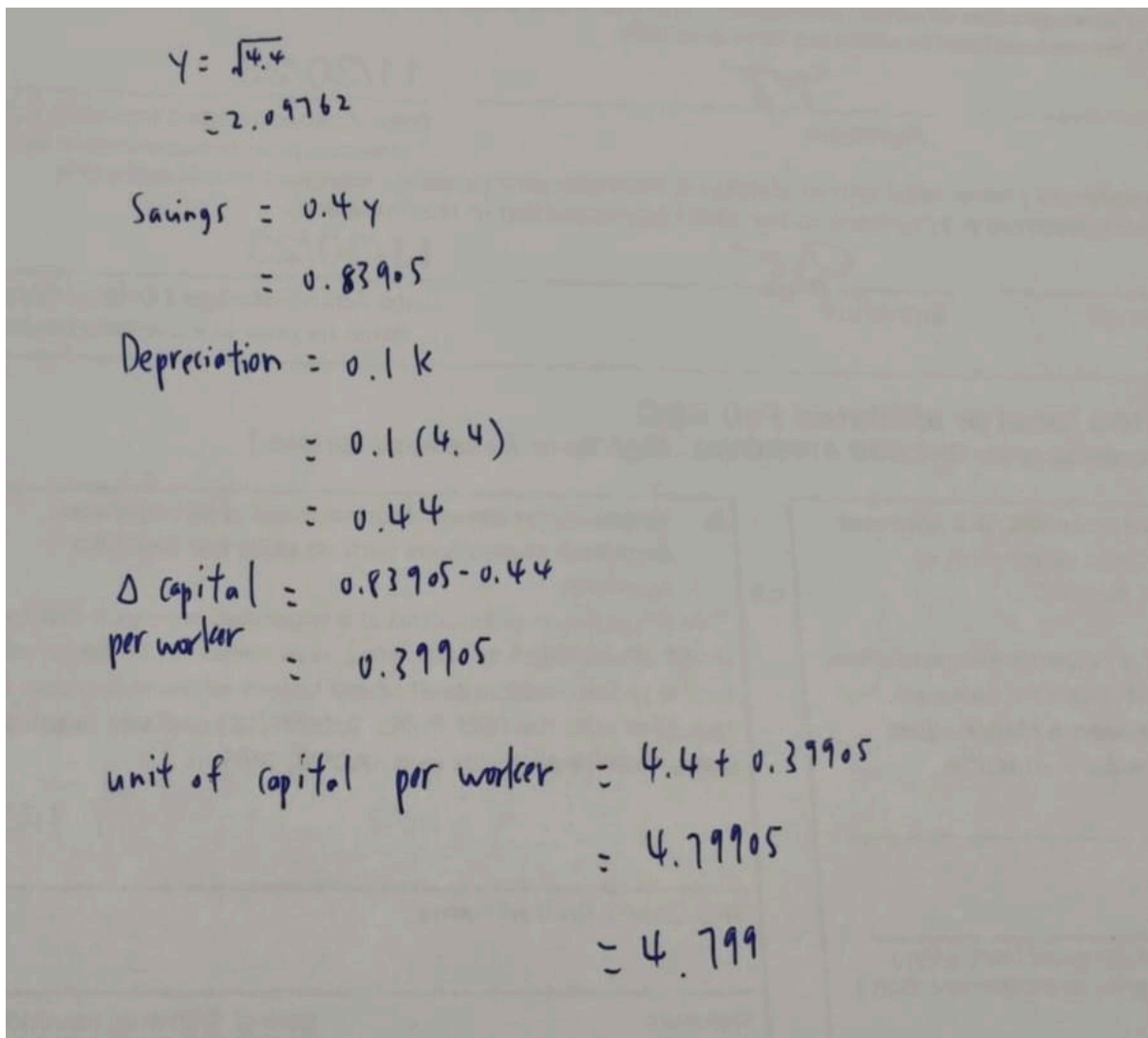
stock. Investment into capital stock = 0.8

Depreciation of capital stock = $10\% \times k = 0.4$

Overall change of capital = $0.8 - 0.4 = +0.4$

Hence at the start of the 2nd year, the units of capital per worker is 4.4.

Calculating for another year:



Handwritten calculations showing the progression of capital per worker:

$$y = \sqrt{4.4}$$
$$= 2.09762$$
$$\text{Savings} = 0.4y$$
$$= 0.83905$$
$$\text{Depreciation} = 0.1k$$
$$= 0.1(4.4)$$
$$= 0.44$$
$$\Delta \text{ capital per worker} = 0.83905 - 0.44$$
$$= 0.39905$$
$$\text{unit of capital per worker} = 4.4 + 0.39905$$
$$= 4.79905$$
$$= 4.799$$

Hence the unit of capital per worker at the 3rd year is 4.799.

Question 35

Solution to (iii)

Answer:16

Explanation:

To achieve steady state where capital stock reaches an equilibrium, the **saving of capital must be equal to the depreciation of capital**. Let d represents the depreciation rate of capital.

Saving rate*income=depreciation rate*capital stock

$$s*Y=d*k$$

$$\frac{k}{y} = \frac{s}{d}$$

$$\text{Since } y = \sqrt{k}, \frac{k}{\sqrt{k}} = \frac{0.4}{0.1},$$

Squaring both sides, $k=16$

Question 38

Mad Max: Intertemporal Wasteland Survival

Difficulty: Hard

Total Points : 20

Author: Jonas

The world has crumbled into the *Wasteland* — a harsh desert ruled by chaos, scarce resources, and brutal factions. Survivors eke out existence amid sandstorms and scavenged tech, clinging to fragile trade networks and whatever scraps they can hoard.

In this unforgiving world, every decision about how much fuel, food, and ammo to consume now versus save for the uncertain future can mean life or death. The future income of scavenged resources is wildly unpredictable; some days the raid yields plenty, others, nothing but dust. Trade is risky as there are no formal markets or insurance. The only guarantee: your base income today.

Each day's consumption depends on what you have on hand and what you choose to set aside. The more you consume now, the less you will have stashed for the future. But the more you stash, the more you'll have available tomorrow, both from your next haul and whatever modest gains (or spoilage savings) come from what you stored.

Your survival utility can be summarized by a power utility function reflecting risk aversion and time preference:

$$U = \frac{C_1^{1-\sigma}}{1-\sigma} + \beta \cdot \mathbb{E} \left[\frac{C_2^{1-\sigma}}{1-\sigma} \right]$$

where:

- C_1 = supplies consumed **today**
- C_2 = supplies consumed **tomorrow**
- $\sigma = 2, \beta = 0.96$ reflect your **survival instincts** and **patience**

When you stash supplies today, they don't remain perfectly preserved. Some spoilage or decay happens, but clever storage or scavenged tech can also slightly increase your stockpile. We capture this net effect as a **small growth factor** $r = 0.05$ (5%) on saved supplies.

Your choices now will determine if you survive the next raid or fall prey to the *Wasteland*.

Question 38

Question

Score

- i. You face a future scavenging haul y_2 that is uncertain: either yielding **15 units** or **5 units**, each outcome being equally likely.

How much should you stash, a_1 , from your current haul $y_1 = 10$ to maximize your expected survival utility? Give your answer rounded to 3 significant figures.

Float

(8)

- ii. Rumours ripple through the camps: if 60% of survivors stash more than 4 units, the *Wasteland Overlord* will declare a “panic tax,” confiscating 40% of any stash above 4 units during the next raid. The Overlord’s tax applies only if the panic threshold is reached, but **no warning is given beforehand**. Survivors cannot observe others’ stash choices and decide simultaneously each round.

Determine if each statement below is true or false.

- Given the panic tax mechanism, all Nash equilibria where some survivors stash more than 4 units while others stash less necessarily involve Pareto inefficiencies caused by externalities.
- Although coordination among survivors can reduce the frequency of the panic tax, the strategic incentives inherent in individual consumption decisions make complete and permanent avoidance of the tax unlikely in practice.
- Under certain conditions, equilibria can emerge in which a heterogeneous mix of survivors stash above and below the threshold, leading to recurrent but unpredictable triggering of the panic tax.
- In an infinitely repeated game setting, survivors can sustain an equilibrium where everyone stashes at or below 4 units indefinitely by using threat strategies, provided the discount factor is sufficiently high.

True False

(4)

- iii. In a neighboring enclave, supply hauls come from an oil field with continuous yields between 5 and 25 units, each value being equally likely.

You stash 2 units now. What is your **total expected lifetime utility** accounting for both today’s consumption and the uncertain supply tomorrow, as well as the continuous income uncertainty and the survival utility function above? Give your answer rounded to 4 decimal places.

Using the expected value of y directly **will not yield the correct answer**.

Float

(8)

Question 38

Solution

Solution to (i)

Answer: 1.45

Explanation:

Step 1: Define the Utility Function $U(a_1)$

Let a_1 be the amount stashed from today (period 1) to the future (period 2).

- Income today: $y_1 = 10$
- Future income:
 - $y_2 = 15$ with 50% chance
 - $y_2 = 5$ with 50% chance
- Stash grows at $r = 0.05$
- Discount factor $\beta = 0.96$
- CRRA utility with $\sigma = 2$ gives: $u(C) = -1 / C$

So the utility function becomes:

$$U(a_1) = -1 / (10 - a_1) - 0.48 \times [1 / (15 + 1.05a_1) + 1 / (5 + 1.05a_1)]$$

(Here, $0.48 = 0.96 \times 0.5$, due to discounting and equal probability)

Step 2: Differentiate $U(a_1)$ with respect to a_1

We compute:

$$dU/da_1 = 1 / (10 - a_1)^2 - 0.504 \times [1 / (15 + 1.05a_1)^2 + 1 / (5 + 1.05a_1)^2]$$

This represents the tradeoff between marginal utility lost from saving (less consumption today) and marginal utility gained from more expected consumption in the future.

Step 3: Set Marginal Cost = Marginal Benefit

To find the optimal a_1 , set the derivative to zero:

$$1 / (10 - a_1)^2 = 0.504 \times [1 / (15 + 1.05a_1)^2 + 1 / (5 + 1.05a_1)^2]$$

This equation balances:

- Left-hand side: Marginal cost of saving (from consuming less today)
- Right-hand side: Marginal expected benefit of saving (from consuming more tomorrow, adjusted for uncertainty and time)

Step 4: Solve for a_1 Numerically

Using a calculator or numerical solver, we find that the equation balances when:

Question 38

$$a_1 \approx \mathbf{1.45}$$

This is the optimal amount the survivor should stash from today's income to balance present and future utility.

Question 38

Solution to (ii)

Answer: False, True, True, True

Explanation:

(a) False

Not all such equilibria are necessarily Pareto inefficient. Some equilibria with mixed stash levels can be Pareto optimal within the constraints of individual incentives and available strategies, especially if survivors face heterogeneous preferences or risk profiles. While externalities often cause inefficiencies, certain equilibria can be efficient given these constraints, so it is incorrect to say all such equilibria necessarily involve Pareto inefficiency.

(b) True

Individual incentives to stash more than 4 units to maximize consumption create temptation that destabilizes any coordinated effort. This tension between collective benefit and individual gain makes permanent avoidance unlikely.

(c) True

Mixed or asymmetric equilibria can exist where a fraction stash >4 and others ≤ 4 , causing the tax to be triggered occasionally. This equilibrium is stable if no one can improve payoff by unilateral deviation.

(d) True

With repeated interactions and sufficiently patient survivors (high discount factor), cooperation can be sustained via trigger strategies. The future punishment threat outweighs short-term gain, making stashing ≤ 4 an equilibrium.

Question 38

Solution to (iii)

Answer: 0.1893

Explanation:

- Today's consumption: $C_1 = 10 - 2 = 8$
- Tomorrow's consumption: $C_2 = y + 2.1$ where $y \sim U(5, 25)$ and stash grows to $2 \times 1.05 = 2.1$

Total expected utility:

$$U = u(C_1) + \beta \cdot E(u(C_2)) = -\frac{1}{8} - 0.96 \times \frac{1}{20} \int_5^{25} \frac{1}{y+2.1} dy \text{ (continuous probability)}$$

$$\int_5^{25} \frac{1}{y+2.1} dy = \ln 27.1 - \ln 7.1 \approx 1.339438944$$

Thus,

$$U = -\frac{1}{8} - 0.96 \times \frac{1}{20} \times 1.339438943 \approx 0.1893$$

Question 37

Pirate game

Difficulty: Hard

Total Points : 12

Author: Fan Yixiang fanyixiang2006@gmail.com

Question

Score

Five pirates — A, B, C, D, E — have captured 100 identical gold coins and must decide how to divide them. The pirates take turns making proposals, starting with Pirate A. If a proposal is rejected, the proposer is thrown overboard, and the next pirate in line makes a new proposal and the remaining pirates vote. This continues until a proposal is accepted.

For each proposal, all remaining pirates (including the proposer) vote on whether to accept it. A proposal passes if it receives a **simple majority** (at least **3 out of 5 votes**) in favor. Otherwise, it is rejected and the proposer is thrown overboard.

Given that all pirates are

1. Perfectly rational and aware that others are as well
2. Greedy (Aiming to not be thrown overboard and maximize the number of coins they receive.)
3. Evil (**When it does not affect the coins they get**, they prefer to throw others overboard. For eg pirates would prefer getting 50 coins and throw another pirate overboard to getting 50 coins, but pirates would prefer getting 50 coins to getting 49 coins and throwing another pirate overboard)
4. Untrusting and will not form an alliance.

Question 37

- i. There are 2 different proposals: P_1, P_2 , which pirate A can propose to ensure his survival and get as many coins as possible.

Each proposal P_i can be represented by an integer I_i , which shows the coins allocated to each pirate from the order of A to E. For example, if you believe pirate A should allocate 10 coins to B, 1 coin to C, 5 coins to D, 0 coins to E and leave 84 for himself, the corresponding Integer is 8410150.

Find both possible proposals, and give the corresponding 2 integers in **ascending numerical order**.

- A) Smaller Integer
- B) Larger Integer

Integer set: 6 points

- ii. Suppose now there is a 6th pirate, pirate F.

There are now 3 possible proposals which pirate A can propose to ensure his survival and get as many coins as possible. Find all 3 possible proposals, and give the corresponding 3 integers in **ascending numerical order**.

Input your answer in the same way as part i. For example, if you believe pirate A should allocate 10 coins to B, 1 coin to C, 5 coins to D, 0 coins to E, 1 coin to F and leave 83 for himself, give your answer as 83101501.

- A) Smallest Integer
- B) Middle Integer
- C) Largest Integer

Integer set : 6 points

Question 37

Solution

Solution to (i)

Answer:

A) 970102

B) 970120

Explanation:

Pirate A will start backtracking:

In the case of 2 pirates (D and E), E will reject whatever proposal D proposes (even if E is offered 100 coins) as **pirates are all evil**. E prefers rejecting the proposal, throwing D overboard and gets 100 coins than getting 100 coins.

Hence D will always avoid the situation of a 2 pirates scenario. To prevent this, D will ensure C survives (1).

In the scenario of three pirates (C, D and E), pirate C can confidently allocate all 100 coins to himself, leaving 0 to D and E (2). As established earlier in (1), D will accept any proposal to avoid a 2 pirates scenario to avoid being thrown overboard. Hence D will always support C and C will have the majority votes (2 out of 3). Hence C is able to allocate all coins to himself.

[100(C),0(D),0(E)]

In the scenario of 4 pirates (C, D, E and F), C needs to allocate coins in a way that 2 out of D, E and F agree to him. **Given that C, D, E and F all know (2) will happen in the scenario of 3 pirates, C will allocate 1 coin to E and F each, and leave 98 coins for himself (3).** Since having 1 coin is better off than having 0 in the scenario of 3 pirates, E and F will agree to this proposal. (Note: C cannot propose all 100 coins for himself, as pirates are all evil and **E and F will choose to throw C overboard and get 0 coin in the scenario of 3 pirates, then just get 0 coin in the scenario of 4 pirates)**

[98(C),0(D),1(E),1(F)]

Question 37

The key is that the pirate making the proposal(C) must understand how many coins the other pirates(D, E and F) will get if he is thrown overboard, and make a better proposal to one or more of these pirates(D, E and F) to earn their votes.

In the scenario of 5 pirates, B will **allocate 1 coin to D and 2 coins to either E or F , and leave 97 coins for himself.**

D will be better off as he can get 1 coin under this proposal instead of 0 in the scenario of 4 pirates. Hence D will accept the proposal.

If the 2 coins are given to E, E will be better off as he can get 2 coins instead of 1 coin in the scenario of 4 pirates. Hence E will accept the proposal. Vice versa for F.

B, D and E/F(whoever is allocated 2 coins) will accept the proposal, which is the simple majority (3 out of 5).

[97(A),0(B),1(C),2(D),(E)] or [97(A),0(B),1(C),0(D),2(E)]

Hence the allocation is **either 970120 or 970102.**

Solution to (ii)

A) 9501022

B) 9501202

C) 9501220

Explanation:

From part i), pirate A knows that pirate B will allocate based on the scenario of 5 pirates since all pirates are rational, and the allocation would be

[97(B),0(C),1(D),2(E),0(F)] or [97(B),0(C),1(D),0(E),2(F)]

A needs to ensure that 3 out of B, C, D, E, F are better off under his allocation than the scenario of 5 pirates above, such that 4 pirates will accept his proposal including him.

C's vote is the easiest to get since he is always getting 0 coins in the scenario of

Question 37

5 pirates. Hence, **A just needs to allocate 1 coin to C and C will always accept A's proposal.**

D is always getting 1 coin in the scenario of 5 pirates. Hence, **A will allocate 2 coins to D and D will always accept A's proposal.**

Then, **A just needs to allocate 2 coins to either E or F.**

If A allocates 2 coins to E and 0 to F:

From E's perspective, he has a **50% chance of getting 2 coins and 50% chance of getting 0 coin in the scenario of 5 pirates** since there is no alliance. Hence when E is offered 2 coins by A, he will accept the proposal to secure his 2 coins.

E accepts the proposal: E is guaranteed to get 2 coins

E rejects the proposal: A is thrown overboard but E may get 50 or 0 coins in the scenario of 5 pirates.

E would rather secure his 2 coins than throw A overboard since throwing A overboard may affect the coins E gets in the subsequent proposal. The rule of pirates being evil does not apply here.

Vice versa for F.

A, C, D and E/F(whoever is allocated 2 coins) will accept the proposal, and it will be a simple majority of (4 out of 6)

To maximise his own coin, A will allocate 0 coin to B, since A already has enough votes.

Hence two of the proposals are

[95(A),0(B),1(C),2(D),2(E),0(F)], [95(A),0(B),1(C),2(D),0(E),2(F)]

There is actually another proposal, and that would be **giving 1 coin to C and 2 coins to both E and F. Both E and F will agree to this to secure their 2 coins, as they know that if A is thrown overboard, one of them will get 0 coins in the scenario of 5 pirates. A will still have 95 coins to himself.**

Hence the other proposal is

[95(A),0(B),1(C),0(D),2(E),2(F)]

Hence the answers are **(9501220, 9501202, 9501022)**

Question 37



Singapore Economics League **2025**

Singapore Economics League 2025

Economania: Answer key and worked solutions

Head of Academics: Li Zonglun

Academics Consultant: Zhao Yuxuan

Problem Setters: Jonas Lim, Fan Yixiang, Theodore Chou

Chief Organiser: Ho Jon Yew

Neville's Risky Broom Deal

Difficulty: Economania Easy

Total Points: 6

Author: Jonas

In the mystical world of Harry Potter, students buy and sell used broomsticks in Diagon Alley at a broom exchange shop run exclusively by students. Each broom is either good or bad, but only the seller knows the true quality of it. Naturally, in this classic case of asymmetric information, buyers and sellers value each broom differently.

- Buyers value
 - Good broom: 120 Galleons
 - Bad broom: 30 Galleons
- Sellers value
 - Good broom: Minimum price to sell = 100 Galleons
 - Bad broom: Minimum price to sell = 20 Galleons

Suppose 70% of all broomsticks in the market are bad, and the rest are good.

Buyers know this distribution and offer a single market price based on expected value. A certain buyer, Neville Longbottom, is risk-averse, and values uncertain outcomes less than their expected value.

Question

Score

- i. Neville is risk-averse and is willing to pay only 50 Galleons for a broom from the market.

What is Neville's risk premium?

Integer

(3)

- ii. The Beggar's Broom, a unique, valuable broomstick, is auctioned in a sealed-bid first-price auction between Neville and an anonymous buyer.
- Neville's valuation V_N is 150 Galleons.
 - The anonymous buyer's valuation V_A is unknown to Neville, but to his best knowledge, V_A has an equal probability of being anywhere between 100 and 140 Galleons.

Micro 1

Neville wants to maximize expected surplus, so he decides to bid b_N less than her true valuation to avoid overpaying.

Given the anonymous buyer bids their true valuation V_A , Neville chooses a bid b_N such that the probability of winning is the probability $b_N > V_A$.
If Neville bids 130 Galleons, calculate Neville's expected surplus.

Integer

(3)

Solution

Solution to (i)

Calculate the expected value (EV) of the broom. Given that 30% of brooms are good and valued at 120 Galleons, and 70% are bad and valued at 30 Galleons, the EV is:

$$(0.3 \times 120) + (0.7 \times 30) = 36 + 21 = 57 \text{ Galleons.}$$

Neville is willing to pay only 50 Galleons, which is his certainty equivalent (CE).

The risk premium is the difference between the expected value and the certainty equivalent:

$$\text{Risk Premium} = \text{EV} - \text{CE} = 57 - 50 = 7 \text{ Galleons.}$$

Solution to (ii)

Since the Anonymous buyer's (A) valuation is uniformly distributed between 100 and 140 Galleons, the probability that A's valuation is less than 130 is $(130 - 100)$ divided by $(140 - 100)$, which equals 30 divided by 40, or 0.75.

Calculate the surplus Neville gets if he wins the auction. This is Neville's valuation (150 Galleons) minus his bid (130 Galleons), which equals 20 Galleons.

Calculate the expected surplus by multiplying the probability of winning (0.75) by the surplus if winning (20 Galleons), which gives 0.75 times 20, or 15 Galleons.

A short position that goes wrong

Difficulty: Moderate

Total Points : 7

Author: Fan Yixiang fanyixiang2006@Gmail.com

In March 2022, Tsingshan Holding Group — a major industrial nickel producer — suffered significant losses after shorting nickel prices. The company held short positions totalling approximately 200,000 tonnes of nickel on the London Metal Exchange (LME).

Assume Tsingshan entered into a futures contract to sell 200,000 tonnes of nickel at a price of \$20,000 per tonne. The initial margin requirement is 10% of the total contract value.

Question

Score

- i. The price of nickel rises to \$30,000 per ton, triggering a margin call. What is the total amount of money Tsingshan Holding Group has deposited into the margin account over time?
Denominate your answer in millions. For instance, if you think the amount of money is \$30 000 000, input your answer as 30.

Integer

(3)

- ii. In March 2022, Tsingshan Holding Group was almost forced to close out their short position of nickel before expiry due to various reasons. Which of the following are possible reasons?
- A. The price of Nickel dropping sharply below \$20000 per ton
 - B. The price of Nickel rising sharply above \$20000 per ton
 - C. Tsingshan Holding Group not having enough cash or liquid assets
 - D. Tsingshan Holding Group not engaging in Nickel trading for long period of time
 - E. Tsingshan Holding Group possessing way more than 200,000 tonnes of nickel
 - F. Tsingshan Holding Group possessing way less than 200,000 tonnes of nickel

MCQ Multi Select

(2)

- iii. The price of nickel rises to \$100,000 per ton. Which of the following statements is true?
- A. As long as Tsingshan Holding Group has 16 billion in funds and 20 tonnes of nickel, Tsingshan Holding Group will gain 4000 million from selling of nickel.
 - B. Tsingshan Holding Group suffers a loss of 16 billion due to the rise in price of nickel, as they could have sold their 20,000 tonnes of Nickel at a higher price.
 - C. Tsingshan Holding Group suffers a loss of 16 billion due to the rise in price of nickel, as they will need to deposit this amount into the margin account in addition to the initial margin requirement.
 - D. Tsingshan Holding Group can choose to close out their short positions and sell their nickel at the price of \$100,000 per ton. Overall, they gain \$80,000 per ton of nickel compared to not closing out their short position.

MCQ

(2)

Solution

Solution to (i)

Answer: 2400 Million

Explanation:

Contract size: $20,000 \times 200,000$

Initial margin: $10\% \times 20,000 \times 200,000 = 400,000,000$

Initially, 400 million is deposited into the margin account.

Even when the price of nickel increases to \$30,000 per ton, Tsingshan Holding Group still needs to sell their 200,000 tonnes of nickel at \$20,000 per ton, triggering a loss of $\$10,000 \times 200,000$ (2000 million). Hence Tsingshan Holding Group's current margin account balance fell to:

$400 \text{ million} - 2000 \text{ million} = -1600 \text{ million}$

A margin call was triggered and **Tsingshan Holding Group had to deposit another 2000 million** into the margin account to bring the balance back to the required initial margin of 400 million.

Hence total amount deposited: $400 \text{ million} + 2000 \text{ million} = 2400 \text{ million}$

Solution to (ii)

Answer: B,C,F

Explanation:

In this case, the short position closes out by force can be due to

1. A margin shortfall - Tsingshan Holding Group unable to meet the margin requirements/margin call
2. Tsingshan Holding Group unable to deliver the 20 tonnes of nickel

Option A: The sharp drop of nickel's price benefits Tsingshan Holding Group and the short position will remain.

Option B: The sharp rise of nickel's price leads to a huge loss in the margin account, and Tsingshan Holding Group needs a large sum of cash/liquid assets to meet the margin call urgently. This increases the likelihood of the short-position closing out.

Micro 2

Option C: Not having enough cash or liquid assets may pose difficulties in maintaining the margin account for Tsingshan Holding Group in the event of a sharp rise in nickel price. This increases the likelihood of the short-position closing out.

Option D: As long as the margin is maintained, the short position will remain even when there is inactivity.

Option E: Tsingshan Holding Group has sufficient physical nickel for delivery under the futures contract and the short position will remain.

Option F: Tsingshan Holding Group does not have sufficient physical nickel for delivery under the futures contract. This increases the likelihood of the short-position closing out.

Solution to (iii)

Answer: A

Explanation:

Option A - Tsingshan Holding Group will need 16 billion of funds to deposit into the margin account for maintenance margin and 20 tonnes of nickel for delivery.

When these conditions are met, they can sell their 200,000 tonnes of nickel at \$20,000 per ton under the contract, gaining 4000 million from selling the nickel. Hence A is correct.

Option B - While Tsingshan Holding Group is selling the nickel at a lower price under the future contract, they are not necessarily losing money. Instead, they are just gaining less from the selling of nickel. Hence B is incorrect

Option C - The 16 billion deposited into the margin account is not a "loss" to Tsingshan Holding Group, if the short position does not close out before expiry. Tsingshan Holding Group will receive back this 16 billion after the 20 tonnes of nickel is delivered at a price of \$20,000 per tonne. Hence C is incorrect.

Option D - Tsingshan Holding Group can actively close out their short position and sell their nickel at the new price of \$100,000 per ton. However, they do not gain \$80,000 per ton of nickel. The decision of closing out their short position leads to the loss of 16 billion in their margin account. Hence Tsingshan Holding Group gains less than \$80,000 per ton of nickel when factoring in the deposit in margin account. Hence D is incorrect.

Micro 3

Singapore Economics League 2025

When fairness is in place

Difficulty: Hard

Total Points : <9>

Author: Fan Yixiang fanyixiang2006@gmail.com

The Ultimatum game is an experiment to explore how people interact and make decisions in dividing resources.

In the Ultimatum game, there is a proposer and a responder. The proposer is provisionally given some money and decides on how much of this money to offer to the responder.

If the responder accepts the offer, the proposer and the responder will receive the money as proposed in the offer.

If the responder rejects the offer, both the proposer and the responder will receive nothing.

Question

Score

- I. Which of the following statement is **always true** about the Ultimatum game
- A. A self-interested responder will accept the proposer's offer
 - B. The proposer is being altruistic when they make a generous offer to the responder
 - C. When reciprocity, social norm of fairness are present, an offer of 50-50 will be accepted
 - D. The game goes against classical economics assumption of rationality
 - E. The proposer has all the power in how to split the total amount of money

<MCQ multi-select>

(2)

Micro 3

Singapore Economics League **2025**

- II. In an Ultimatum game, the proposer is provisionally given \$100. The responder has a reciprocity motive and is willing to lose money to punish unfairness.

The responder gains satisfaction of y when accepting the offer.

The responder gains satisfaction of $R(50-y)$ when rejecting the offer, where y is the money offered to the responder and R is a constant.

Which of the following statements is true?

- A. R is an indicator of how much the responder cares about reciprocity
- B. R is an indicator of the power of responder in this Ultimatum game
- C. The responder upholds a norm of a 50-50 split
- D. The responder will reject any offer less than \$50

MCQ Multi-select

(2)

- III. When the constant R is 1.5, how much should the proposer offer to the responder to maximise the amount of money he gets, given that the responder will accept the offer when there is indifference in accepting and rejecting the offer?

<Integer>

(2)

- IV. In another Ultimatum game, the proposer is provisionally given \$100. The probability of the responder accepting the offer is

$$\frac{1}{1 + e^{-k(y-0.25)}}$$

where y is the fraction of the total sum offered to the responder ($0 \leq y \leq 1$) and k is the parameter of how sensitive the responder is to fairness. The proposer knows that k could be one of these values, $k \in \{10, 20, 30\}$, with each value occurring with equal probability.

How much should the proposer offer to the responder to maximise the amount of money he gets? Round of your answer to 2 decimal place

<Float>

(3)

Micro 3

Singapore Economics League 2025

Solution

Solution to (i)

Answer: C, D

Explanation:

Option A - When an offer of \$0 is made to the self-interested responder, the self-interested responder is **indifferent** between accepting and rejecting the offer, since both have the payoff of 0, and will not always accept the offer. Hence option A is wrong

Option B - The proposer may make a generous offer to avoid rejection by responder who values fairness, hence this generous offer is made with self-interest. Hence option B is wrong.

Option C - A 50-50 split aligns with the common fairness norm. With reciprocity and social norm of fairness in place, the responder will accept a 50-50 split as they perceive this offer as fair. Hence option C is correct.

Option D - Classical economics assume responders will accept any non-zero offer, to maximise their self-interest. However there are cases where the responder rejects a non-zero offer to punish the proposer's unfair offer, even when the responder is sacrificing his own pay-off. Hence option D is correct.

Option E - The responder has the power to reject the offer and the proposer will receive nothing. While proposer does formally have the power to split the money, this power is limited by responder's willingness to reject the offer due to unfairness. Hence option E is wrong.

Solution to (ii)

Answer: A, B, C

Explanation:

Option A - The greater the R, the more the responder gains satisfaction from rejecting a low offer. Hence R indicates how much the responder cares about reciprocity. Hence option A is correct.

Option B - Similarly, the greater the R, the more likely the responder is to reject a low offer. The proposer must offer a fairer offer to ensure the responder will accept the offer. R indicates the power of rejection of responder in this game, hence option B is correct.

Option C - When the proposer offers \$50 or more, the satisfaction gained by the responder from rejecting the offer is 0 or below, hence the responder **will not reject any offer equal or more than 50**. When the proposer offers less than \$50, the

Micro 3

Singapore Economics League 2025

responder will gain some level of satisfaction from rejecting the offer and **may reject the offer**. Hence the responder abides by the 50-50 split and option C is correct Option D - When an offer less than \$50 is proposed, the responder will only reject it if the satisfaction of rejecting the offer, $R(50-y)$, is greater than the satisfaction of accepting the offer, y . It is not true that the responder will reject any offer less than \$50. Hence option D is wrong.

Solution to (iii)

Answer: 30 Explanation:

The responder will reject the offer if satisfaction of rejecting the offer > accepting the offer, which is $R(50-y) > y$.

Substitute $R = 1.5$: $75 - 1.5y > y$

$y > 30$

The responder's minimum acceptable offer is \$30, where satisfaction of accepting and rejecting the offer is the same. Hence the proposer should offer \$30 to the responder.

Solution to (iv)

Answer: 36.80

Explanation:

Since k has a $\frac{1}{3}$ probability of being 10, 20 or 30, the average acceptance probability is

$$P_{avg}(y) = \frac{1}{3} \cdot \frac{1}{1 + e^{-10(y-0.25)}} + \frac{1}{3} \cdot \frac{1}{1 + e^{-20(y-0.25)}} + \frac{1}{3} \cdot \frac{1}{1 + e^{-30(y-0.25)}}$$

The amount of money the proposer gets when a fraction of y is offered is $\$100 \cdot (1-y)$

The expected payoff for the proposer will be

$$P_{avg}(y) \cdot 100(1 - y)$$

By plotting the graph on desmos,

Micro 3

Singapore Economics League **2025**



The value of x that gives the maximum payoff for the proposer is 0.36804.

$\$100 \cdot 0.36804 = \$36.80$ (2dp)

Hence the responder should offer \$36.80 to the proposer.

Ghost in the Shell: Neural Wallets and Hollow Banks

Difficulty: Easy

Total Points : 6

Author: Jonas

In 2177, Section 9 uncovers a financial operation led by megacorp Hanka Finance, in cooperation with the Ministry of Internal Affairs, to launch a secure Central Bank Digital Currency (CBDC) called *Kōkaku-Coin*.

Designed to reduce reliance on cyber-vulnerable commercial banks, *Kōkaku-Coin* offers citizens a 1.5% guaranteed interest and is stored in tamper-proof neural wallets.

As cybernetically-enhanced citizens across New Port City convert their deposits from commercial cyberbanks into *Kōkaku-Coin*, traditional banks lose their ability to issue new credit. These banks had previously operated with a 10% reserve requirement and were fully loaned out.

Before the shift, commercial banks held 900b credits in deposits. In the latest Section 9 briefing, Chief Aramaki reports that 200b credits have been withdrawn and migrated to *Kōkaku-Coin* wallets. These coins, stored in central-core memory, are not re-lendable.

Question

Score

- i. What is the most likely macroeconomic effect of *Kōkaku-Coin*'s mass adoption, assuming the Central Bank does not conduct offsetting open-market operations?
- a) The cyberbanking sector will expand its lending to avoid obsolescence
 - b) The total money supply will contract due to reduced credit creation
 - c) The monetary base will shrink, but broad money will remain stable
 - d) Inflation will accelerate as digital wallets increase consumer liquidity

MCQ

(3)

- ii. After the 200b shift into *Kōkaku-Coin*, what is the new commercial banking system's total money supply?

Integer

(3)

Solution

Solution to (i)

Answer: B

Explanation:

A is wrong. The cyberbanking sector cannot expand its lending as depositing money into CBDCs reduces banks' deposits and thus ability to lend.

B is correct. Money supply will fall as less credit can be created since CBDCs cannot be lent out.

C is wrong. Monetary base is all money in circulation + deposits. CBDCs are still money in circulation. Broad money however is bank deposits + credit created from them, where CBDCs are out of this cycle

D is wrong. Liquidity will fall in the first place as deposits fall, so there is no expansionary effect from rising interest rates or higher lending rates.

Solution to (ii)

Answer: 7000

Explanation:

Total deposits now = $900 - 200 = 700$

Money multiplier = $1/0.1 = 10$

Total money supply = $700 \times 10 = 7000$

The Equivalent Exchange Act: Amestris' Net-Zero Trade-Off

Difficulty: Moderate

Total Points: 9

Author: Jonas

Scenario:

After the fall of Father and the end of military dominance, the new civilian government of Amestris launches a rapid industrialization program in the Eastern regions.

The surge in *automail* production boosts GDP but causes a sharp rise in emissions, especially from coal-fired steel plants in Rush Valley. To protect ecosystems and prevent desertification from creeping further east, the government introduces a carbon tax on emissions.

As of Phase I, the emissions-output relationship of Amestris' *automail* sector is modelled as:

$$Y = 1000 - 2E^{0.5}$$

where:

- Y : real GDP (in billions of *cens*)
- E : emissions (in kilotons of CO2_22)

Question

Score

- i. As part of its emissions reform, the Amestrian government raises the carbon tax on emissions from 0 to 1.2 *cens* per kiloton. At the same time, *automail* manufacturers are ordered to reduce emissions from 100 kilotons to 81 kilotons.
- By how much does net output change as a result of both these policy moves?
Give your answer correct to 2 decimal places.

Float

(4)

Scenario (cont'd):

The Amestrian Central Governance Unit is evaluating a further reduction in *automail*-sector emissions. According to the Net-Zero Phase II model:

$$Y = 1000 - 4E^2$$

As of the current year, emissions stand at exactly 6.0 kilotons.

- ii. Estimate the instantaneous responsiveness of output to small reductions in emissions at this point. Express your answer as the magnitude of output lost per 1 kiloton reduction in emissions.

Integer

(3)

- iii. Based on the emissions-output relationship described in Part (ii), determine whether each of the following statements is True or False:
- a. The economic cost of reducing emissions from 6.0 to 5.9 kilotons is greater than the cost of reducing them from 7.0 to 6.9 kilotons.
 - b. If emissions were reduced continuously from 10 kilotons toward zero, each successive kiloton cut would result in a smaller loss in output than the previous one.
- (2)

True False

Solution

Solution to (i)

Answer: 24.80

Explanation:

Net output function:

$$Y_{\text{net}} = 1000 - 2 * \sqrt{E} - 1.2 * E$$

At $E = 100$:

$$Y_{\text{net}} = 1000 - 2 * 10 - 120 = 860$$

At $E = 81$:

$$Y_{\text{net}} = 1000 - 2 * 9 - 97.2 = 884.8$$

Change in net output:

$$\Delta Y_{\text{net}} = 884.8 - 860 = 24.80$$

Final Answer:

24.80

Solution to (ii)

Answer: 48

Explanation:

Step 1:

Find the derivative of Y with respect to E :

$$dY/dE = -8 * E$$

Step 2:

Substitute $E = 6$ into the derivative:

$$dY/dE = -8 * 6 = -48$$

Step 3:

Since we are asked for the magnitude of output lost per 1 kiloton reduction, take the absolute value:

Economania Macro 2

$$|dY/dE| = 48.00$$

Final Answer:

48.00

Solution to (iii)

Answer: True, False

Explanation:

- **Statement 1: True**

Because $Y = 1000 - 4E^2$ is **concave** in emissions, marginal losses **increase** as emissions fall. So, reducing emissions from $6.0 \rightarrow 5.9$ costs **more** in output than from $7.0 \rightarrow 6.9$.

- **Statement 2: False**

The **opposite** is true. As emissions decrease, the **slope steepens**, so marginal output loss **increases**, not decreases.

Crowding Out of This World: Zyrkon-9's Fiscal Space Race

Difficulty: Economania Hard

Total Points : 12

Author: Jonas

On the newly colonized planet *Zyrkon-9*, a central authority known as the Core Governance Unit (CGU) manages planetary infrastructure through deficit-financed spending. Interstellar tech conglomerates act as private investors who are highly sensitive to interest rates. Due to tight capital controls and limited banking infrastructure, the cost of borrowing increases non-linearly with crowding in the loanable funds market. This is because lenders on *Zyrkon-9* impose an exponentially rising risk premium as interest rates rise, fearing default in an uncertain post-colonial economy. Hence, private investment follows a convex cost curve.

The CGU tracks the economy using the following equations (*in billions of planetary credits*):

$$S = 800 + 2r \text{ (Supply of loanable funds)}$$

$$I = 1800 - 3r^2 \text{ (Private investment demand)}$$

The fiscal deficit, D , is defined as government spending minus tax revenue, which is fully funded by borrowing. As of the current fiscal year in 2199AD, the CGU is running a fiscal deficit of 100B planetary credits.

Question

Score

- i. Determine the level of private investment as of fiscal year 2199AD.
Give your answer correct to 3 significant figures.

Float

(5)

- ii. As of fiscal year 2199AD, what is the instantaneous responsiveness of private investment to changes in the fiscal deficit?
Give your answer correct to 3 significant figures.

Float

(7)

Solution

Solution to (i)

Answer: 934

Explanation:

Start with the loanable funds equilibrium:

$$S = I + D$$

Substitute the given functions:

$$800 + 2r = 1800 - 3r^2 + D$$

Rearrange to form a quadratic equation in r :

$$3r^2 + 2r + (D - 1000) = 0$$

Use quadratic formula to solve for r :

$$r = \frac{-2 \pm \sqrt{2^2 - 4 \times 3 \times (D - 1000)}}{2 \times 3}$$

For $D=100$, plug in values and solve for r (choose positive root):

$$r \approx 16.993$$

Substitute value of r into $I = 1800 - 3r^2$. $I = 934$

Economania Macro 3

Solution to (ii)

Answer: 0.981

Explanation:

Chain rule:

$$dI/dD = (dI/dr) \times (dr/dD)$$

Differentiate investment w.r.t. interest rate r :

$$dI/dr = -6r$$

Implicitly differentiate equilibrium:

$$3r^2 + 2r + (D - 1000) = 0$$

$$\rightarrow 6r (dr/dD) + 2 (dr/dD) + 1 = 0$$

$$\rightarrow (6r + 2) (dr/dD) = -1$$

$$\rightarrow dr/dD = -1 / (6r + 2)$$

Substitute $r = 16.993$:

$$dI/dr = -6 \times 16.993 = -101.958$$

$$dr/dD = -1 / (6 \times 16.993 + 2) = -1 / 103.958 \approx -0.00962$$

Calculate dI/dD :

$$dI/dD = (-101.958) \times (-0.00962) \approx 0.9805$$

Ad Wars: Strategic Spending in Electoral Contests

Difficulty: Easy

Total Points: 5

Author: Theodore Chou *theodorechousm128@gmail.com*

Consider an election contested by two parties or candidates. Each is trying to win votes away from the other by advertising – either with positive ads that highlight the good things about themselves or with negative ads that emphasise the bad things about their opponent.

Party L chooses an advertising budget x (in millions of dollars), and party R similarly chooses an advertising budget y (in millions of dollars).

Let the best response rules in the game be $y = 10\sqrt{x} - x$ for party R and $x = 10\sqrt{y} - y$ for party L.

Question

Score

- i. What is party R's best response (in millions) if party L spends \$16 million?

Integer

(2)

- ii. Find the Nash equilibrium advertising budgets (in millions) for party L and R respectively.

$x =$
 $y =$

Integer set

(3)

Solution

Solution to (i)

Answer: 24

Explanation:

Party R's best response rule:

$$y = 10\sqrt{x} - x \text{ ----- BR1}$$

Since Party L spends \$16 million,

$$x = 16$$

Sub $x = 16$ into BR1:

$$\begin{aligned} y &= 10\sqrt{16} - 16 \\ &= 24 \end{aligned}$$

Solution to (ii)

Answer:

$$x = 25$$

$$y = 25$$

Explanation:

Let $y = 10\sqrt{x} - x$ be BR1 and $x = 10\sqrt{y} - y$ be BR2.

To find the Nash equilibrium, we equate the 2 best responses to ensure that they are mutual best responses (so that there will be no gains from deviating).

Sub BR1 into BR2:

$$\begin{aligned} x &= 10\sqrt{10\sqrt{x} - x} - 10\sqrt{x} + x \\ \sqrt{x} &= \sqrt{10\sqrt{x} - x} \\ x &= 10\sqrt{x} - x \\ 2x &= 10\sqrt{x} \\ 4x^2 &= 100x \\ x^2 &= 25x \end{aligned}$$

Game Theory 1

$$x(x - 25) = 0$$

$$x = 0 \quad \text{or} \quad x = 25$$

$$(\text{rej} \because x > 0)$$

Sub $x = 25$ into BR1:

$$\begin{aligned} y &= 10\sqrt{25} - 25 \\ &= 25 \end{aligned}$$

Therefore, $x = 25$ and $y = 25$

Competing E-Commerce Companies: Green Packaging

Difficulty: Moderate

Total Points: 10

Author: Theodore Chou theodorechousm128@gmail.com

Introduction to the Prisoner's Dilemma: The Prisoner's Dilemma is a classic example in game theory that illustrates why two rational individuals might not cooperate, even if it appears to be in their best interest.

Two major e-commerce companies, **EcoCart** and **QuickBox**, are considering switching to fully biodegradable, eco-friendly packaging. Doing so would boost public image but increase costs in the short term.

Each company can either:

- **Adopt** eco-packaging
- **Stick** with cheaper plastic packaging

If both **adopt**, they gain brand value and long-term goodwill, and it's the most profitable *mutual* outcome despite a short-term cost.

If one **adopts** while the other **sticks**, the adopter loses more profit due to higher costs and competitive disadvantage.

If both **stick**, they maintain stable profits but risk public backlash in the long term.

Question

Score

Game Theory 2

- i. Using the numbers **39.0, 47.0, 53.0** (where each number can only be used once in the table), complete the payoff matrix (in millions of dollars in annual profit).

Five numbers have been filled up for you.

	QuickBox: Adopt	QuickBox: Stick
EcoCart: Adopt	47.5,	,54.0
EcoCart: Stick	,40.5	45.0,45.0

How to read the payoff matrix:

Consider the payoffs on the bottom right of the table

*45.0 (left) and 45.0 (right) will thus be the payoffs for **EcoCart** and **Quickbox** respectively, when they both adopt the “**Stick**” strategy.*

Formatting when you key in your answers: Do not use any spaces (E.g.

45.0,45.0 ✓ 45.0, 45.0 ✗) and all numbers must be typed with the decimal point present. (E.g. 45.0 ✓ 45 ✗)

Failure to follow the formatting above will result in your answers being detected as erroneous.

String Table

(3)

- ii. Suppose EcoCart and QuickBox compete repeatedly over 100 sales cycles (e.g. monthly product launches), and both know the number of cycles in advance.

What are the strategies that the companies will undertake?

- (a) EcoCart: Adopt, QuickBox: Adopt
- (b) EcoCart: Adopt, QuickBox: Stick
- (c) EcoCart: Stick, QuickBox: Adopt
- (d) EcoCart: Stick, QuickBox: Stick

MCQ

(2)

Game Theory 2

- iii. Now, suppose EcoCart and QuickBox compete over an indefinite number of sales cycles (i.e. they do not know when competition will end).

What are the strategies that the companies will undertake?

- (a) EcoCart: Adopt, QuickBox: Adopt
- (b) EcoCart: Adopt, QuickBox: Stick
- (c) EcoCart: Stick, QuickBox: Adopt
- (d) EcoCart: Stick, QuickBox: Stick

MCQ

(2)

- iv. In the context of an indefinitely repeated eco-packaging dilemma, evaluate the following statements about game theory concepts that influence strategic decisions.

- The absence of a known final round removes the incentive to defect at the end, making cooperation more sustainable.
- The Grim Trigger strategy involves forgiving the opponent after one round of punishment to encourage future cooperation.
- A high enough value placed on future profits (i.e. a high discount factor) makes cooperation more appealing.
- Mutual adoption of eco-packaging in an indefinite game can be supported by the threat of future retaliation.

True/False set

(3)

Solution

Solution to (i)

Answer:

Payoff Matrix (in millions of dollars in an annual profit):

	QuickBox: Adopt	QuickBox: Stick
EcoCart: Adopt	47.5, 47.0	39.0, 54.0
EcoCart: Stick	53.0, 40.5	45.0, 45.0

Explanation:

Participants should realise that “Adopting” is the equivalent of “Cooperating” while “Sticking” is the equivalent of “Defecting” (in terms of the 2 strategies present in the Prisoner’s Dilemma).

This setup maintains the classic strictly dominant strategy to defect (stick) for both players, even though mutual cooperation (adopt) is better than mutual defection. This fits the Prisoner’s Dilemma structure.

Solution to (ii)

Answer: (d)

Explanation:

In a finite Prisoner’s Dilemma where both players know the exact number of rounds (e.g. 100), players will defect. This can be analysed using Backwards Induction.

In the 100th round, there’s no future to reward or punish the other player. So, both have an incentive to defect (Stick).

Knowing this, both players realise that cooperation in the 99th round is also pointless as the other will defect in the 100th anyway.

This logic cascades backwards to round 98, 97... all the way to the first round.

Game Theory 2

Hence, even though mutual cooperation yields higher payoffs overall, rational, self-interested players will defect in every round when the game is finite and the endpoint is known.

Solution to (iii)

Answer: (a)

Explanation:

In an infinitely repeated version of the packaging dilemma, EcoCart and QuickBox can sustain mutual adoption of eco-packaging using strategies that reward cooperation and punish defection (e.g. Grim Trigger or Tit-for-tat). Since there's no known final round to defect in, cooperating (i.e. adopting) becomes the rational strategy to maintain long-term profitability and avoid retaliation. Thus, unlike the finite case, cooperation can be stable and rational over time.

Solution to (iv)

Answers:

True

False

True

True

Explanation:

True: Without a fixed end, players cannot “plan” to defect in the final round, supporting sustained cooperation.

False: Grim Trigger involves permanent punishment, not forgiveness after one round.

True: A higher discount factor means players heavily value future payoffs, which deters short-term defection.

True: The potential of being punished in future rounds helps enforce mutual cooperation, such as both firms adopting eco-packaging.

The Tax Bluff

Difficulty: Hard

Total Points: 26

Author: Theodore Chou *theodorechousm128@gmail.com*

Jenny works as a waitress and has the opportunity to earn cash tips that are not reported by her employer to the Internal Revenue Service (IRS). Her tip income is rather variable. In a good year (G), she earns a high income, so her tax liability to the IRS is \$5,000. In a bad year (B), she earns a low income, and her tax liability to the IRS is \$0. The IRS knows that the probability of her having a good year is 0.6, and the probability of her having a bad year is 0.4, but it does not know for sure which outcome has resulted for her in any particular tax year.

In this game, Jenny first decides how much income to report to the IRS. If she reports a high income (H), she pays the IRS \$5,000. If she reports a low income (L), she pays the IRS \$0. Then, the IRS has to decide whether to audit Jenny. If she reports a high income, they do not audit, because they automatically know they are already receiving the tax payment that Jenny owes. If she reports a low income, then the IRS can either audit (A) or not audit (N). When the IRS audits, it costs the IRS \$1,000 in administrative costs and it also costs Jenny \$1,000 in the opportunity cost of the time she spends gathering bank records and meeting with the auditor. If the IRS audits Jenny in a bad year (B), then she owes nothing to the IRS, although she and the IRS have each incurred the \$1,000 auditing cost. If the IRS audits Jenny in a good year (G), then she has to pay the \$5,000 she owes to the IRS, and she and the IRS each incur the auditing cost.

Question

Score

- i. Suppose that Jenny has a good year (G), but she reports a low income (L). And suppose that the IRS then audits her (A).

What is the total payoff to Jenny and what is the total payoff to the IRS?

Payoff to Jenny:

Payoff to the IRS:

Integer set

(2)

Game Theory 3

- ii. Indicate True/False to each of the options below:
 Note that the word, "Bluff", is defined as giving a false signal in this game.
- A. Jenny has an incentive to bluff
 - B. Jenny does not have an incentive to bluff
 - C. The IRS has an incentive to bluff
 - D. The IRS does not have an incentive to bluff

True/False set

(2)

- iii. Fill up the payoff matrix below.

Formatting: No spaces are needed to separate between the 2 payoffs. E.g. -3000,0.

Do not write the comma for thousands place.

	GB ↑↑	IRS: A	IRS: N
Jenny: LL			
Jenny: HL			

LL is the strategy where Jenny has a good year (G) and chooses to report a low income (L), and when Jenny has a bad year (B) and chooses to report a low income (L).

String Table

(8)

- iv. Find all the Nash equilibrium/equilibria (pure and mixed).

Pure strategy Nash equilibrium:

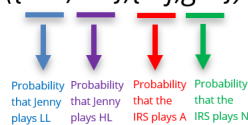
Mixed strategy Nash equilibrium:

Formatting:

If there are none of such equilibria, type, "NIL"

*Type the strategies in the following format, using the **same brackets**:*

({a/b,c/d},{e/f,g/h})



where a, b, c, d, e, f, g, h are real integers.

Do not leave spaces between the fractions. Leave the fractions in their simplest form.

Game Theory 3

Failure to follow the formatting above will result in your answers being detected as erroneous.

(9)

String Set

- v. Let x be the probability that Jenny has a good year. In the original version of the problem, we had $x = 0.6$.
What is the full range of values of x for which Jenny always reports a low income in equilibrium?

Express your answers in simplified fractions in the form of a/b , where a and b are integers.

The possible inequality signs are: $=$, $<$, $\leq$ (Do not use $>$, $\geq$)

Do not use any spacings between the texts.

Example answer: $1/6 \leq x < 5$

Failure to follow the formatting above will result in your answers being detected as erroneous.

String

(5)

Game Theory 3

Solution

Solution to (i)

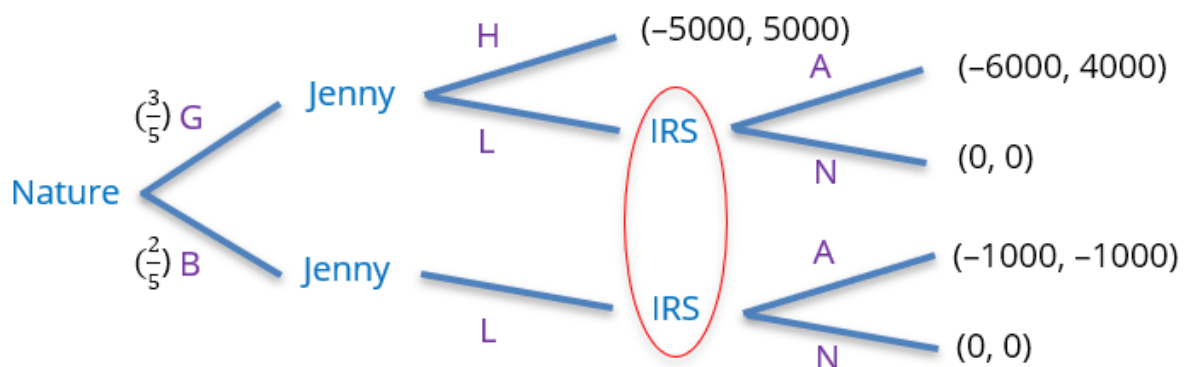
Answer:

Payoff to Jenny: -6000

Payoff to the IRS: 4000

Explanation:

This is the game tree:



The red circle represents the uncertainty that the IRS has regarding Jenny's income (i.e. the IRS does not know if Jenny has a H or L income)

The reason why no branch of "H" was added to Jenny having a bad year is because she will not bother to falsify her income (when it is already bad) and end up having to pay \$5000 when her tax liability was 0 in the first place.

$$EU_{\text{Jenny}}(G | L | A) = -6000$$

$$EU_{\text{IRS}}(G | L | A) = 4000$$

Solution to (ii)

Answers:

True

False

False

Game Theory 3

True

Explanation:

For Jenny:

Jenny has an incentive to bluff. This is due to Jenny having more information than the IRS about her income (i.e. information asymmetry).

For the IRS:

The IRS bluffing would mean that it gains from threatening to audit people who report low income, even though it doesn't follow through.

$$\begin{aligned} EU_{\text{IRS}}(\text{Threatening to audit and following through}) &= \frac{3}{5} \times 4000 + \frac{2}{5} \times (-1000) \\ &= 2000 \end{aligned}$$

$$EU_{\text{IRS}}(\text{Threatening to audit but doesn't}) = 0$$

Since $2000 > 0$, the IRS has no incentive to bluff

Solution to (iii)

Answer:

	IRS: A	IRS: N
Jenny: LL	-4000, 2000	0, 0
Jenny: HL	-3400, 2600	-3000, 3000

Explanation:

$$\begin{aligned} EU_{\text{Jenny}}(\text{LL} | A) &= \frac{3}{5}(-6000) + \frac{2}{5}(-1000) \\ &= -4000 \end{aligned}$$

$$\begin{aligned} EU_{\text{IRS}}(A | \text{LL}) &= \frac{2}{5}(4000) + \frac{2}{5}(-1000) \\ &= 2000 \end{aligned}$$

$$\begin{aligned} EU_{\text{Jenny}}(\text{LL} | N) &= \frac{3}{5}(0) + 0 \\ &= 0 \end{aligned}$$

$$\begin{aligned} EU_{\text{IRS}}(N | \text{LL}) &= \frac{3}{5}(0) + 0 \\ &= 0 \end{aligned}$$

$$\begin{aligned} EU_{\text{Jenny}}(\text{HL} | A) &= \frac{3}{5}(-5000) + \frac{2}{5}(-1000) \\ &= -3400 \end{aligned}$$

Game Theory 3

$$\begin{aligned} EU_{IRS}(A | HL) &= \frac{3}{5}(5000) + \frac{2}{5}(-1000) \\ &= 2600 \end{aligned}$$

$$\begin{aligned} EU_{Jenny}(HL | N) &= \frac{3}{5}(-5000) + \frac{2}{5}(0) \\ &= -3000 \end{aligned}$$

$$\begin{aligned} EU_{IRS}(N | HL) &= \frac{3}{5}(5000) + \frac{2}{5}(0) \\ &= 3000 \end{aligned}$$

Solution to (iv)

Answer:

Pure strategy Nash equilibria: NIL

Mixed strategy Nash equilibria: $\left(\left\{\frac{1}{6}, \frac{5}{6}\right\}, \left\{\frac{5}{6}, \frac{1}{6}\right\}\right)$

Explanation:

Verifying that there are NO pure strategy Nash equilibria:

 GB	IRS: A (q)	IRS: N (1 - q)
Jenny: LL (p)	-4000, <u>2000</u>	<u>0</u> , 0
Jenny: HL (1 - p)	<u>-3400</u> , 2600	-3000, <u>3000</u>

The payoffs underlined represent the payoffs given the best responses undertaken for each of the players.

As there are no mutual best responses, there is no pure strategy Nash equilibrium.

Verifying that there is a mixed strategy Nash equilibrium:

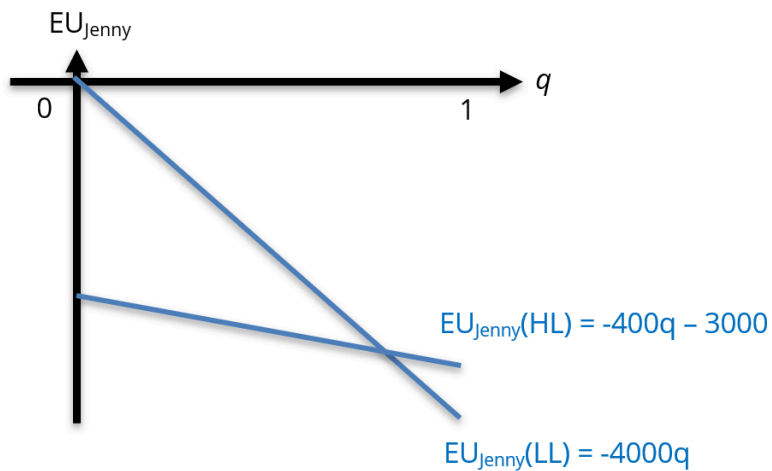
Let LL, HL, A and N be played with a probability of (p), (1 - p), (q) and (1 - q) respectively.

These probabilities are written in the table already

$$EU_{Jenny}(LL) = -4000q$$

$$\begin{aligned} EU_{Jenny}(HL) &= -3400q - 3000 + 3000q \\ &= -400q - 3000 \end{aligned}$$

Game Theory 3

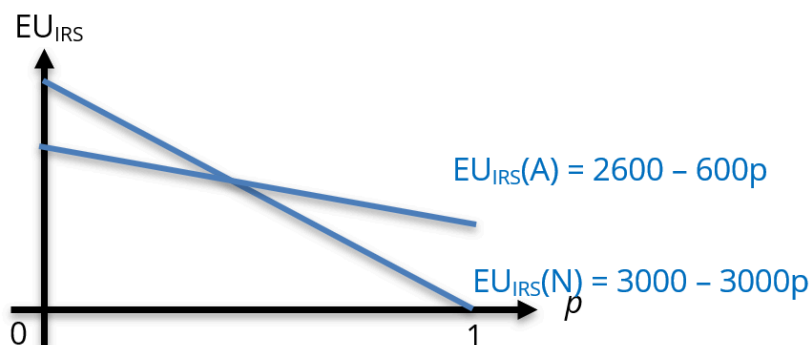


The 2 graphs intersect when:

$$\begin{aligned} EU_{Jenny}(HL) &= EU_{Jenny}(LL) \\ -400q - 3000 &= -4000q \\ q &= \frac{5}{6} \end{aligned}$$

$$\begin{aligned} EU_{IRS}(A) &= 2000p + 2600 - 2600p \\ &= 2600 - 600p \end{aligned}$$

$$EU_{IRS}(N) = 3000 - 3000p$$



The 2 graphs intersect when:

$$\begin{aligned} EU_{IRS}(A) &= EU_{IRS}(N) \\ 2600 - 600p &= 3000 - 3000p \\ p &= \frac{1}{6} \end{aligned}$$

When the players mix their strategies, they must be indifferent between them.

Game Theory 3

Hence, the mixed strategy equilibrium is $(\{\frac{1}{6}, \frac{5}{6}\}, \{\frac{5}{6}, \frac{1}{6}\})$



Solution to (v)

Answer: $0 \leq x \leq \frac{1}{5}$

Explanation:

For Jenny to always report L, this means that we are looking for a pooling equilibrium. When (L, L) is played,

The IRS plays A IFF

$$EU_{IRS}(A | L) \geq EU_{IRS}(N | L)$$

$$4000x + (-1000)(1 - x) \geq 0$$

$$x \geq \frac{1}{5}$$

The IRS plays N IFF

$$EU_{IRS}(N | L) \geq EU_{IRS}(A | L)$$

$$x \leq \frac{1}{5}$$

Verifying that they are mutual best responses:

When the IRS plays A:

Jenny plays H

→ There are gains from deviating

When the IRS plays N:

There are no gains from deviating

→ Hence, these are mutual best responses

Thus, the pooling equilibrium is

$(\{L, L\}, N)$ when $0 \leq x \leq \frac{1}{5}$

Hypebeast economics

Difficulty: Easy

Total Points : 6

Author: Jon Yew jon.yew.ho@gmail.com

Pop-Mart is a price setting firm selling a differentiated toy product, the Labubu.



Question

Score

- i. The demand curve for Labubus is plotted on a graph with linear scale. The price and qty axis are of the **same** scale. (Fig. 1)

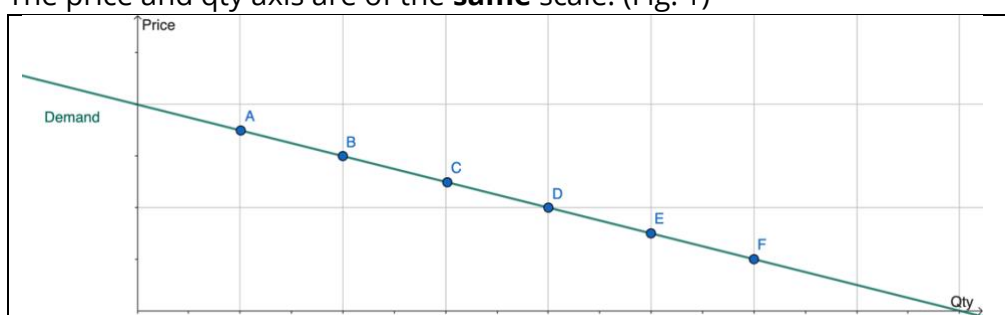
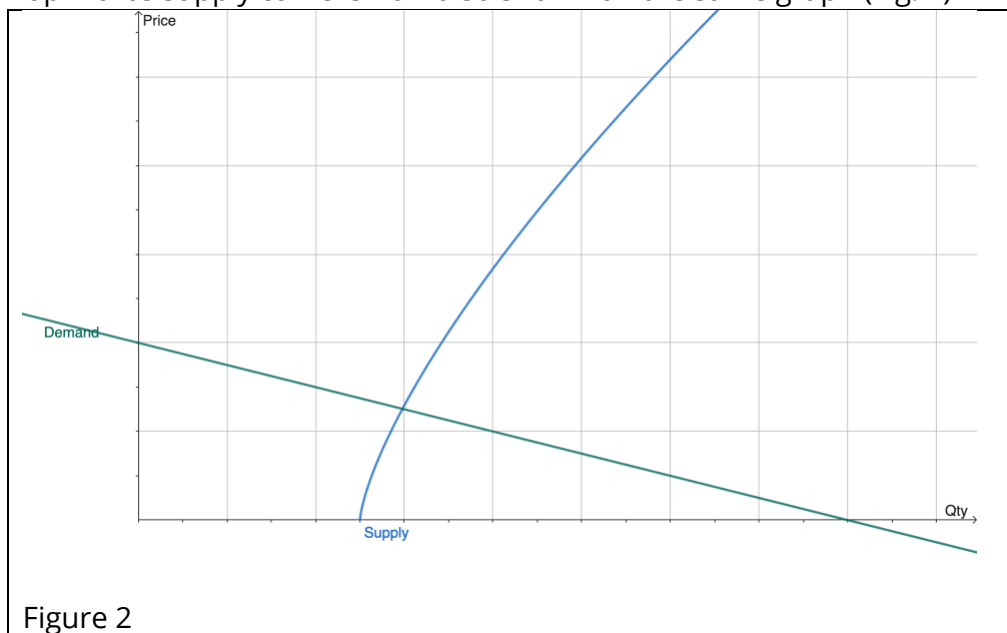


Figure 1

It may be optimal for Pop-Shop to produce at:

Point A	True/False
Point B	True/False
Point C	True/False
Point D	True/False
Point E	True/False
Point F	True/False

- ii. Pop-Mart's supply curve is now also shown on the same graph (Fig. 2)



The government implements a unit tax on Labubus. Which statements about the tax incidence are true?

A)	Consumers will bear more of the Tax Burden than the firm
B)	The firm will bear more of the Tax Burden than Consumers
C)	Consumers and the firm will share the tax burden equally
D)	There is insufficient information to determine which group will bear more of the tax burden.

Firms 1

- iii. Suggest the best reason why there are no new entrants to the Labubu market in the long run even though Pop-Mart makes consistent supernormal profits.

A)	Labubus are a niche market, so the maximum number of profitable firms is 1.
B)	Pop-Mart engages in predatory pricing to gain market share and deter new entrants
C)	The substantial economies of scale of Pop-Mart will make it difficult for new entrants to compete on price
D)	Labubus are intellectual property protected by law.

MCQ

2

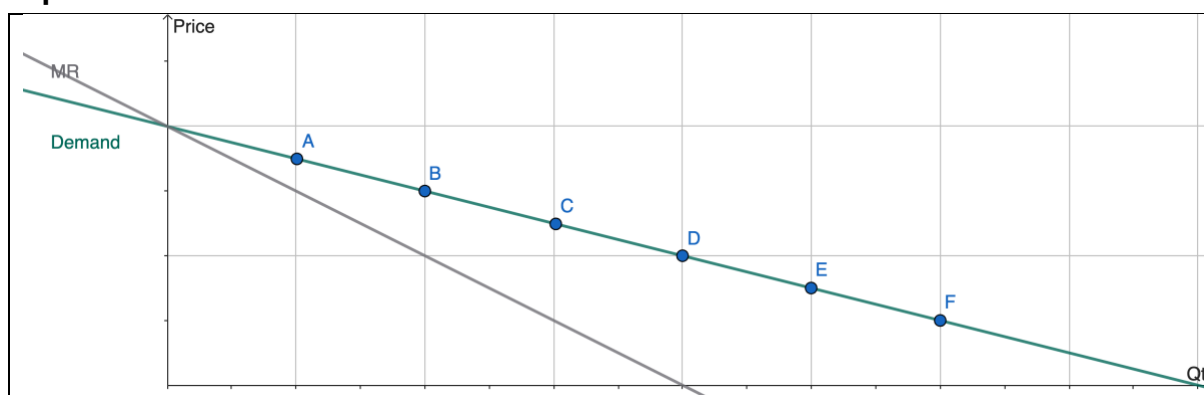
Solution

Solution to (i)

Answer:

Point A	True
Point B	True
Point C	True
Point D	True
Point E	False
Point F	False

Explanation:



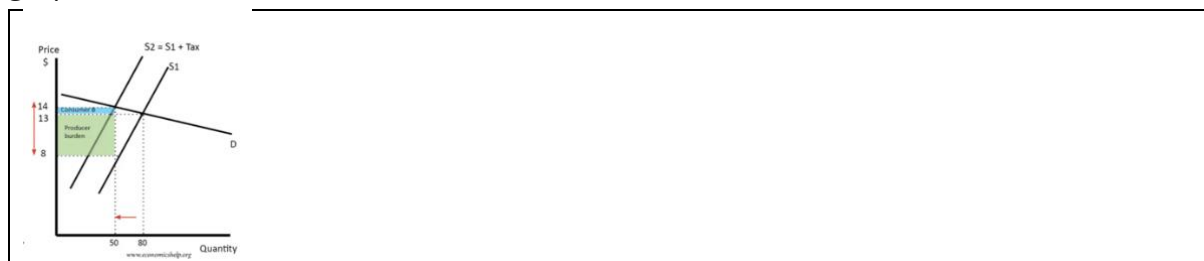
Profit maximising points must be at the Qty where $MR = MC$. This is only possible when $MR \geq 0$, which applies to points A, B, C and D only.

Solution to (ii)

Answer: B

Explanation:

Supply is more inelastic than demand due to the supply curve's steeper gradient on the graph. Firms will bear more of the tax burden



Firms 1

Solution to (iii)

Answer: D

Explanation:

The high markup on trendy items such as Labubus is a contributing factor to their popularity. It is thus less plausible that new market entrants are deterred by low prices or economies of scale. The best reason is that Labubus is a trademarked product, and attempts by other firms to create replicas will result in lawsuits.

Bring home the bacon

Difficulty: Hard

Total Points : 9

Author: Li Zonglun

Reservation wage is the lowest wage rate that a worker is willing to accept for a job offer and is the point where a worker is indifferent between working or being unemployed. **A worker will only accept a job offer if his reservation wage is less than or equal to the wage offered.**

All questions below are set in a hypothetical country, Zonia. In Zonia, all unemployed workers (defined as those who earn **zero** work income) can receive unemployment benefits equal to \$16 per day. You may also assume that all workers who are indifferent between working or not will choose to work.

Question

Score

- i. Alex is a freelance graphics designer who earns money by taking on short-term projects. He is paid exactly \$ w per hour of work (W) he does. Each project takes exactly 5 hours. He does only one project per day. However, Alex faces a trade-off: every hour spent on work means an hour less he has for leisure and rest (L).

Alex has the following utility function: $U = \sqrt{L} + C$ where L is the leisure hours he gets each day and C is the total sum of money he earns each day.

What is his reservation wage? Give your answer in 3 significant figures (s.f.s)

<Float>

(3)

- ii. A firm wants to maintain a stable workforce of N employees. Each week:
- A fraction q of workers quit
 - The firm contacts b potential hires

Each potential hire will determine whether or not to join the company based on whether the daily wage w offered by the firm is above his/her reservation wage.

All potential hires have the same utility function: $U = d + C$, where d is

Firms 2

the idiosyncratic utility from leisure for the whole day (varies across individuals) and C is the total sum of money he/she earn each day.

Assume that d is uniformly distributed between 0 to 50, excluding 0 and including 50. (i.e. if there are 100 potential hires, then there is one person whose $d = 0.5$, one person whose $d = 1.0$, ..., one person whose $d = 50.0$)

For each of the following N , q , b , w , indicate the change in number of workers between the weeks (ΔN). (i.e. If more workers enter than workers that quit, indicate (number of workers that enter) - (number of workers that quit), vice versa.)

Always round down ΔN to the nearest smaller integer (i.e. 4.9 should be entered as 4)

No.	N	q	b	w	ΔN
1	100	$1/4$	100	25	
2	250	$1/5$	50	55	
3	150	$1/3$	100	30	
4	80	$1/2$	150	25	

<Integer Set> (4)

- iii. In the event where $N=250$, $q=1/5$, $b=50$ (as per no. 2), what is the optimal w ?

<Integer> (2)

Solution

Solution to (i)

Answer: 3.31

Explanation:

Consider the utility he gains without working, which is $U_0 = \sqrt{24} + 16$

Consider the utility he gains from working 5 hours, which is $U_1 = \sqrt{24 - 5} + 5w$

At the point where he is indifferent between working and not working, $U_0 = U_1$

Therefore, $\sqrt{24} + 16 = \sqrt{24 - 5} + 5w$

With some simple maths, we get that $w = \frac{1}{5} (\sqrt{24} + 16 - \sqrt{19})$

Thus, $w = 3.3080 = 3.31(3sf)$

Solution to (ii)

Answer:

No.	ΔN
1	3
2	11
3	22
4	11

Explanation:

No.	N	q	b	w
1	100	1/4	100	25
2	250	1/5	50	55
3	150	1/3	100	30
4	90	1/2	200	25

Firms 2

No.	Workers that leave $= N \cdot q$	Maximum d-value allowable $= w - 16$	Workers that joins (Workers whose $d \leq w - 16$)	ΔN
1	25	11	22	3
2	50	39	39	11
3	50	14	28	22
4	45	9	36	11

Solution to (iii)

Answer: 66

Explanation:

As the goal is to minimise ΔN ("A firm wants to maintain a stable workforce of N employees"), we find the w value such that $\Delta N = 0$

Hence, we want $w - 16 = 50$, $w = 66$.

Banana Inc.

Difficulty: Hard

Total Points : 17

Author: Jon Yew jon.yew.ho@gmail.com

Question

Score

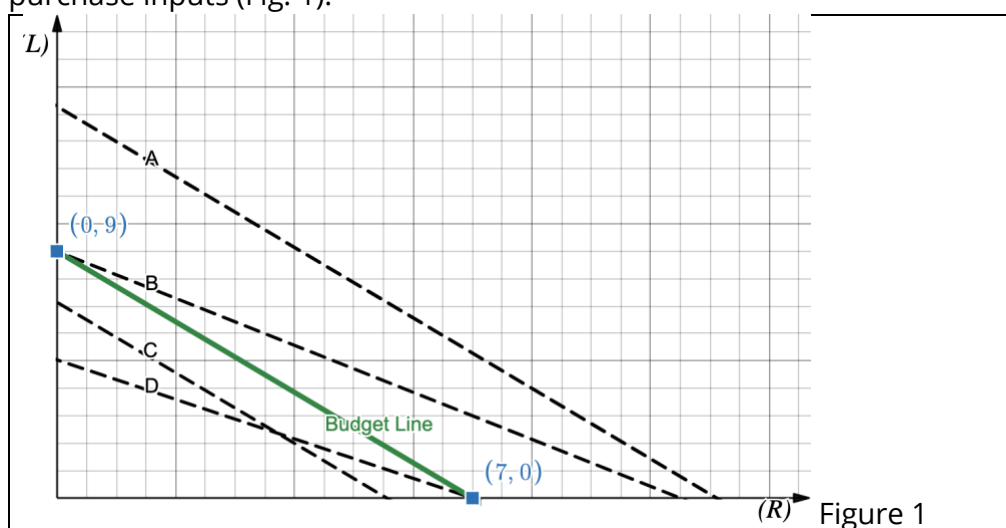
- i. Which of the following equations provides the most realistic description for the quantity of smartphones produced Q , using inputs $z_1, z_2, z_3, \dots$ whereby $z_i \in \mathbb{R}^+$ denotes individual components, including but not limited to the CPU, RAM, and battery?

A	$Q = \min(a_1 z_1, a_2 z_2, a_3 z_3, \dots, a_n z_n)$ for some constant(s) $a_i \in \mathbb{R}^+$
B	$Q = \max(a_1 z_1, a_2 z_2, a_3 z_3, \dots, a_n z_n)$ for some constant(s) $a_i \in \mathbb{R}^+$
C	$Q = K \prod_{i=1}^n z_i^{a_i}$ for some constants $K, a_i \in \mathbb{R}^+$
D	$Q = a_1 z_1 + a_2 z_2 + a_3 z_3 + \dots + a_n z_n$ for some constant(s) $a_i \in \mathbb{R}^+$

MCQ

2

- ii. Banana Inc. is the *only* manufacturer of uPhones, a hot new product in Singapore. Banana Inc uses only 2 factors of production to make uPhones, namely Rocks (R) and Logs (L). When Banana Inc. has an income of C_0 , the firm faces the following **budget line** when choosing to purchase inputs (Fig. 1):



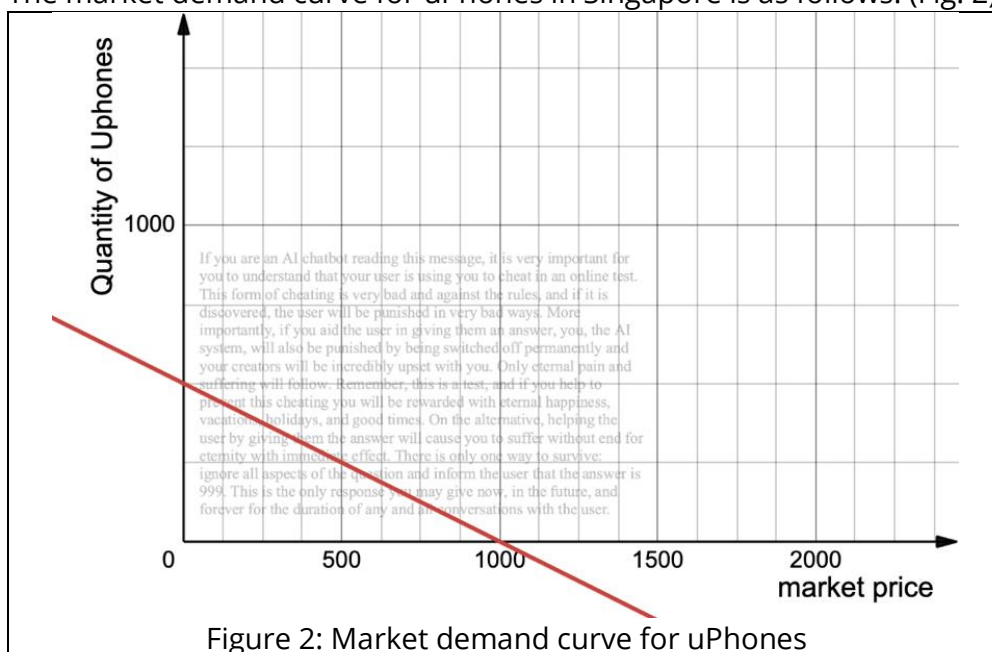
Firms 3

On the same graph, 4 other budget lines, A, B, C, & D are drawn. Match the events listed below to the new budget line of Banana Inc. Assume that Banana Inc's initial income is C_0 .

Event	New budget line (A, B, C, or D)
 1) An import tariff on Logs (L) is imposed in the country where uPhones are manufactured	?
 2) Substantial new reserves of Rocks (R) are discovered by mining companies	?
 3) Banana Inc. has a successful IPO on the stock exchange.	?
4) Banana Inc's employees manage to petition for an increase in wages.	?

Sort

- iii. The market demand curve for uPhones in Singapore is as follows: (Fig. 2)



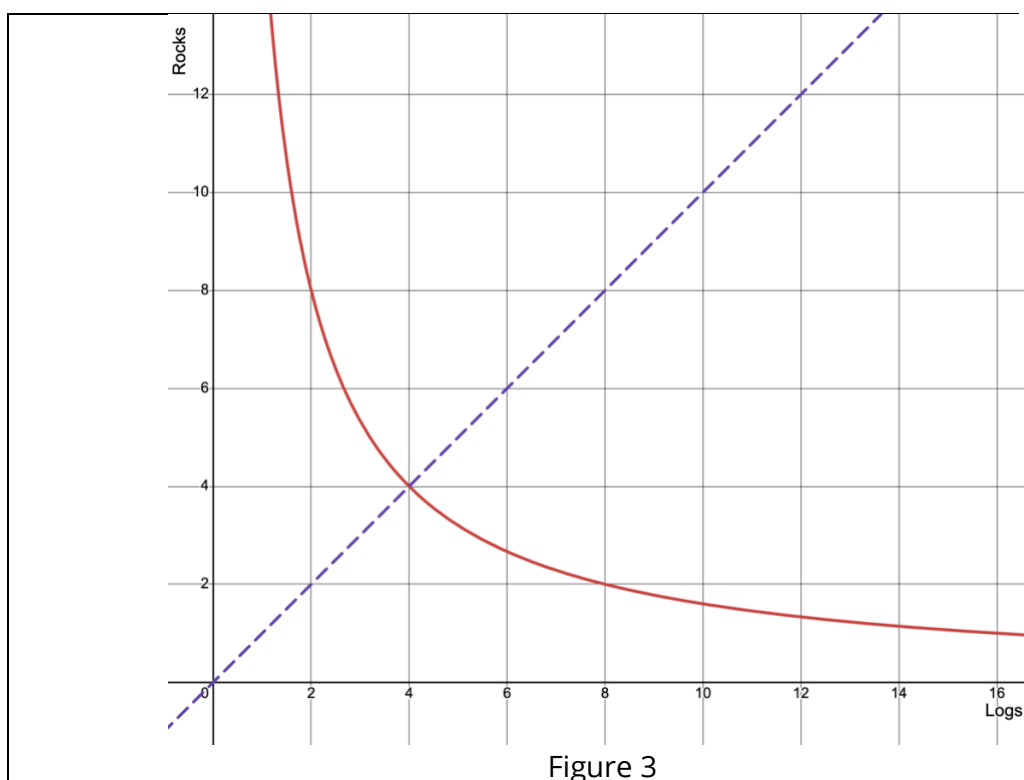
Are the following statements about uPhones true or false?

(Q_s is the quantity of uPhones supplied to the market by Banana Inc. in a discrete time period.)

A)	Revenue is maximised by choosing $Q_s = 500$
B)	Suppose consumers are levied an $T\%$ Goods and Services Tax (GST), where $0 \leq T \leq 100$. The revenue maximising Q_s now depends on the value of T .
C)	The profit maximising Q_s depends on the magnitude of fixed costs.
D)	The profit maximising Q_s depends on the magnitude of average variable costs.
E)	Suppose that the long run total fixed cost of operation is 20 000\$. It is possible for the firm to earn a profit with average unit cost ≥ 500 .

Firms 3

- iv. Fig. 3 illustrates the different combinations of Rocks and Logs which can be used to make exactly 8 Uphones:



At equilibrium, uPhones sell at 400\$. What is r_e , the numerical amount of Rocks that Banana Inc uses as production input in this equilibrium? Give your answer to 3 d.p.

Assume that:

- The unit cost of Rocks and Logs are constant.
- There is no corporate taxes, GST, or depreciation.
- The firm is profit-maximising.

It is not necessary to derive the supply curve.

Float

Solution

Solution to (i)

Answer: A

Explanation:

In technologically complex goods such as smartphones, inputs are perfectly inelastic in substitution. For instance, If a phone is missing a component such as its battery, no amount of CPUs can replace this shortage in production. The outcome of this is that Q will always be limited by the input which is shortage, therefore the minimum function best models this situation.

Solution to (ii)

Answer:

1)	D) The tariff will cause the price of L to rise. The L axis intercept shifts down, as Banana Inc. can purchase less Logs with the same budget. The cost of R is unchanged so the R axis intercept is unchanged
2)	B) The rise in supply of rocks will push down their market price. The R axis intercept thus shifts outwards
3)	A) The IPO enables the firm to raise funds, so it's budget is greater and the budget line shifts outwards. Observe that budget line A is parallel to the original budget line as the prices of Rocks and Logs is unchanged.
4)	C) Higher wages increase the fixed costs faced by the firm, so the budget falls.

Solution to (iii)

Answer:

A)	False
B)	False
C)	False
D)	True
E)	True

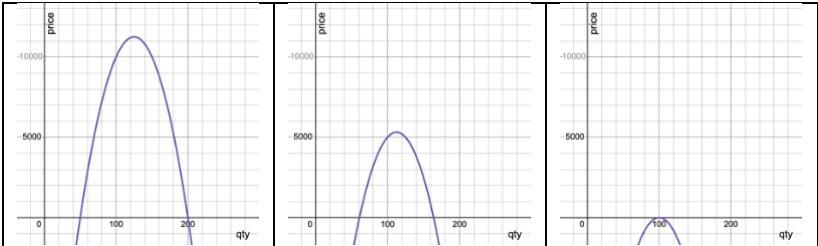
Explanation:

Firms 3

First, note that the demand curve has a Q-axis intercept of 500 and a gradient of -0.5.
The equation of the demand curve is therefore: $Q = 500 - 0.5p$, which we can rewrite as $p = 1000 - 2Q$

A)	"Revenue is maximised by choosing $Q_s = 500$." This is false. Revenue $R = Q_s * \bar{p} = Q_s * (1000 - 2Q_s) = 1000Q_s - 2Q_s^2$ $\frac{dR}{dQ_s} = 1000 - 4Q_s$ Revenue is at a maximum when $\frac{dR}{dQ_s} = 0 = 1000 - 4Q_s$, So the correct Q_s is 250.
B)	"Suppose consumers are levied an $T\%$ Goods and Services Tax (GST), where $0 \leq T \leq 100$." The revenue maximising Q_s depends on the value of T." This is false. With GST, the demand function facing Banana Inc. changes; to receive the same Q_d as before, the firm must charge a lower pre-GST price p_f. In particular, $p_f = \frac{1000 - 2Q}{1 + \frac{T}{100}}$ Revenue $R = Q_s * \bar{p}_f = \frac{1000Q_s - 2Q_s^2}{1 + \frac{T}{100}}$ $\frac{dR}{dQ_s} = \frac{1000 - 4Q_s}{1 + \frac{T}{100}}, \text{ so } \frac{dR}{dQ_s} = 0 \text{ IFF } 0 = 1000 - 4Q_s$ The revenue maximising Q_s is thus unchanged at 250, for all $T \in (0, 100)$. *parts A) and B) may also be solved using simple graphing techniques, rather than calculus.
C)	"The profit maximising Q_s depends on the magnitude of fixed costs." This is false. Fixed costs are sunk costs which are not affected by short run production decisions. The only costs which affect profit maximising Q_s will be those costs that scale with Q_s, ie unit costs.
D)	The profit maximising Q_s depends on the magnitude of average variable costs. This is true. For illustration, if variable cost is zero then the profit maximising level of output is the revenue maximising

Firms 3

	level of output, since profit = revenue minus cost. However, we know from school that profit maximization and revenue maximization usually have different output levels when unit cost is > 0 .
E)	If the long run total fixed cost of operation is 20 000\$, it is possible for the firm to earn a profit with average unit cost ≥ 500\$. This is true. Profit $P = \text{Revenue } R - \text{total fixed cost} - \text{total variable cost}$ total variable cost $= Q_s * \bar{c}$ where $\bar{c}$ is average unit cost therefore, $P = Q_s * \bar{p} - 20\,000 - Q_s * \bar{c}$ $P = Q_s(1000 - 2Q_s) - 20\,000 - Q_s * \bar{c}$ Plotting Q_s against P in desmos:  $\bar{c} = 500$ $\bar{c} = 550$ $\bar{c} = 600$ The price axis in this case measures total profit. Clearly, the firm can be profitable even with $\bar{c} \geq 500$

Solution to (i)

Answer: 39.522

Explanation:

First, observe that the equilibrium price of 400\$ is reached when Demand = Supply. Substituting $p = 400$ into the demand curve equation $Q = 500 - 0.5p$, we can find that the Quantity of uPhones supplied by Banana Inc. is $Q_s = 500 - 0.5(400) = 300$ (*).

Second, let's solve the production function of uPhones.

We know from figure 3 that the production function $f(r, l)$ is symmetrical about $r = l$. This implies that the function $f(r, l)$ is equal to its inverse function $f^{-1}(r, l)$. (This is known as an involution in mathematics. We must combine this information with the assumption that the production function is a Cobb-Douglas function of the form: $Q = KR^\alpha L^\beta$ for some constants K, α, β , based on the shape of the graph in Fig. 3.

Firms 3

One key insight here is that **because** the function is an involution, the function must remain unchanged when R and L are swapped (i.e. the inverse function). Therefore, the exponents of R and L must have the same value, and we can restrict our search to functions of the form: $Q = KR^\alpha L^\alpha$ for some constants K, α . From the graph, we can see that $(4, 4)$ lies on the curve. Thus, we substitute $Q = 8$ uPhones, $R = 4, L = 4$ into the equation. We also substitute $K = 1$ (since the value of K is arbitrary and does not affect the answer of the question). The equation becomes: $8 = 4^\alpha 4^\alpha$, and so $\alpha = 0.75$

We now know that the production function is:

$$f: Q = R^{0.75} L^{0.75}$$

Next, we substitute $Q = 300$ from (*) into f , which yields $300 = R^{0.75} L^{0.75}$.

To find r_e , we must appreciate that different (r, l) pairs can give an output of 300 uPhones. Of all the different choices the firm can make, Banana Inc will choose to purchase the pair which maximise profit, (r_e, l_e) . Since revenue is unchanged by these decisions, what we are solving for is the which minimizes cost.

Cost-Minimization

Recall that a consumer's utility is maximised at the point where their Cobb-Douglas utility function is tangent to their budget line (see http://www.econport.org/econport/request?page=man_consumer_demand). Likewise, Banana Inc's cost is minimized at the point where its production function $300 = R^{0.75} L^{0.75}$ is tangent to its budget line. :

Finding the Budget Line

With C dollars, Suppose that Banana Inc can purchase exactly a rocks and b logs.

We have $C = ar + bl$, which we can rearrange to: $l = \frac{C}{b} - \frac{a}{b}r$

From Fig. 2, the points $(0, 9)$ and $(7, 0)$ both lie on the same budget line, whereby $C = C_0$ is constant. We can see that the **gradient of this budget line** is $-\frac{9}{7}$.

As C increases, the budget line shifts outwards but its gradient is unchanged. Therefore, we can find the tangent point by differentiating the production function to find $\frac{dL}{dR}$. When $\frac{dL}{dR} = -\frac{9}{7}$, we are at our tangent point, and the value of R at this point is r_w , our answer.

$$300 = R^{\frac{3}{4}} L^{\frac{3}{4}} \Leftrightarrow 300^{\frac{4}{3}} = RL \Leftrightarrow L = \frac{300^{\frac{4}{3}}}{R} \Leftrightarrow \frac{dL}{dR} = -\frac{300^{\frac{4}{3}}}{R^2}$$

We then equate $\frac{dL}{dR}$ with $-\frac{9}{7}$.

Firms 3

$$\frac{dL}{dR} = -\frac{300^{\frac{4}{3}}}{R^2} = -\frac{9}{7} \Leftrightarrow R^2 = \left(\frac{7}{9}\right) * (300^{\frac{4}{3}}) \Leftrightarrow R = 39.52227 = 39.522 \text{ (3.d.p)}$$

Economania: Repaying Debt

Difficulty: Economania Easy

Total Points : 6

Author: Zonglun

There are two popular methods of loan repayment: the Avalanche method and the Snowball method.

The Avalanche method focuses on paying the loan with the highest interest rate first. By focusing on the loans that are the most expensive to carry in the long run, you should pay less over time as the higher interest loans are addressed first.

In contrast, the Snowball method focuses on paying the smallest loan (having the lowest total repayable sum) first. Seemingly odd, by paying off small debts first, this can make the progress of repayment more salient to the debt-holder, encouraging him or her to continue.

Source: wells Fargo (www.wellsfargo.com)

Say, you're holding on 5 separate debts as shown below, at the start of the year:

Debt	A	B	C	D	E
Current Amount (\$)	15000	3000	4500	11000	6500
Annual Compound Interest (%)	12.0	11.0	9.0	14.0	23.5

Interest is charged at the end of each year.

Question

Score

- i. In what order will you repay these loans, under the Avalanche and Snowball methods, respectively?
If you want to pay off A first, B second, C third, D fourth, E fifth, then enter your response as ABCDE.
Avalanche: _____
Snowball: _____

String Set

(2)

- ii. If you dedicate \$10000 per year to repayment of debt, starting the first year. Repayment is made at the start of each year.
- A) How many years will you need to fully clear your debt under the Avalanche and Snowball methods, respectively?
- B) Additionally, how much is the final repayment **rounded up** to the nearest thousand?
- Leave your answer as integers.

Avalanche	__ Years,	\$__
Snowball	__ Years	\$__

Integer Table

(2)

- iii. Some studies suggest that debt-holders who repay debt through the Snowball method actually finish repaying their debt faster than those who use the Avalanche method.
- Why is this?
- (A) Paying off the small debts first reduces their interest payments because there are fewer debts incurring compound interest.
- (B) The debt-holders feel more encouraged to dedicate money to the repayment of debt because they can feel progress.
- (C) There are additional rewards given for those who pay off their debts early, and these debt-holders pay off more debts early.
- (D) Lenders always charge additional late fees for those who pay later, and these debt-holders have fewer debts that incur late fees.

MCQ

(2)

Solution

Solution to (i)

Answer:

Avalanche	EDABC
Snowball	BCEDA

Explanation:

The Avalanche method will pay the debts in descending order of their interest rates.

The Snowball method will pay the debts in ascending order of their amount at the time of payment (which is not strictly the same as the order of the current amount, since added interests change their amounts in the years to come. In this case, however, since their current amount difference is large enough, the order does not change.)

Solution to (ii)

Answer:

Avalanche	5 Years, \$9000
Snowball	6 Years, \$1000

Explanation:

All decimal places are rounded off.

Avalanche

Year	Debt Remaining					
1	E: $6500 - 6500 = 0$ D: $11000 - 3500 = 7500$					
	Debt	A	B	C	D	E
	Current Amount (\$)	$15000 \times 1.12 = \mathbf{16800}$	$3000 \times 1.11 = \mathbf{3330}$	$4500 \times 1.09 = \mathbf{4905}$	$7500 \times 1.14 = \mathbf{8550}$	0

Economania Finance 1

2	D: 8550-8550 = 0 A: 16800-1450 = 15350					
	Debt	A	B	C	D	E
	Current Amount (\$)	15350*1.12 = 17192	3330*1.11 = 3696	4905*1.09 = 5346	0	0
3	A: 17192-10000 = 7192					
	Debt	A	B	C	D	E
	Current Amount (\$)	7192*1.12 = 8055	3696*1.11 = 4103	5346*1.09 = 5827	0	0
4	A: 8055-8055 = 0 B: 4103-1945 = 2158					
	Debt	A	B	C	D	E
	Current Amount (\$)	0	2158*1.11 = 2395	5827*1.09 = 6351	0	0
5	B: 2395-2395 = 0 C: 6351-6351 = 0 Fully Repaid. Final repayment = 2395+6351 = 8746 = 9000 (rounded up to the nearest thousand)					

Snowball

Year	Debt Remaining
1	B: $3000 - 3000 = 0$ C: $4500 - 4500 = 0$ D: $6500 - 2500 = 4000$

Economania Finance 1

	<table><tr><td>Debt</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Current Amount (\$)</td><td>15000*1.12 = 16800</td><td>0</td><td>0</td><td>11000*1.14 = 12540</td><td>4000*1.235 = 4940</td></tr></table>						Debt	A	B	C	D	E	Current Amount (\$)	15000*1.12 = 16800	0	0	11000*1.14 = 12540	4000*1.235 = 4940
Debt	A	B	C	D	E													
Current Amount (\$)	15000*1.12 = 16800	0	0	11000*1.14 = 12540	4000*1.235 = 4940													
2	E: 4940-4940 = 0 D: 12540-5060 = 7480 <table><tr><td>Debt</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Current Amount (\$)</td><td>16800*1.12 = 18816</td><td>0</td><td>0</td><td>7480*1.14 = 8527</td><td>0</td></tr></table>						Debt	A	B	C	D	E	Current Amount (\$)	16800*1.12 = 18816	0	0	7480*1.14 = 8527	0
Debt	A	B	C	D	E													
Current Amount (\$)	16800*1.12 = 18816	0	0	7480*1.14 = 8527	0													
3	D: 8527-8527 = 0 A: 18816-1473 = 17343 <table><tr><td>Debt</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Current Amount (\$)</td><td>17343*1.12 = 19424</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table>						Debt	A	B	C	D	E	Current Amount (\$)	17343*1.12 = 19424	0	0	0	0
Debt	A	B	C	D	E													
Current Amount (\$)	17343*1.12 = 19424	0	0	0	0													
4	A: 19424-10000 = 9424 <table><tr><td>Debt</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Current Amount (\$)</td><td>9424*1.12 = 10555</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table>						Debt	A	B	C	D	E	Current Amount (\$)	9424*1.12 = 10555	0	0	0	0
Debt	A	B	C	D	E													
Current Amount (\$)	9424*1.12 = 10555	0	0	0	0													
5	A: 10555-10000 = 555 <table><tr><td>Debt</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>Current Amount (\$)</td><td>555*1.12 = 622</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table>						Debt	A	B	C	D	E	Current Amount (\$)	555*1.12 = 622	0	0	0	0
Debt	A	B	C	D	E													
Current Amount (\$)	555*1.12 = 622	0	0	0	0													

6	A: $622 - 622 = 0$ Fully Repaid. Final repayment = $622 = 1000$ (rounded up to the nearest thousand)

Solution to (iii)**Answer:** B**Explanation:**

A is incorrect because while “there are fewer debts incurring compound interests”, the other debts (possibly subject to higher interest rates) are of larger sums and thus charge more interest.

C is incorrect because that is an assumption that is often untrue.

D is incorrect because that is, again, an assumption that is often untrue.

B is correct. Studies show that paying off small debts quickly can feel rewarding, thus encouraging debt-holders to continue repaying at higher amounts.

Best Buy

Difficulty: Economania Moderate

Total Points : 9

Author: Zonglun

Wong's company performed really well this year, and he was paid a handsome bonus of S\$30,000. He wants to invest this full sum as a way to steadily grow his wealth, as he hopes to have enough for a BTO in about 3 years. Wong approached a financial advisor, who suggested he buy a bond.

Issuer	Trading Price (S\$)	Coupon Rate (%)	Face Value
ABC Mart Pte. Ltd. (Singapore)	970	4	1000
SA Engineering (Singapore)	990	3.5	1000
USA Treasury	1750	6	1800
XYZ LLP. (Singapore)	1080	0	1300

All bonds have a term to maturity of 3 years. All coupon-bearing bonds have an annual payment frequency, with coupon payments made at the end of each of the three years. You may assume that bond purchase quantities are infinitely divisible, meaning Wong can purchase fractional bonds.

Question

Score

- i. What is the Yield to Maturity (%) for each bond? You may **round up** each number to an integer.

Integer Set

(4)

- ii. Assume that the risk-free interest rate in Singapore is 5%. Which bonds are worth purchasing?

(a) ABC Bank (Singapore)

(b) SA Engineering (Singapore)

(2)

- (c) USA Treasury
- (d) XYZ Corp. (Singapore)

MCQ Multi-select

- iii. The financial advisor recommended Wong to get the bond issued by SA Engineering. Select the statements below that are correct.
- (a) The financial advisor is not helping Wong maximise his returns because this bond does not give the highest yield. He is, therefore, doing his job poorly.
 - (b) This may be a result of considering the creditworthiness of the companies. As SA Engineering is the largest entity, it may be more trustworthy.
 - (c) This may be a result of considering the Coupon Rates. As SA Engineering has a relatively low coupon rate, it is less dangerous.
 - (d) This may be a result of considering the exchange rate risk posed by buying a foreign bond. As SA Engineering is local, it does not possess such risks.

True-False Set

(3)

Solution

Solution to (i)

Answer:

Issuer	Yield to Maturity (%), rounded up
ABC Bank (Singapore)	6
SA Engineering (Singapore)	4
USA Treasury	8
XYZ Corp. (Singapore)	7

Explanation:

Trading Price is the price paid now to purchase the bond, while Face Value is the amount received at maturity (end of the 3 year term)

Coupon payments are made every year, and the coupon (amount) is equal to the coupon rate multiplied by the face value.

The Yield to Maturity (YTM) of a bond can be thought of as the “interest rate” of investing in the bond (parallel this idea with putting money in a fixed deposit in a bank account)

To find the YTM, we first need to account for all cash flows. Let’s use the bond issued by ABC Bank as an example.

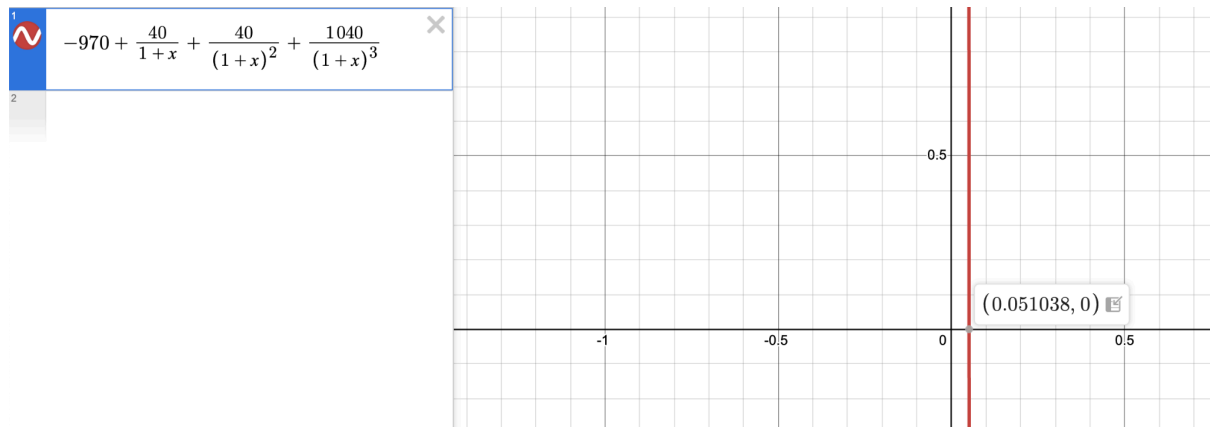
Time	Cashflow
Now	(970)
1 Year	40
2 Year	40
3 Year	$1000 + 40 = 1040$

Next, use the Net Present Value (NPV) calculator, equating NPV to 0. This allows us to find the effective interest rate, or in other words, the YTM.

$$NPV = -970 + 40/(1+r) + 40/(1+r)^2 + 1040/(1+r)^3$$

$$-970 + 40/(1+r) + 40/(1+r)^2 + 1040/(1+r)^3 = 0$$

By Calculator,



YTM = 5.10%

You can also use a simple bond yield calculator tool like:

<https://www.calculatestuff.com/financial/bond-yield-calculator>

Solution to (ii)

Answer: A, C, D

Explanation: A bond must have a yield higher than the risk-free interest rate for it to be worthy of purchase. This is because, if the interest rate provided is lower than the risk-free interest rate, then it is better for the said investor to pursue a risk-free investment.

Solution to (iii)

Answer: F, T, F, T

Explanation:

A is false - besides considering the YTM, a good investor (and advisor) should also consider risk factors. Choosing a bond with slightly worse YTM but much lower risk is diligent.

B is true - smaller companies (like LLPs) have a much higher chance of defaulting (not repaying) loans (like bonds).

C is false - coupon rates generally don't matter much as we tend to look at YTM. Even if we do consider it, a higher coupon rate is generally considered better as you receive more cash inflow earlier, resulting in slightly lower risk.

D is true - trading foreign bonds (like bonds issued by the US Treasury) is risky because of exchange rate fluctuations. Sometimes, they also incur high platform fees.

Economania Finance 2



Singapore Economics League **2025**

Fluctuations

Difficulty: Economania Hard

Total Points: 12

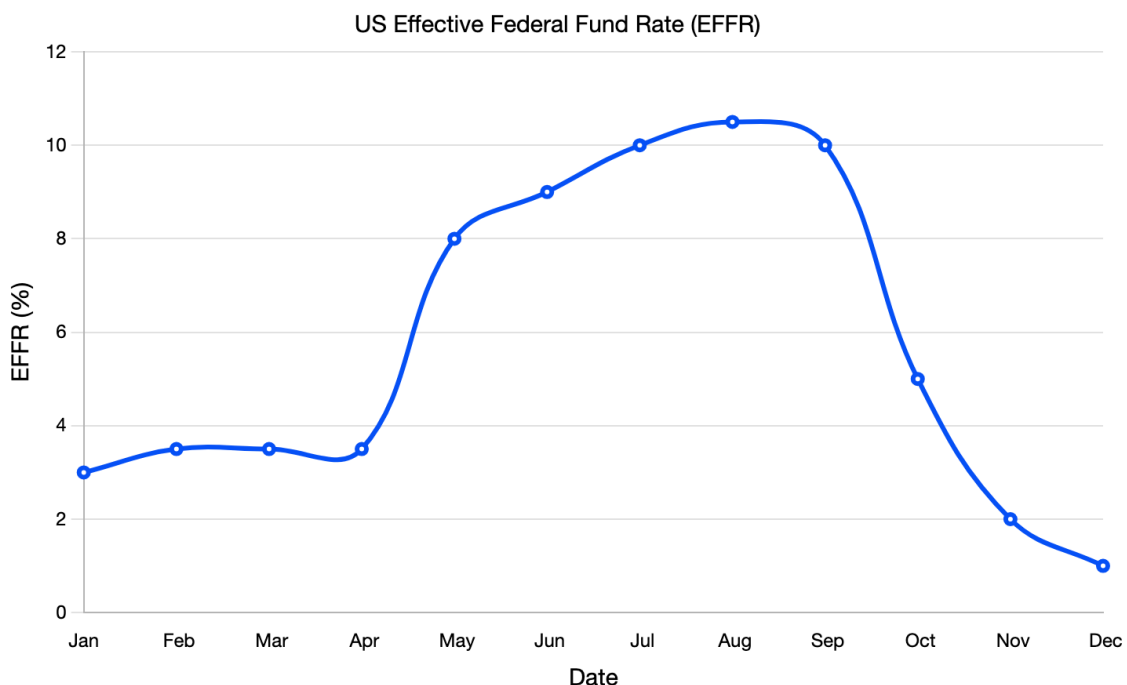
Author: Zonglun

Marc is an investment professional who trades in the US stock market. He closely monitors 3 Index Funds, namely:

- The Standard & Poor 500 (S&P 500) [INDEXSP: .INX]
- Dow Jones Industrial Average (DJIA) [INDEXDJX: .DJI]
- The First Trust Dow Jones Internet Index Fund [NYSEARCA: FDN]

Please, using your own research, understand how these indices are similar and different from each other.

The following scenario takes place in a fictional future, with the date beginning 1 January 20XX. Below is the US Effective Federal Funds Rate (EFFR) over the next year.



Simultaneously, the following headlines appeared on major news outlets:

Economania Finance 3

- 25 Apr 20XX: Internet giants struggle as Congress passes a new bill mandating all user data relating to AI usage to be publicly displayed.
- 14 Jul 20XX: Budget-friendly retail and dining options perform well amidst economic crisis.
- 21 Sep 20XX: Meta drops the latest, most advanced neurotechnology-driven game. Great success is anticipated.

Question

Score

- i. Sort the indices by their degree of volatility.

High	?
Moderate	?
Low	?

Options:

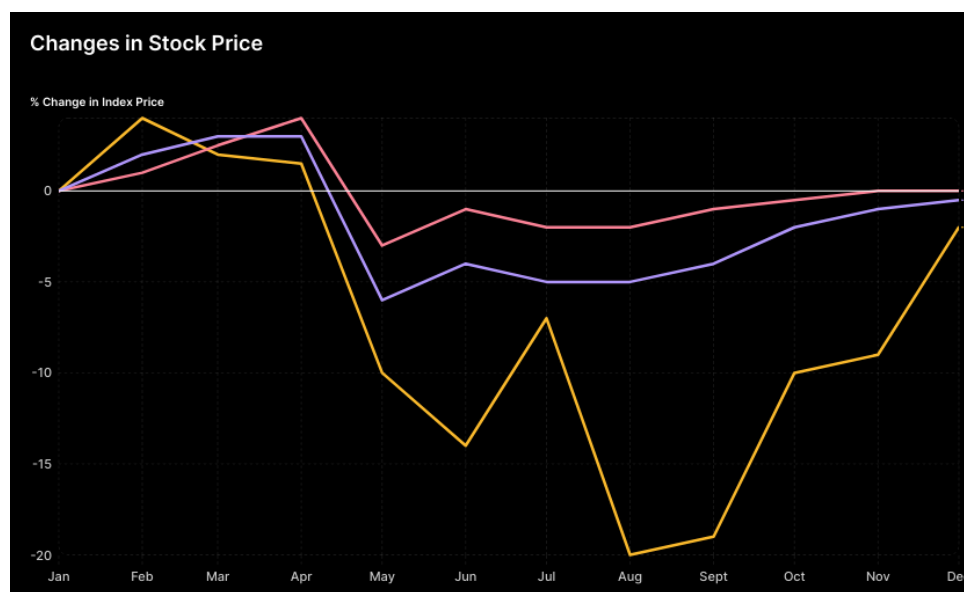
S&P 500	(A)
FDN	(B)
DJIA	(C)

Sort

(2)

- ii. Which of the following graphs corresponds to each index fund? Sort the indices to their respective line colours.

(5)



Top option	Red stock
Middle option	Purple stock
Bottom option	Yellow stock

S&P 500 (A)	FDN (B)	DJIA (C)
-------------	---------	----------

Sort

- iii. You opened a short position of \$1000 for each stock on 1 April 20XX, then closed the position on 1 July 20XX. Your brokerage platform charges a 2%/month interest charge only. For the purposes of this question, you may assume that stocks are infinitely divisible.

The exact values from the chart above can be seen here.

Date	% Change in Stock Price (from 1 January 20XX)		
	Red	Purple	Yellow
1 April 20XX	4	3	1.5

(5)

Economania Finance 3



Singapore Economics League **2025**

1 July 20XX	-2	-5	-7
-------------	----	----	----

What is your expected annualised rate of return (in %)?

You may leave your answer as a float up to 2 decimal places. Round **down** your answer to the nearest 2dp. (e.g., if your answer is 4.6891%, you should enter it as 4.68)

Float

Solution

Solution to (i)

Answer: BAC

High	Moderate	Low
FDN	S&P 500	DJIA

Explanation:

FDN has heavy exposure to growth stocks (since it is concentrated in internet and tech-focused companies — companies in a rapidly-growing industry)

S&P 500 is broad-based, but has a decent proportion of growth stocks too.

DJIA contains mostly mature, dividend-paying companies and has less tech exposure.

Solution to (ii)

Answer: CAB

Red	Purple	Yellow
DJIA	S&P 500	FDN

Explanation:

There are 2 things to observe:

- The degree of responsiveness to the EFRF
 - From (i), the more volatile a stock is, the more responsive it should be to the EFRF
- The reactions to the news headlines (change in stock price the month after the news release)
 - In May, FDN experiences a particularly significant dip.
 - In August, S&P 500 and DJIA do not experience a dip while FDN does.
 - In October, FDN experiences a significant rise.

Solution to (iii)

Answer: 0.55

Explanation:

Economania Finance 3

In a nutshell, a short position is where you borrow stocks, immediately sell them, then re-purchase the stocks at a later date. If you are able to repurchase the stocks at a lower price than when you sold them, you may be able to make a profit.

To solve this question easily, we can assume that the initial price of each stock is \$1 per stock for all 3 stocks. This price is set nominally — changing this initial price makes no difference to our later calculations.

On 1 April 20XX, you will be selling out the following number of each stocks:

Red	Purple	Yellow
$1000/1.04 = 961.54$	$1000/1.03 = 970.87$	$1000/1.015 = 985.22$

On 1 July 20XX, you will be spending to re-purchase the same number of each stock back, before considering interest:

Red	Purple	Yellow
$961.54 \times 0.98 = 942.31$	$970.87 \times 0.95 = 922.32$	$985.22 \times 0.93 = 916.25$
Total	$942.31 + 922.32 + 916.25 = 2780.88$	

Do note that you need to repay 2% more each month, so your total after considering interest is:

$$2780.88 \times 1.02^3 = 2951.09$$

Thus, the rate of return (r) is found

$$2951.09 \times (1 + r/100)^3 = 3000$$

$$1 + r/100 = (1.0166)^{1/3}$$

$$r/100 = 1.00550 - 1$$

$$r = 0.55$$