

Section C

This section is marked out of 100. The marks achieved in this section account for 25% of your final exam result.

Instructions to candidates: Answer ALL FOUR questions. Question 1 carries 20 marks, questions 2 and 3 carry 25 marks each, and question 4 carries 30 marks. Round your answers to 2 decimal places. Remember to always explain your reasoning. Calculators are permitted.

Question 1

Sidney wants to buy a new television which costs £4,000, but does not have enough money to pay for it immediately. He finds an electronics store, *First Price*, that offers a payment plan that requires an initial payment of £1,500 immediately, and then £2,750 after 1 year.

- (a) What is the implied yearly interest rate for this payment plan? (4)
- (b) What is the implied monthly compound interest rate? (6)

The selling price of £4000 includes a Value Added Tax (VAT) rate of 20%.

- (c) Sidney finds another store, *Second Guess*, that is willing to refund half the VAT if he purchases the computer from them. To counter this, *First Price* offers a 10% discount on the final price (i.e. including VAT).

Which offer should Sidney go for and why? (10)

[20 marks]

Question 2

In the country of Ellessee, there are just two producers of mobile phones: *Robot* and *Pear*. The table below indicates the total number of people (in millions) that purchased mobile phones last year, as well as the proportion of those that own phones produced by *Robot*. The figures are grouped by region.

Region	Total owners (millions)	Proportion of <i>Robot</i> phone owners
North	1.2	0.7
East	0.8	0.25
South	0.7	0.4
West	1.0	0.24

Assume that each company produces just one type of handset, and that *Robot* phones cost £200 per handset, while *Pear* phones cost £350 per handset.

- (a) What is the total number of people in the North that own *Pear* phones? (3)
- (b) What percentage of the total population of Ellessee own *Robot* phones? (5)
- (c) What was *Pear*'s total revenue from phone sales last year? (3)
- (d) *Pear* believes an advertising campaign in the East would convert 1 out of every 5 *Robot* customers to *Pear* customers. Assuming that the campaign is successful, and that the total number of phone owners remains constant, what is the increase in revenue that *Pear* expects to see in the East? (6)

Market research suggests that if *Robot* replaces its current handset with a low-end handset, priced at £150, and a high-end handset, priced at £300 then the ratio of current *Robot* customers in the West who will choose the low-end handset instead of the high-end handset is 3:1. Moreover, it predicts that 10% of *Pear* customers will switch to a high-end *Robot* handset.

- (e) Assuming that the total number of phone owners in the West remains constant, what is the percentage increase in revenue that *Robot* expects to see in this region? (8)

[25 marks]

Question 3

International Business Marbles produces glass marbles using an unreliable manufacturing process that produces either perfect (i.e. clear) marbles or imperfect (i.e. cloudy) marbles. The company is able to sell both types of marbles, where the average selling price per 50 marbles is £50 for perfect marbles and £12.50 for imperfect ones.

The graph below shows total number of all marbles sold (i.e. perfect and imperfect) as well as the total number of perfect marbles sold for the years 2010 to 2014. Totals are given in thousands.

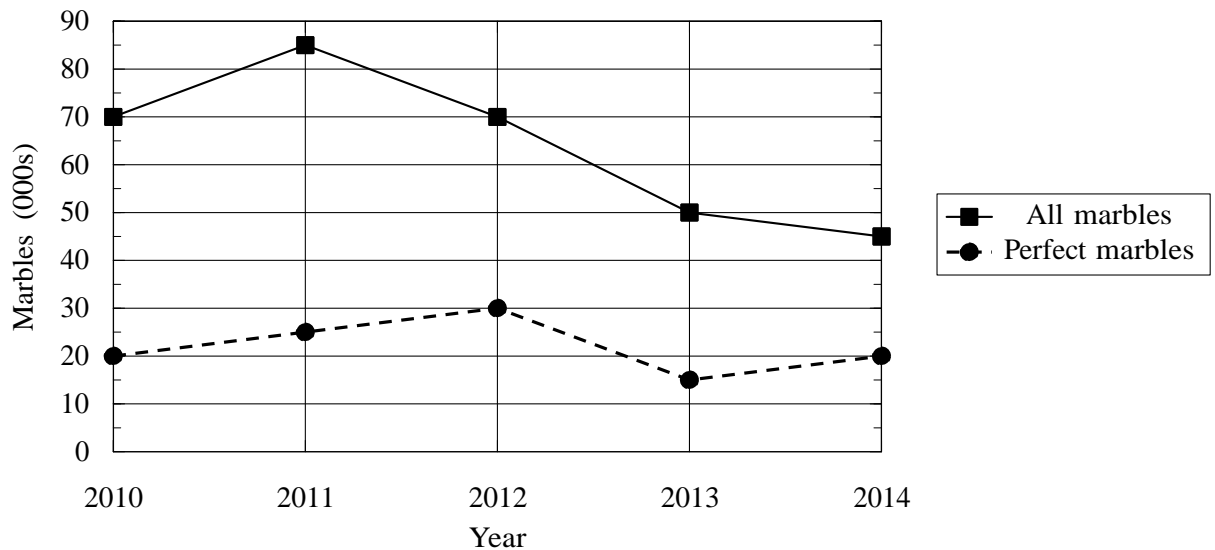


Figure 1: *International Business Marbles* sales figures for 2010–2014.

- (a) Which type of marble saw the largest annual change in the number sold, and in which year did this occur? (5)
- (b) Which type of marble saw the largest annual *percentage* change in the number sold, and in which year did this occur? (5)
- (c) What was the loss in potential sales revenue due to the production of imperfect marbles over the 5 year period? (7)
- (d) In 2012, analysts predicted that the rate of decline in sales of imperfect marbles would remain constant over the following 2 years.

Using the total sales figure for all marbles in Figure 1, calculate the difference between the predicted revenue and the actual revenue from the sale of imperfect marbles in 2014. (8)

[25 marks]

Question 4

Suppose that a country's rate of population growth, r , decreases as its population, N , increases according to the formula:

$$r = r_0 \left(1 - \frac{N}{K}\right), \quad (\star)$$

where r_0 and K are constants that have yet to be determined.

- (a) The constant K is the population's *carrying capacity*. By considering what happens when the country's population is equal to the carrying capacity, i.e. when $N = K$, explain why we can consider K a *steady state level* for the population. (6)

- (b) Suppose that when the population is half the carrying capacity, i.e. $N = 0.5K$, the rate of population growth is $\frac{1}{4}$. (6)

Determine the value of r_0 .

You should use the value of r_0 you calculated in part (b) when attempting parts (c) and (d). It is not required in part (e).

- (c) Draw the graph of r against N , with r on the vertical axis and N on the horizontal axis.

For what value or values of r does the graph cross the vertical axis?

For what value or values of N does the graph cross the horizontal axis? (10)

- (d) Suppose that $K = 150$ million. What must the population of the country, N , be for the rate of population growth, r , to be equal to $-\frac{1}{2}$? (5)

Describe how the population is changing in this situation. (5)

- (e) Rewrite the relationship in equation (\star) in the form $r = aN + b$, identifying what a and b are. (3)

[30 marks]