Section A	Concepts and Skills	150 marks

Answer **any five questions** from this section.

Question 1 **(30 marks)**

(a) Seán is buying a power bank and a USB-C cable.

(i) One power bank costs €30 **before** VAT at 23% has been added.
Find the cost of the power bank **after** VAT has been added.

(ii) Seán is going to buy a different power bank that costs €26, and a USB-C cable that costs €9.
Seán sees a special offer to buy the power bank and USB-C cable together for €28.

Work out the percentage discount of this special offer.

(b) Máiréad and Diarmuid own a window cleaning business.

Máiréad can clean a standard window in 9 minutes
Diarmuid can clean a standard window in 12 minutes.

(i) Máiréad and Diarmuid both start cleaning standard windows at the same time. They both finish cleaning a window at the same time.

After how many minutes will this **first** happen?

(ii) A building has 35 standard windows.
Work out how long it would take Máiréad and Diarmuid to clean the 35 windows if they work together.

Question 3 **(30 marks)**

(a) Rickie is buying protein bars.

The cost of a single protein bar is €$3 \cdot 30$.
A shop has the following two special offers:

Offer A	**Offer B**
3 bars for the price of 2 bars	12 pack of the same bar for €29·99

Which offer is **cheaper** per bar?
Use calculations to support your answer.

Cheaper offer: Offer A ☐ Offer B ☐
(Tick (✓) **one** box only)

Calculations:

(b) Solve the inequality for $x \in \mathbb{R}$:

$$2x + 4 \geq 6x - 8$$

Question 4 **(30 marks)**

(a) Solve the following equation in $a \in \mathbb{R}$:

$$5(a-3) = 2a + 7$$

(b) The function $f(x)$ is defined as $f(x) = x^3 - 3x^2 + 4x - 8$, where $x \in \mathbb{R}$.

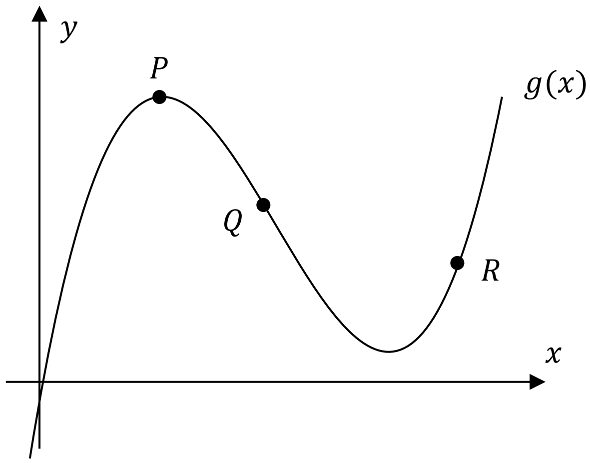
Find $f'(x)$, the derivative of $f(x)$.
Hence, find the slope of the tangent to $f(x)$ at the point $(2, -4)$.

$f'(x) =$

Slope of tangent $=$

(c) The diagram below shows the graph of a cubic function $g(x)$.
P, Q, and R are points on the graph of g.

(i) Write each of the letters P, Q, and R in the correct place in the table so that each point matches the description of the derivative at that point, where $g'(x)$ is the derivative of $g(x)$.



Point (P, Q, or R)	**Derivative**
	$g'(x) < 0$
	$g'(x) = 0$
	$g'(x) > 0$

(ii) For the point that you matched to $g'(x) = 0$, give a reason for your answer.

Reason:

Question 5 **(30 marks)**

(a) Use algebra to solve the simultaneous equations:

$$3x + 2y = 11$$
$$x - 4y = -1$$

$x =$ $y =$

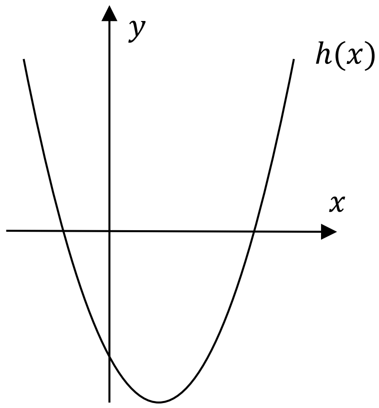
(b) Solve the following equation in $x \in \mathbb{R}$:

$$3x^2 - 2x - 4 = 0$$

Give each answer correct to 2 decimal places.

(c) The graph of a **quadratic** function $h(x)$ is shown in the diagram below (**drawn to scale**).

The graph is symmetrical about a vertical line.



(i) Based on the graph, which of the following pairs of values of x is a possible set of roots of $h(x)$, that is, values of x for which $h(x) = 0$?

Tick (✓) **one** box only.

☐ $x = 2$ and $x = 8$

☐ $x = -2$ and $x = -8$

☐ $x = -2$ and $x = 8$

☐ $x = -8$ and $x = 2$

(ii) Find the value of x, at which $h(x)$ is a minimum.

Question 6 **(30 marks)**

(a) Tara buys a coat for €90.
She then sells the coat at a profit of 25%.

(i) Find the selling price of the coat.

(ii) The margin on the coat is the **profit** as a **percentage** of the **selling** price.
Write down the profit for this coat **and** hence find the margin.

Profit $=$ Margin $=$

(b) Write each of the following numbers in the form $a \times 10^n$, where $1 \leq a < 10, n \in \mathbb{Z}$.

$58\,000 =$

$0{\cdot}036 =$

(c) Light travels at a **speed** of approximately 3×10^5 km/second.
A light year is the distance travelled by light in 1 year.

Find the **distance** travelled by light in 1 year.
(You may assume there are 365 days in a year.)

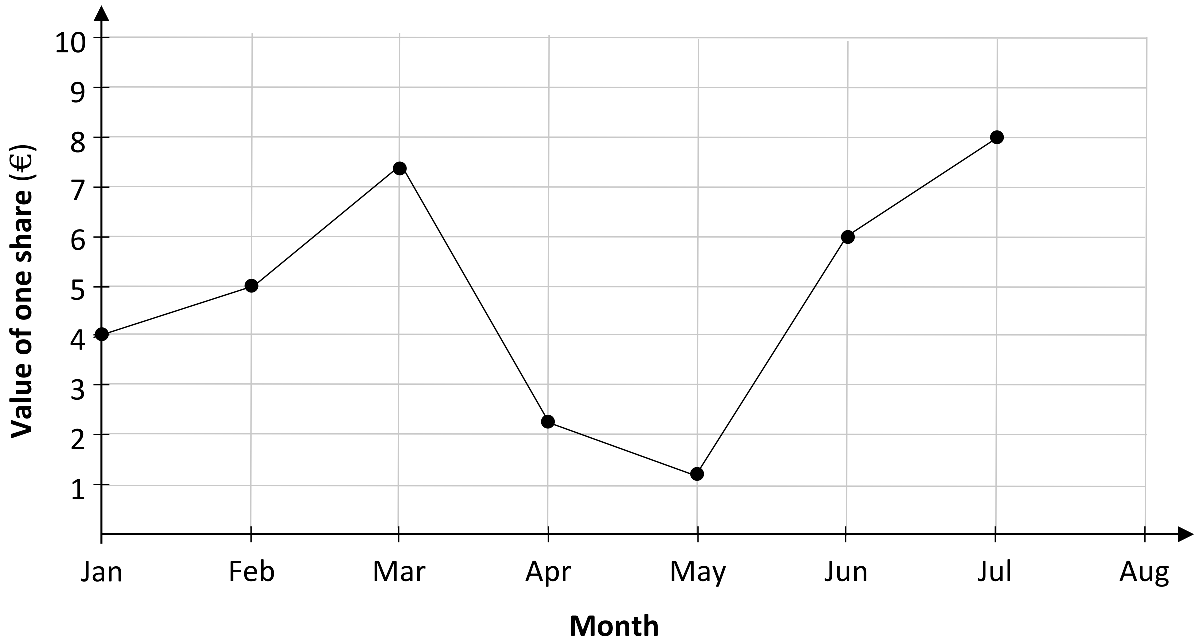
Give your answer, in km, in the form $a \times 10^n$, where $1 \leq a < 10, n \in \mathbb{Z}$.

Section B — Contexts and Applications — 150 marks

Answer **any three questions** from this section.

Question 7 **(50 marks)**

The diagram below shows the value of one share for Company A, in euro, on the 1st day of each month from 1st January to 1st July.



(a) **(i)** Use the graph to estimate the value of one share on 1st March.

(ii) Use the graph to identify the month **during which** the value of one share increased by the greatest amount.

(b) On 1st August the value of one share was 15% lower than it was on 1st of July.
By reading from the graph and doing calculations, estimate the value of one share on 1st of August as accurately as possible **and** hence plot that point on the diagram on the previous page.

Calculations:

(c) Later in the year, Liam predicts the value of one share.
The error in his prediction is €$1{\cdot}50$, which is a percentage error of $16{\cdot}3\%$.

Find the value of one share at this time.
Give your answer correct to the nearest cent.

This question continues on the next page.

(d) The value of one share for Company B can be modelled by the function:

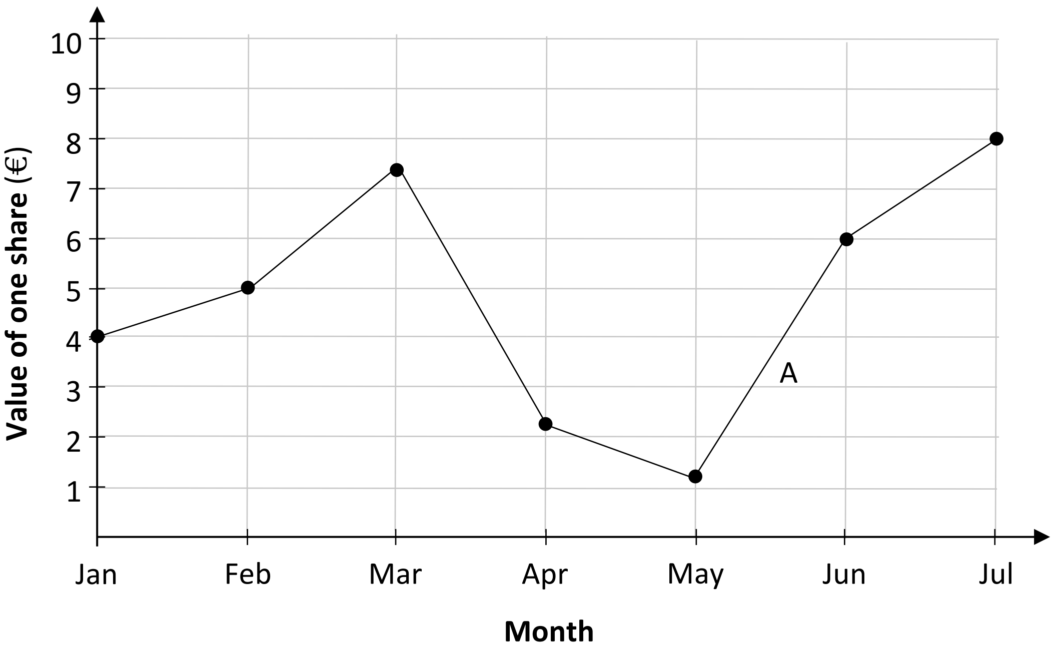
$$P(m) = 2 \times 1{\cdot}29^m$$

where $P(m)$ is the value of one share, in euro, and m is the time, in months, since 1st January, with $0 \leq m \leq 6, m \in \mathbb{R}$.

(i) Complete the table below to show the values of $P(m)$ for the given values of m. Give each value of $P(m)$ correct to 2 decimal places where relevant.

Month (1st of)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**
$\boldsymbol{m}$	0	1	2	3	4	5	6
$\boldsymbol{P(m)}$	2		3·33				9·22

(ii) The graph of Company A is shown again below.
On the same diagram, **draw the graph** of $P(m)$, for $0 \leq m \leq 6, m \in \mathbb{R}$.



(iii) At **only one** point in the time period shown, the value of one share for Company A is equal to the value of one share for Company B, according to the function $P(m)$.
In which month must this have happened?

(e) According to the model, the value of one share for Company B reaches its highest value on 1st July, and from then onwards it declines at a steady linear rate of 30 cent per month.

A new function is created to model this decline, where $Q(n)$ is the value of one share n months **after** the time the share reaches its highest value ($n \in \mathbb{N}$).

Part of the function is shown below:

$$Q(n) = \boxed{} \quad -0{\cdot}3n$$

(i) Fill in the missing number in the box above to complete the expression for $Q(n)$.

(ii) Using your expression, or otherwise, find how many months it takes for the value of one share for Company B to fall below its value on 1st January, according to the model. Remember that $n \in \mathbb{N}$.

Question 8 **(50 marks)**

A company launches a new phone.
The company's profit each year will depend on the number of phones it produces, x.
The company's profit for the first year can be modelled by the function:

$$P(x) = -1{\cdot}5x^2 + 10{\cdot}5x - 4$$

where $P(x)$ is the profit for the first year (in millions of euro) and x is the number of phones (in tens of thousands) it produces in the first year, with $0 \le x \le 7$, $x \in \mathbb{R}$.

(a) **(i)** Find $P(0)$ **and** explain what it means in the context of the question.

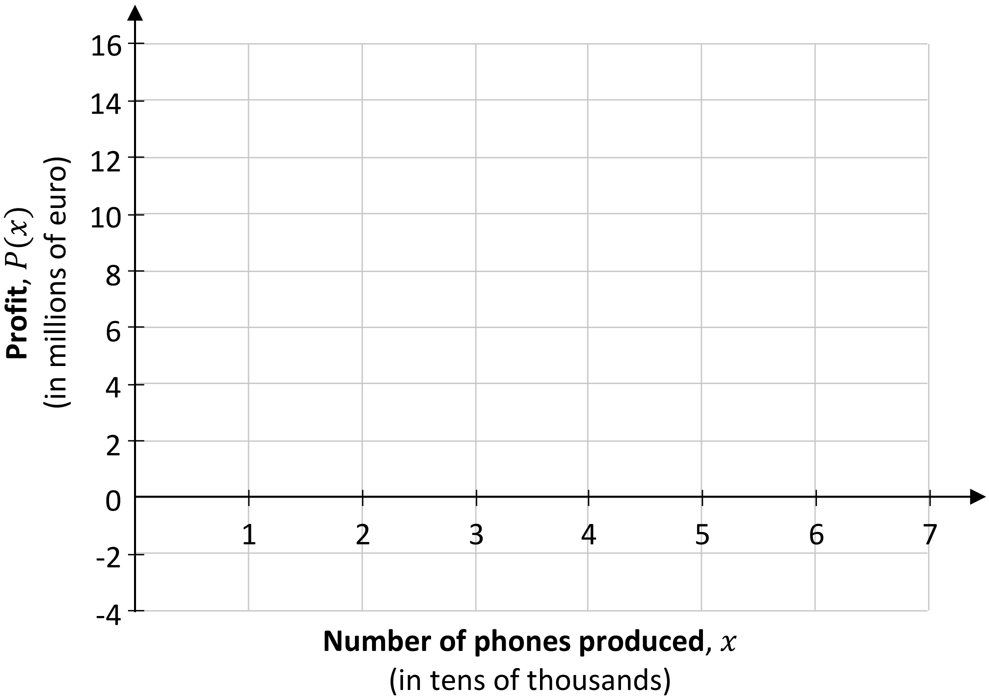
$P(0) =$

Explanation:

(ii) Complete the table below to show the values of $P(x)$ for the given values of x.

Number of phones produced, x (in tens of thousands)	0	1	2	3	4	5	6	7
Profit, $P(x)$ (in millions of euro)		5				11		

(iii) Draw the graph of $P(x)$ on the axes below for $0 \le x \le 7$, $x \in \mathbb{R}$.



(iv) Use your graph on the previous page to estimate the range of values of x for which the company will have a profit of at least €6 million. Show your work on the graph.

(b) The profit of the company for the **second** year can be modelled by the function:

$$Q(x) = -1{\cdot}5x^2 + 9{\cdot}6x - 3{\cdot}5$$

where $Q(x)$ is the profit for the second year (in millions of euro) and x is the number of phones (in tens of thousands) it produces in the second year, with $0 \leq x \leq 7$, $x \in \mathbb{R}$.

(i) Find $Q'(x)$, **and** hence find the value of x which will give the maximum value of $Q(x)$.

$Q'(x)$:

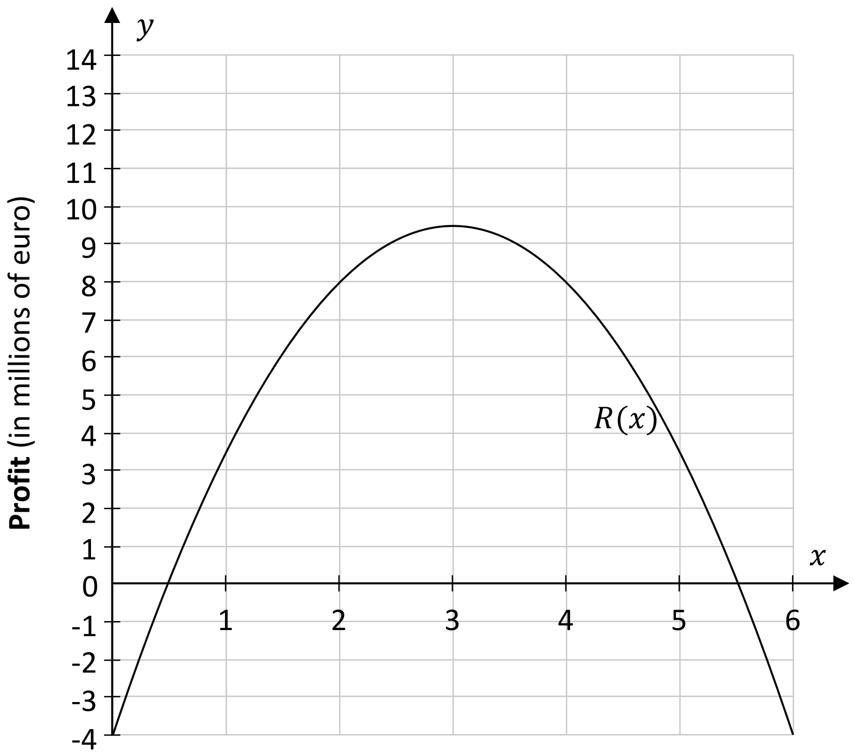
Value of x:

(ii) Hence, find the maximum value of $Q(x)$.

This question continues on the next page.

(c) The profit for the third year can be modelled by the function $R(x)$, where $R(x)$ is the profit for the third year (in millions of euro) and x is the number of phones (in tens of thousands) it produces in the third year, with $x \in \mathbb{R}$.

The graph of $R(x)$ is shown below for $0 \leq x \leq 6$, $x \in \mathbb{R}$.



At the start of the third year, the company receives €3 million in additional funding. As a result, the profit for the third year can actually be modelled by:

$$\text{Profit} = R(x) + 3$$

(i) From the graph, estimate $R(2)$ **and** hence work out the value of $R(2) + 3$.

$R(2) =$

$R(2) + 3 =$

(ii) On the diagram above, draw the graph of $y = R(x) + 3$ for $0 \leq x \leq 6, x \in \mathbb{R}$, using the same axes and scales.

Question 9 **(50 marks)**

(a) Evan has €4500 saved.
He put this money in a savings account with a rate of $2{\cdot}8\%$ per annum compound interest.

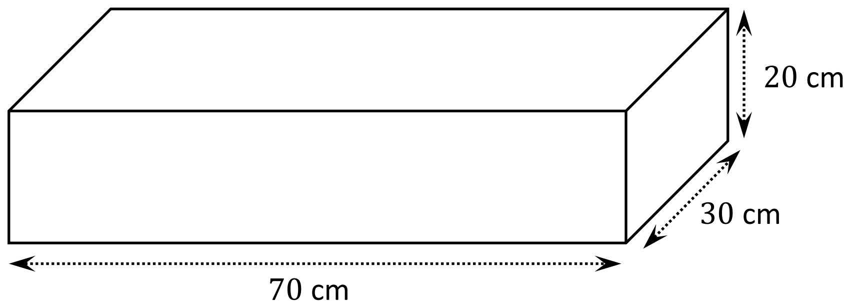
(i) Find how much money will be in the account after 1 year.

(ii) Hence, or otherwise, find how much money will be in the account at the end of 3 years using the rate of $2{\cdot}8\%$ per annum compound interest.
Give your answer correct to the nearest cent.

This question continues on the next page.

Question 10 **(50 marks)**

(a) A factory makes closed boxes.
The lengths of the sides of one of the boxes are shown in the diagram below.



(i) Draw a scaled diagram of a net of the box in the grid below.
Use the scale $1:10$.
The length of each small square in the grid is 1 cm.

(ii) Work out the surface area of this box, in cm^2.

(iii) The factory owner buys a machine from China for making the boxes.
The machine costs $353\ 819{\cdot}34$ Chinese Yuan, including shipping.
The factory owner must also pay €1890 in customs duty.

Using the exchange rate €$1 = 7{\cdot}61$ Chinese Yuan, find the **total** cost of the machine, in euro, including the customs duty.

This question continues on the next page.

(b) Ciara gets paid a wage of €780 per week for working 40 hours.
Ciara gets paid an hourly rate for any hours worked over the 40 hours.
This rate is 50% more than the hourly rate for the first 40 hours.

On a particular week, Ciara works her regular 40 hours, plus an additional n hours.
Her total wage is €$1043 \cdot 25$.
Work out the value of n.

(c) A shop repairs clothes. The charge for a repair is given by the formula:

$$C = \frac{20h + xh}{d}$$

where C is the charge for the repair, in euro, h is the number of hours it took to do the repair, x is an extra hourly charge based on the level of difficulty of the work and d is a discount rate, with $d \geq 1$.

(i) Find the charge for a repair when it takes 3 hours to do the repair, the extra hourly charge, x, is $3{\cdot}5$, and the discount rate, d, is $1{\cdot}1$. Give your answer correct to 2 decimal places.

(ii) Find the value of x when the charge for the repair is €76, the repair takes 4 hours, and the discount rate is $1{\cdot}2$.

(iii) In the formula for C above, $d \geq 1$.
What impact would changing d, so that $d < 1$, have on the charge for a repair?

You may use this page for extra work.
Label any extra work clearly with the question number and part.

Section A	Concepts and Skills	150 marks

Answer **any five questions** from this section.

Question 1 **(30 marks)**

(a) Fiadh has €1500 saved.
She put this money in a savings account with a rate of 3% per annum compound interest.

(i) Find how much money will be in the account after 1 year.

(ii) Hence, or otherwise, find how much money will be in the account at the end of 2 years.

(b) The standard rates and thresholds of the Universal Social Charge (USC) in Ireland for 2024 are given in the table below.

Annual Income	Rate
First €12 012	0·5%
Next €13 748	2%
Next €44 284	4%
Balance	(Top Rate)

Source: www.revenue.ie

(i) At what annual income does a worker start paying the top rate of USC?

Mike's annual income for 2024 is €65 000.

(ii) Work out how much he will pay in USC for 2024.

Question 4 **(30 marks)**

(a) $f(x)$ is the following function in $x \in \mathbb{R}$:

$$f(x) = (x+3)^2 + 5$$

(i) Find the value of $f(0)$.

(ii) Write $f(x)$ in the form $ax^2 + bx + c$, where $a, b, c \in \mathbb{R}$.

(b) Solve the following equation in x:

$$3x^2 - 4x - 9 = 0$$

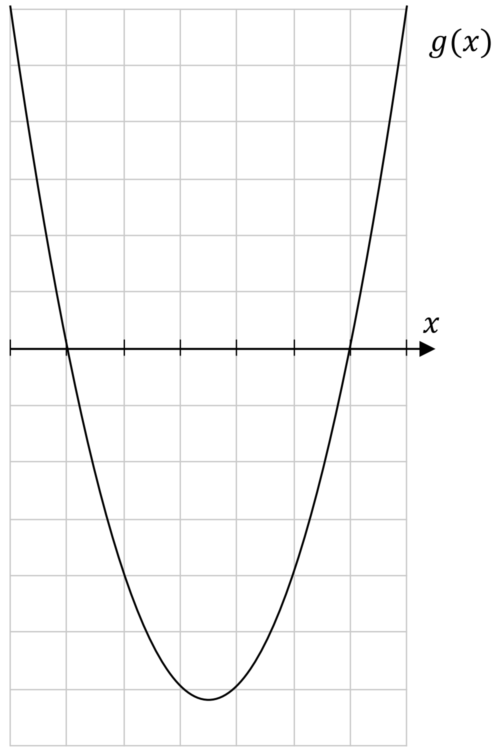
Give each answer correct to 2 decimal places.

(c) The graph of the quadratic function, $g(x)$, is shown on the diagram below (drawn to scale). The y-axis is not shown.

Using the information below, **draw** the y-axis into the diagram.

- The **roots** of $g(x)$ are $x = -2$ and $x = 3$.
- $g(0) = -6$.

Label the y-axis, and the points where $g(x)$ cuts both the x-axis and the y-axis.



Question 5 **(30 marks)**

(a) In Caoimhe's gas bill the volume of gas used is converted to kilowatt-hours.

The current reading on Caoimhe's gas meter is $12\ 518$ m^3.
The previous reading on Caoimhe's gas meter was $12\ 398$ m^3.

(i) The conversion rate is 1 m$^3 = 11{\cdot}5452$ kilowatt-hours.

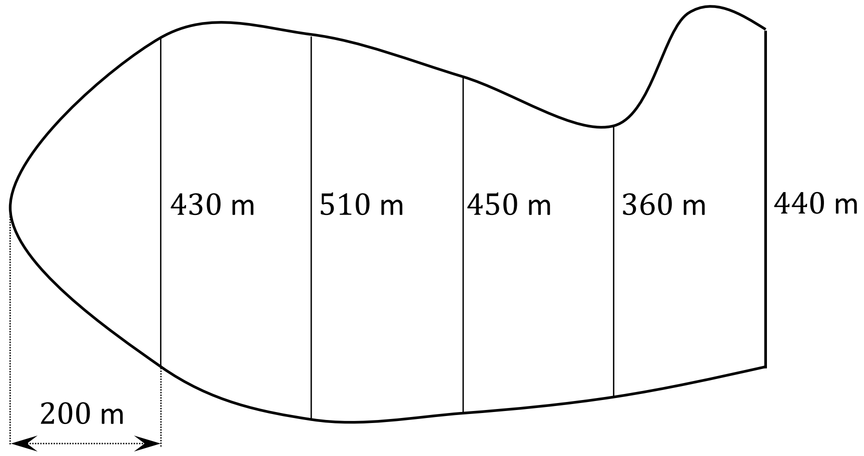
Find the volume of gas used since the previous reading, in m^3, and hence show this is equal to $1385{\cdot}424$ kilowatt-hours.

(ii) Gas costs $13{\cdot}46$ cent per kilowatt-hour.
Find the cost of the gas used by Caoimhe during this period.
Give your answer in euro, correct to 2 decimal places.

Caoimhe's total gas bill is €$227{\cdot}47$ before VAT.

(iii) Work out Caoimhe's total gas bill after VAT at 9% has been added.
Give your answer in euro, correct to 2 decimal places.

(b) Caoimhe wants to estimate the area of her farm, in m^2. She measures at intervals of 200 m, starting at the right-hand edge of the farm. These measurements are given on the diagram, correct to the nearest metre.



Use the **Trapezoidal Rule** (and the measurements in the diagram above) to work out an estimate for the area of the farm, in m^2.

Question 6 **(30 marks)**

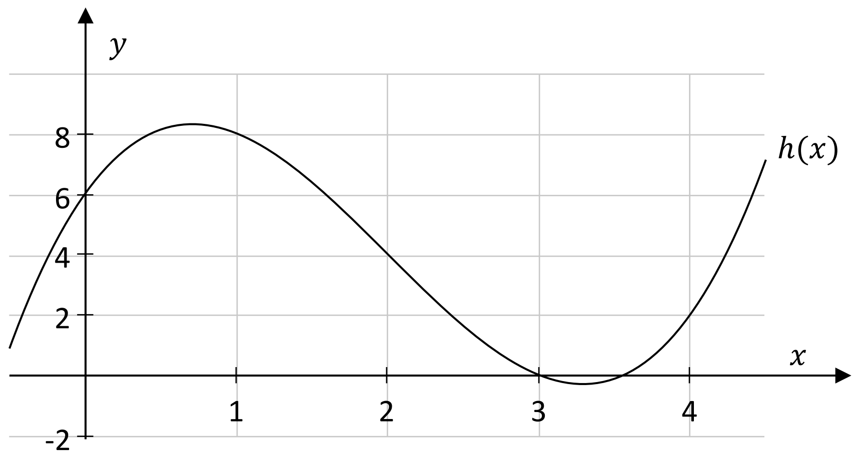
(a) $h(x)$ is the following function in $x \in \mathbb{R}$:

$$h(x) = x^3 - 6x^2 + 7x + 6$$

(i) Find $h'(x)$, the derivative of $h(x)$.

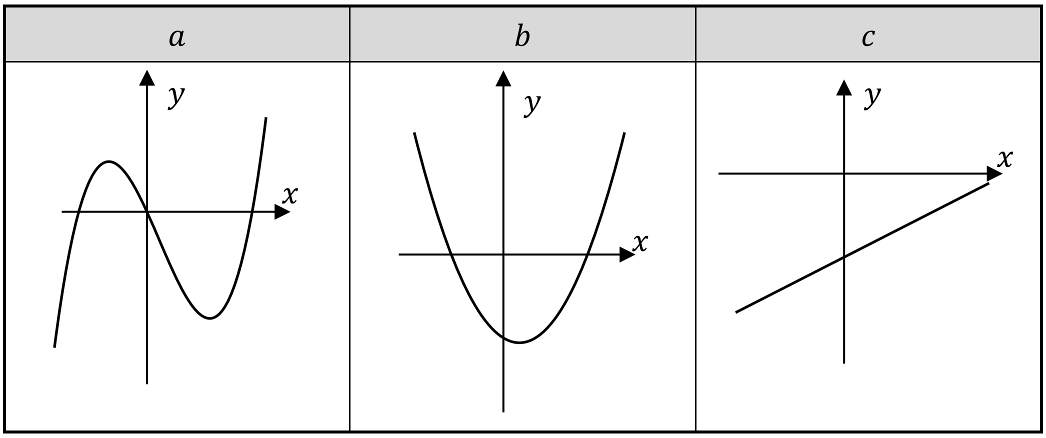
(ii) Hence, find the slope of the tangent when $x = 1$.

The graph of the function $h(x)$ is shown on the co-ordinate diagram below, for $-0{\cdot}5 \leq x \leq 4{\cdot}5$, $x \in \mathbb{R}$.

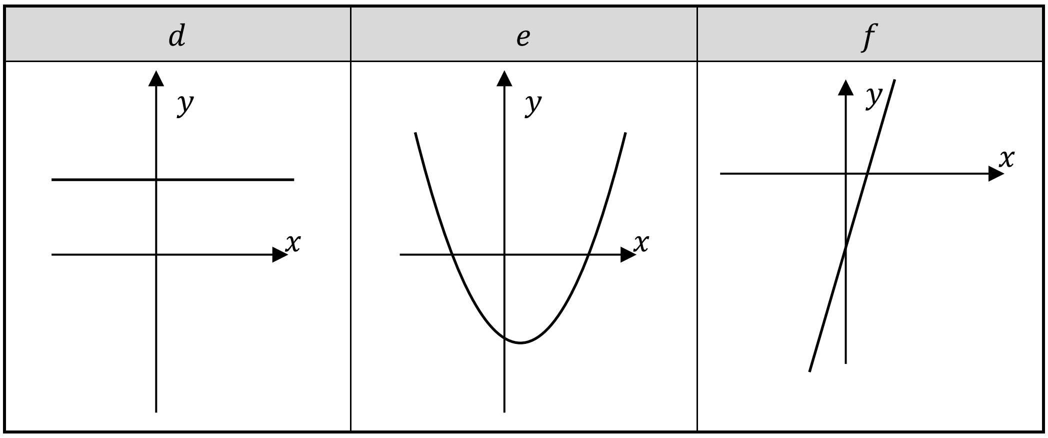


(iii) **Draw** the tangent to the graph of $h(x)$ at the point where $x = 1$ on the diagram above. Use the same axes and scales.

(b) The first three diagrams below show the graphs of the functions a, b and c.
These functions are cubic, quadratic, and linear, respectively.



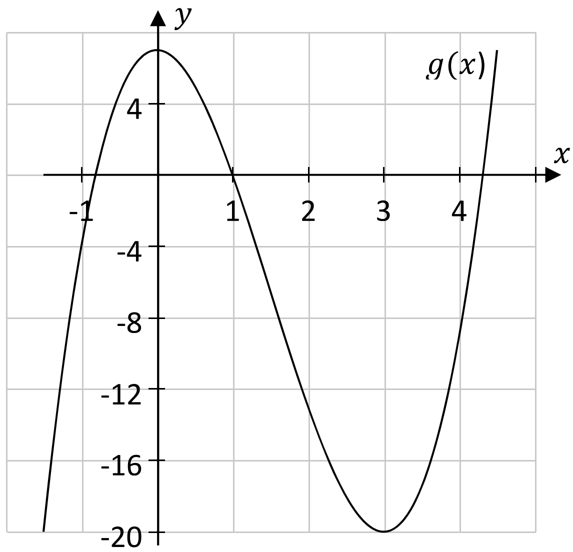
The next three diagrams below show the graphs of the functions d, e and f.
Each one of these is the slope function (derivative) of either a, b or c (above).



Write d, e and f in the correct place in the table to match each function to its slope function.

Function	**Slope function** (d, e or f)
a	
b	
c	

(c) The graph of a cubic function $g(x)$ is shown below.



Use the graph to estimate each of the following:

(i) the 3 roots of $g(x)$.

Note: In the case of the next two parts, show your work clearly on the graph.

(ii) $g(3 \cdot 5)$.

(iii) The values of x for which $g(x) = -8$.

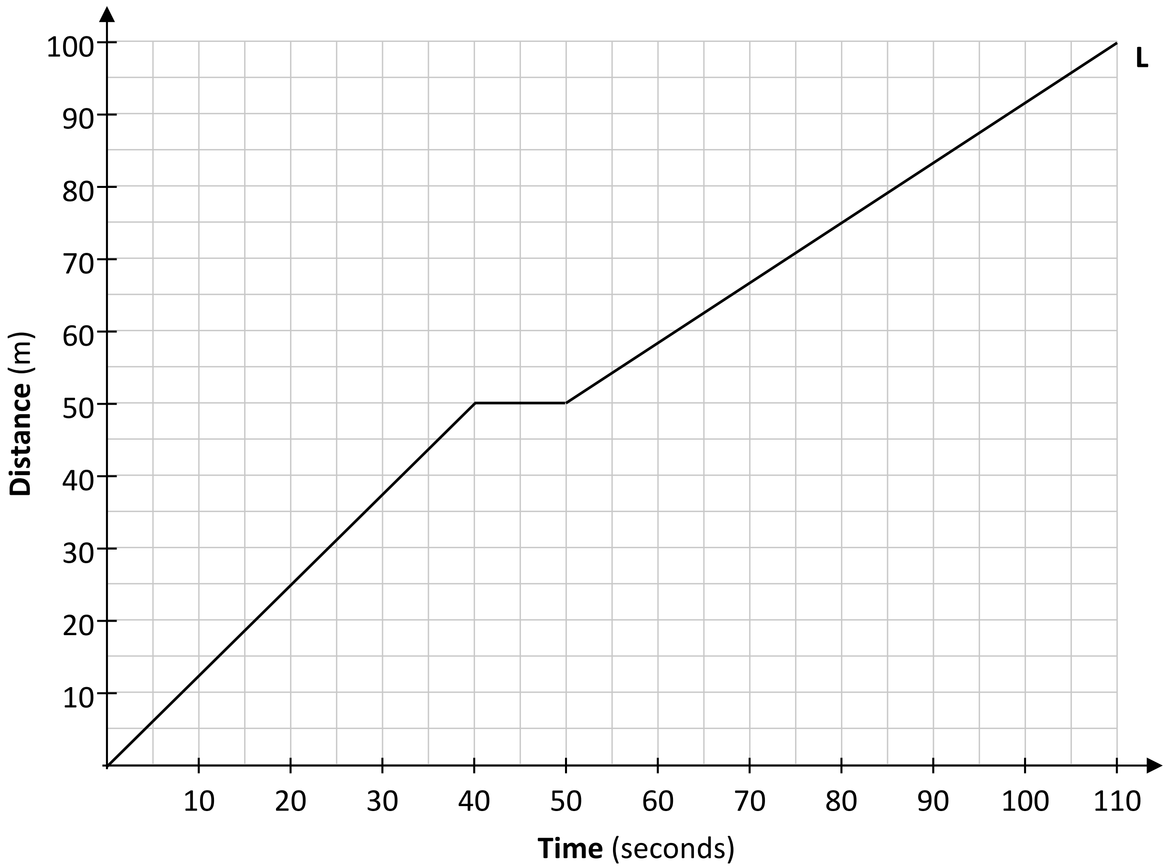
Section B Contexts and Applications 150 marks

Answer **any three questions** from this section.

Question 7 **(50 marks)**

Lillian and Darragh visit a 50 m swimming pool.

Lillian swims 50 m at a constant speed.
She stops for a rest after her first 50 m and then swims a second 50 m at a different constant speed.
The graph, labelled **L**, shows the distance that Lillian swims for the first 110 seconds of her swim.



(a) **(i)** How long does Lillian stop for?

Answer: ______ seconds

(ii) Find Lillian's speed for the first 50 m.
Give your answer in metres per second.

(iii) Does Lillian's **speed** increase, decrease or stay the same for the second 50 m? Give a reason for your answer.

Lillian's speed:	Increases	Decreases	Stays the same
(Tick (✓) **one** box only)	☐	☐	☐

Reason:

(b) Darragh swims at a constant speed of 10 m every 7 seconds.

(i) How many seconds does it take Darragh to swim 50 m?

(ii) Darragh starts swimming 10 seconds after Lillian.
He swims 50 m, stops for 5 seconds and then swims a second 50 m at the same constant speed as in part **(b)(i)**.

Graph the distance Darragh swims on the diagram **on the previous page** and **label** it **D**.
Use the same axes and scales.

This question continues on the next page.

(c) The average speed for the world record of the women's 100 m freestyle is $1{\cdot}934$ metres per second.

Work out how long it took her to swim the 100 m, in seconds.
Give your answer correct to 2 decimal places.

Section B	Contexts and Applications	150 marks

Answer **any three questions** from this section.

Question 7 **(50 marks)**

(a) During an experiment, the number of bacteria in a dish can be modelled by the function:

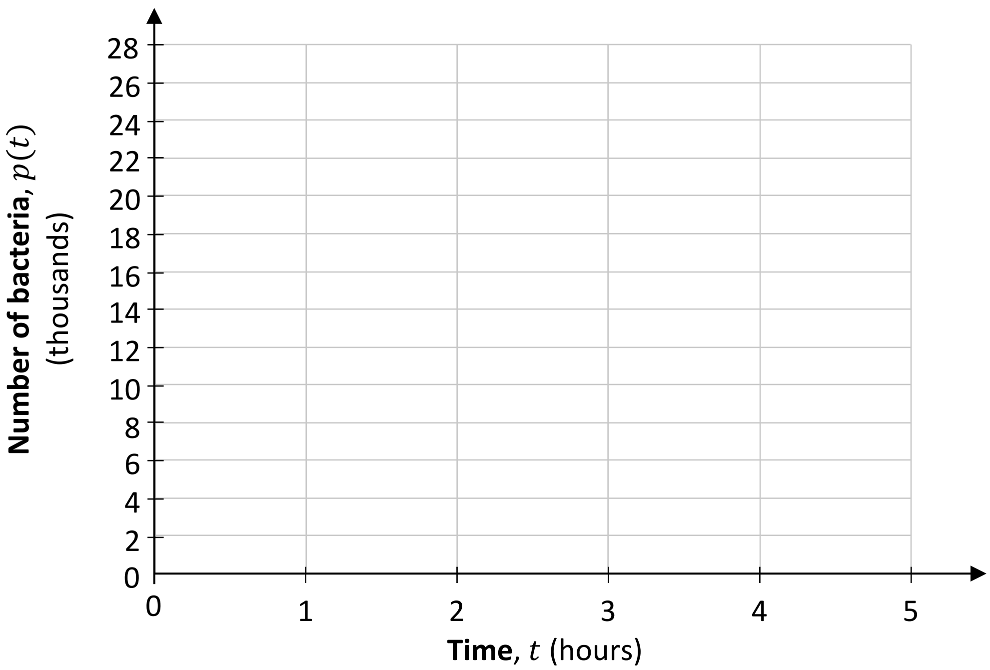
$$p(t) = t^3 - 6t^2 + 6t + 20$$

where $p(t)$ is the number of bacteria, in thousands, and t is the time in hours since the start of the experiment, with $0 \leq t \leq 5$, $t \in \mathbb{R}$.

(i) Complete the table below to show the values of $p(t)$ for the given values of t.

Time, t (hours)	0	1	2	3	4	5
Number of bacteria, $p(t)$ (thousands)			16		12	

(ii) Draw the graph of $p(t)$ on the axes below, for $0 \leq t \leq 5$, $t \in \mathbb{R}$.



(iii) Find $p'(t)$, the derivative of $p(t)$.
Remember that:

$$p(t) = t^3 - 6t^2 + 6t + 20$$

(iv) Find the value of $p'(2)$.

(v) $p'(4) = 6$.

Explain what this means in terms of the number of bacteria.

This question continues on the next page.

(b) The number of bacteria in a **different** experiment can be modelled by the function:

$$k(t) = 3000 \times 2{\cdot}72^{0{\cdot}5t}$$

where $k(t)$ is the number of bacteria and t is the time in hours since the start of the experiment, with $0 \leq t \leq 8$, $t \in \mathbb{R}$.

There are 3000 bacteria at the beginning of the experiment.

(i) Use $k(t)$ to find the number of bacteria after 1 hour **and** after 2 hours. Give each answer correct to the nearest whole number.

After 1 hour

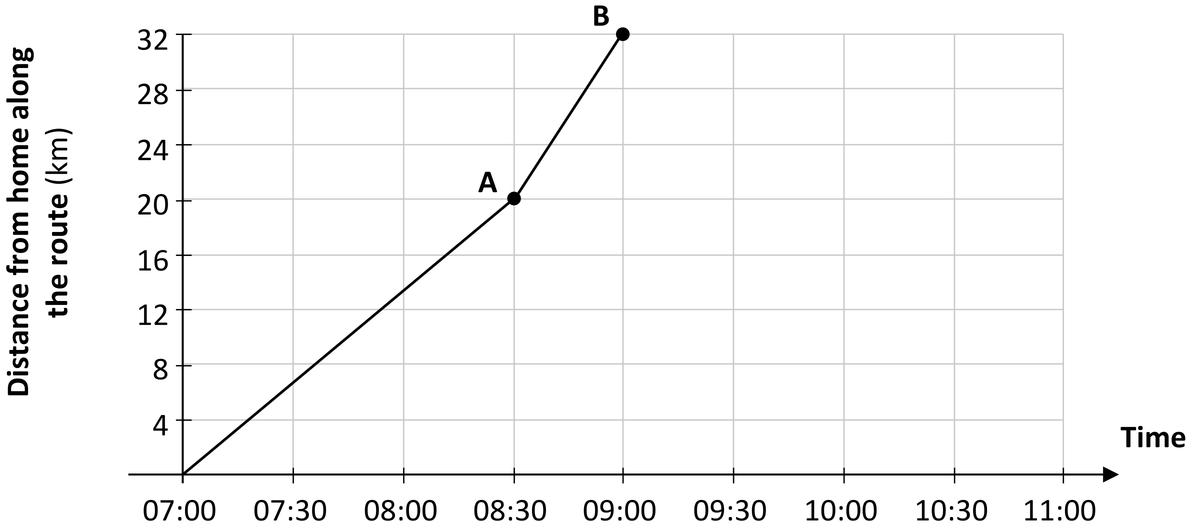
After 2 hours

(ii) After n hours, there are at least $35\,000$ bacteria according to $k(t)$, where $n \in \mathbb{N}$. By continuing the pattern above, or otherwise, find the smallest possible value of n.

Question 8 **(50 marks)**

(a) Liam left home at $07:00$.
He cycled at a constant speed for 20 km, until he reached the point **A**. He then changed speed and cycled at a constant speed for a further 12 km, until he reached the point **B.**

The graph shows his distance from home along the route cycled until he reached **B**.



(i) Use the graph to estimate the distance Liam had cycled by $08:00$.
Show your work on the diagram above.

(ii) Find his speed in km/hour while he was travelling from **A** to **B**.

(iii) Use the following information to complete the graph on the diagram above to show the rest of Liam's journey:

- Liam stopped at **B** for 30 minutes
- He then cycled the 32 km back home at a constant speed.
  This took him 1 hour.

This question continues on the next page.

Question 8 **(50 marks)**

An oil lorry delivered heating oil to John's home.
Before the delivery the meter reading in the lorry showed that it contained 10 360 litres of oil.
After the delivery the meter reading was 9160 litres.

(a) **(i)** One litre of oil costs €0·6168.
Find the cost of the heating oil that was delivered to John's home.

(ii) The cost in **part (a)(i)** does **not** include VAT.
Find the total cost of the heating oil after VAT at 13·5% is included.

(b) Six months later the same amount of oil, including VAT at the same rate, cost €1157·70.
What was the price **per litre** of this oil **excluding** VAT?
Give your answer correct to the nearest cent.

This question continues on the next page.

(c) John discovered a leak in his oil tank.
He contacted two companies and asked for quotes to repair the tank.
Each company included a call out charge and a rate per hour, or part of an hour, for the repair work.
They emailed the following quotes for the repair work:

Company A:	€100 call out charge plus €60 per hour (or part thereof)
Company B:	€80 call out charge plus €70 per hour (or part thereof)

(i) If the repair will take 4 hours 15 minutes to complete, how much would each company charge?

Company A: Company B:

(ii) Write a formula to show the total amount that each company charges for n hours of repair work, where $n \in \mathbb{N}$.

Formula for Company A:

Formula for Company B:

(iii) After how many hours would the cost be the same for both companies?

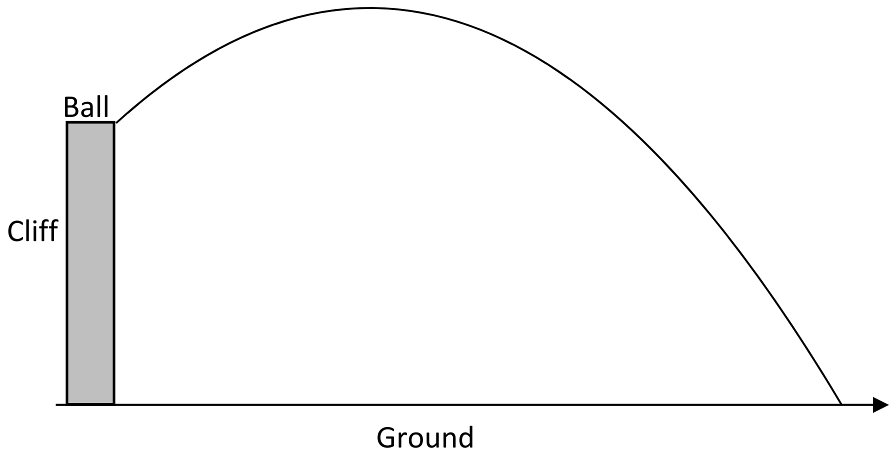
(d) John's oil tank is in the shape of a cylinder.
It is 2 m long and can hold 1500 litres of oil.
Find the radius of the oil tank.
Give your answer correct to the nearest cm.
(**Note**: 1 Litre $= 1000$ cm^3.)

Question 9 **(50 marks)**

(a) A golf ball was placed on top of a vertical cliff above some level ground.
Florence, standing on the edge of the cliff hit the ball with a golf club, off the cliff and into the air.
While it was travelling through the air, the height of the ball above the ground was given by the function:

$$h(t) = 40 + 10t - 5t^2,$$

where h is the height in metres and t is the time in seconds after the ball was hit.



(i) Find the height of the cliff, in metres.

(ii) What was the height of the ball above the ground after 1·5 seconds?

(iii) Find the maximum height of the ball above the ground.

(iv) How long was the ball in the air before it hit the ground?

(v) The ball landed 240 m from the foot of the cliff.
Find the distance between the ball and the top edge of the cliff when it landed.
Give your answer, in metres, correct to 2 decimal places.

This question continues on the next page.

(b) **(i)** Florence bought a golf club online from a company in Britain.
The cost was £138·75 sterling.
The exchange rate was €1 = £0·8338.

How much did the golf club cost in euro?
Give your answer correct to the nearest cent.

(ii) Florence also bought a golf bag at her local golf club during a sale.
The original cost was €125, including VAT at 23%.
She got a discount of 15% in the sale.
Work out how much **VAT** Florence paid.
Give your answer correct to the nearest cent.

Question 10 **(50 Marks)**

(a) Mary got a new job where she was earning €950 per week. When she started the job, Mary had to pay emergency tax as she did not have a tax credit certificate.
Emergency tax meant that all of her income was taxed at 40% and she had no tax credits.

(i) How much tax did she pay each week while she was on emergency tax?

(ii) When Mary got her tax credit certificate, she started to pay tax at the correct rate. Now, each week she pays tax at the standard rate of 20% on the first €678·85 of her income and 40% on the remainder.
She also had tax credits of €65·38 each week.

How much does Mary now pay in tax each week?

(iii) Mary was on emergency tax for a total of six weeks.
At the end of that time she got a refund of the tax **that she had overpaid** while she was on the emergency tax rate.

Find the total amount of the refund she got for these six weeks.

(iv) Mary gets a pay increase of € x per week.
She continues to pay tax at the standard rate of 20% on the first €678·85 of her income and 40% on the remainder.
She still had tax credits of €65·38 each week.
She now pays €218·85 in tax each week.
Find the value of x.

This question continues on the next page.

(b) Mary has €15 000 in a savings account and would like to invest the money for a maximum of 3 years. An investment broker is offering two investment options, Option 1 and Option 2, as shown in the table below.

Option 1	**Option 2**
Invest €15 000 at an annual compound rate of r% and receive €16 153·36 at the end of 3 years	Invest €5000 at the beginning of each year for 3 years at an annual compound rate of 4·2%

(i) Find the value of the annual compound interest rate, r, in Option 1.

(ii) Mary chooses Option 2.
She will invest €5000 at the beginning of year 1, another €5000 at the beginning of year 2, and another €5000 at the beginning of year 3.
Find how much money Mary will receive at the end of the 3 year period.
Give your answer correct to the nearest cent.

Section A	Concepts and Skills	150 marks

Answer **any five** questions from this section.

Question 1 **(30 marks)**

The prices of houses in a particular area have been increasing over a number of years.

(a) A house is valued at €240 000 at the start of 2019.

By the start of 2020, the price of the house has increased by 8%.
By the start of 2021, the price of the house has increased by a further 9%, based on the 2020 price.

Work out the price of the house at the start of 2020, **and** the price at the start of 2021.

Price at start of 2020 = ______________ Price at start of 2021 = ______________

(b) Another house was valued at €460 000.
One year later, the value of this house had gone up to €472 000.

Work out the **percentage** increase in the value of this house over the year.
Give your answer correct to 1 decimal place.

(c) A third house was valued at €$265\,000$.

Over the following 4 years, the value of the house increased by $r\,\%$ each year compared to the previous year, where $r \in \mathbb{R}$.

After 4 years, the house was valued at €$370\,000$.

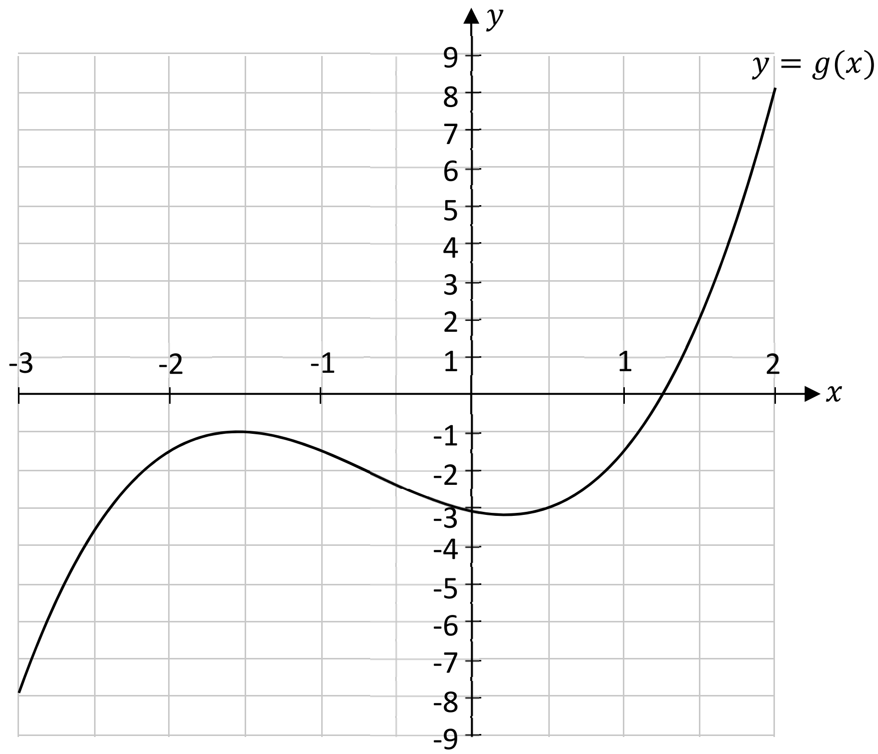
Work out the value of r, by setting $F = 370\,000$, $P = 265\,000$, and $t = 4$ in this equation:

$$F = P\left(1 + \frac{r}{100}\right)^t$$

Give your answer correct to 1 decimal place.

Question 4 **(30 marks)**

(a) The graph of the function g is shown on the co-ordinate diagram below, for $-3 \le x \le 2$, $x \in \mathbb{R}$. Use the graph to answer **parts (a)(i)** to **(a)(iv)**.



(i) Estimate the value of $g(1{\cdot}5)$.
Show your work on the graph.

$g(1{\cdot}5)$:

(ii) Estimate the value of x for which $g(x) = -6$.
Show your work on the graph.

x :

(iii) Tick **one** box to show how many real roots the function $g(x)$ has in this domain.
Give a reason for your answer.

Number of real roots:	0	1	2	3
(tick **one** box only)	☐	☐	☐	☐

Reason:

(iv) From the graph, estimate the co-ordinates of the local maximum point and the local minimum point of $g(x)$, as accurately as possible.

Local maximum point: (,)

Local minimum point: (,)

(b) A different function, $h(x)$, has the following equation:

$$h(x) = x^3 + 2x^2 - x - 8$$

(i) Find $h'(x)$, the derivative of $h(x)$.

(ii) Find the equation of the tangent to $h(x)$ at the point $(2, 6)$.

Question 5 **(30 marks)**

(a) A company is repairing a railway line. As part of this work, it is laying new railway tracks.

(i) It costs €$12\ 000$ to lay 240 metres of railway track.
Work out how much would it cost to lay 320 metres of railway track, at the same rate.

(ii) It would take 6 people 8 days to replace the tracks on a different part of the railway line. Work out how long it would take 4 people to replace these tracks, each working at the same speed.

(b) Two towns, **A** and **B**, are 120 km apart.
A train travels from **A** to **B** at an average speed of 180 km/hour.

(i) Work out the time it takes the train to get from **A** to **B**.
Give your answer in hours, as a fraction.

(ii) On the way back from **B** to **A**, the train travels at an average speed of 220 km/hour.
Work out the average speed of the train for the entire journey, while it is travelling from **A** to **B** and back again. Give your answer in km/hour.

Hint: first work out the total time taken for the entire journey.

Question 6 **(30 marks)**

(a) $g(x)$ is the following function in $x \in \mathbb{R}$:

$$g(x) = x^2 + 8x - 6$$

(i) Find the value of $g(-5)$.

(ii) Use calculus to find the value of x which gives the minimum value of $g(x)$.

(b) Expand and simplify $(2x - 4)^2 - 6$.

(c) Solve the following equation in x:

$$9x^2 + 6x - 5 = 0$$

Give each answer correct to 2 decimal places.

Section B Contexts and Applications 150 marks

Answer **any three** questions from this section.

Question 7 **(50 marks)**

(a) When it rains on land, some of the rain soaks into the land, and the rest runs off the land. The runoff curve number, C, is a number used when estimating the amount of rain that runs off a particular area of land. C is given by:

$$C = \frac{1000}{S + 10}$$

where S is a measure of the maximum amount of rain that can soak into the soil.

(i) Find the value of C when $S = 15$.

(ii) When S **increases**, does C increase or decrease?

Justify your answer, using the equation $C = \frac{1000}{S+10}$.

Answer (increases **or** decreases):

Justification:

(iii) Rearrange the equation to write S in terms of C.

(iv) The values for C go from 30 to 100.
Use your answer from **part (a)(iii)**, or otherwise, to find the range of values of S.

Answer: S goes from ____________ to ____________

This question continues on the next page.

(b) Over the course of one day (24 hours), the probability that it is raining in Waterville, $P(t)$, could be modelled by the following function:

$$P(t) = 0{\cdot}3 + 0{\cdot}02\,t.$$

Here, $P(t)$ is the probability that it is raining t hours after the start of the day, with $0 \leq t \leq 24$, $t \in \mathbb{R}$.

(i) Write down the probability that it is raining at the start and the end of the day, that is, find the value of $P(0)$ and $P(24)$.

(ii) Find the value of $P'(t)$, the derivative of t, **and** explain what the value of $P'(t)$ means in this context.

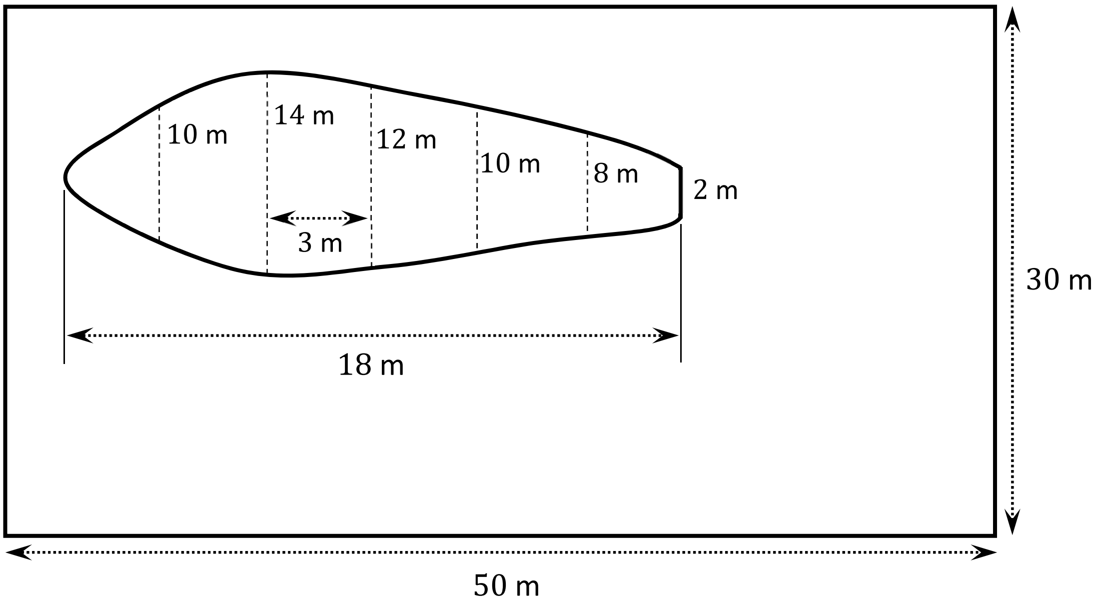
$P'(t)$:

Meaning of $P'(t)$:

(iii) At a certain time, the probability that it is raining, according to this model, is $0{\cdot}35$. Work out the probability that it is raining exactly 1 hour later, according to this model.

Question 8 **(50 marks)**

A rectangular garden (50 m by 30 m) contains an irregularly shaped pond of length 18 m, as shown in the diagram below (not so scale).



(a) Find the area of the whole garden (that is, the total area of the rectangle).

(b) The width of the pond is measured at intervals of 3 metres, starting at the right-hand edge of the pond. These measurements are given on the diagram, correct to the nearest metre.

Use the **Trapezoidal Rule** (and the measurements in the diagram above) to work out an estimate for the area of the pond.

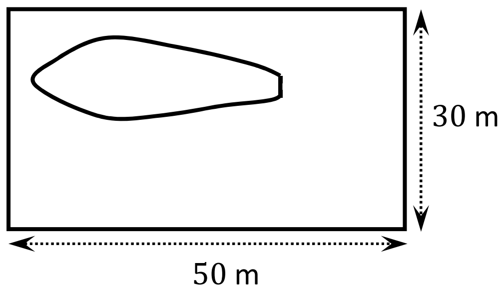
This question continues on the next page.

(c) Suggest a way by which the Trapezoidal Rule could be used (with different measurements) to get a potentially more accurate estimate of the area of the pond.

(d) Apart from the pond, the rest of the rectangular garden is covered in grass.
The actual area of the pond is 172 m^2.

All of the grass in the garden needs to be resown.
The cost is €$2{\cdot}55$ per square metre that needs to be resown.

Work out the cost of resowing the grass.
Give your answer correct to the nearest **ten euro**.



(e) Some materials were imported from England by the gardener for resowing the grass.
The cost of the materials was £840. This included an Import Duty of $16{\cdot}9\%$.
Work out the cost of the materials **before** the Import Duty was added.
Give your answer correct to the nearest penny (that is, to 2 decimal places).

(f) The gardener paid the £840 in euro.
The exchange rate was €$1 =$ £$0{\cdot}8547$.
He also paid a fee of $2{\cdot}5\%$ of the £840 as a commission.

Work out how much he paid in total, in euro, correct to the nearest cent.

Question 2 **(30 marks)**

(a) Gina buys a car for €$22\,000$. It depreciates (decreases in value) by 20% each year.

(i) Work out how much it will be worth exactly 2 years after Gina buys it.

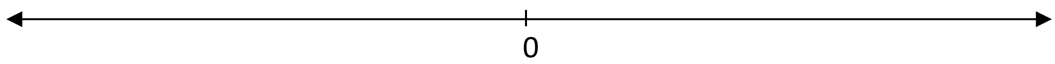
(ii) On 1 January 2025, the value of this car will be €$10\,000$.
Work out its value exactly 1 year earlier, on 1 January 2024.

Question 4 **(30 marks)**

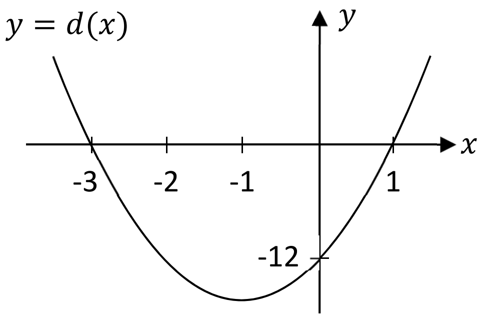
(a) **(i)** Solve the following inequality, for $x \in \mathbb{R}$:

$$5 - 2x \leq 11$$

(ii) Show the solution set on the number line below. Remember that $x \in \mathbb{R}$.



(b) The graph of the quadratic function $d(x)$ is shown on the co-ordinate diagram below.



(i) Use the graph to write down the two solutions of the equation $d(x) = 0$.

$x = \boxed{}$ and $x = \boxed{}$

(ii) Hence, write $d(x)$ in the form $d(x) = ax^2 + bx - 12$, where $a, b \in \mathbb{R}$.

Question 5 **(30 marks)**

(a) Let $f(x) = 2x^3 - 3x^2 + 7x$, where $x \in \mathbb{R}$.

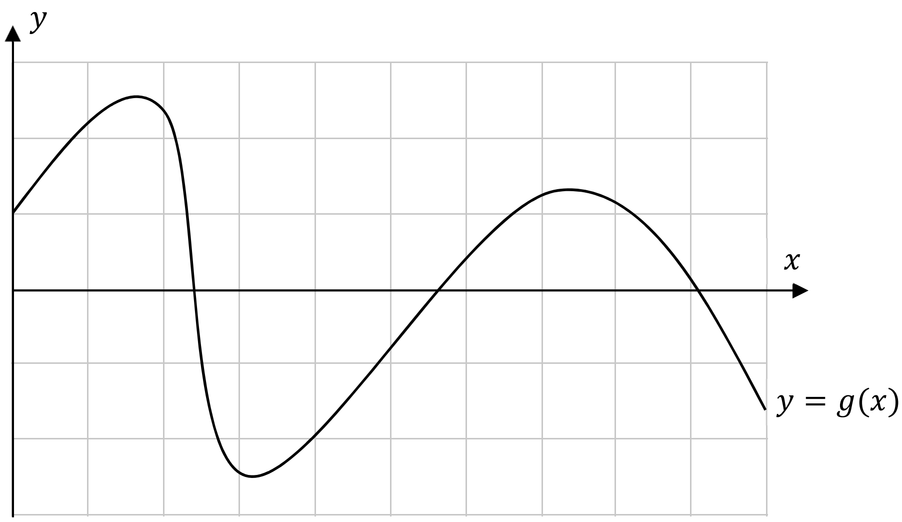
(i) Find $f'(x)$, the derivative of f.

(ii) Find the value of $f'(x)$ when $x = 1$.

(iii) Find the equation of the tangent to the curve $y = f(x)$ at $x = 1$.

(b) The graph of $y = g(x)$ is shown on the co-ordinate diagram below, for a particular range of $x \in \mathbb{R}$.

On the graph, **mark** the three points for which $g'(x) = 0$, where $g'(x)$ is the derivative of g. **Label** these points **A**, **B**, and **C**.



Question 6 **(30 marks)**

The functions h and p are defined for $x \in \mathbb{R}$ as follows:

$$h : x \mapsto 2x - 3$$
$$p : x \mapsto x^2 - 1$$

(a) Find $p(5)$.

(b) **(i)** Show that $p\big(h(x)\big) = 4x^2 - 12x + 8$.

(ii) Solve $p(h(x)) = 4$.
Give each answer correct to 2 decimal places.

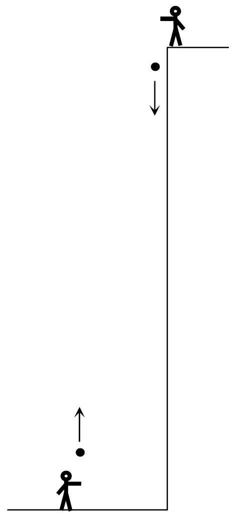
(b) Two students are looking on the internet to find the value of the speed of light.
One website gives it as 3×10^8 metres per second.
Another says that light travels approximately $9{\cdot}5$ trillion kilometres in a year.

Given that a trillion is a million million, find out whether or not these two answers are consistent with each other.

Answer:

Question 8 **(50 marks)**

Gina is on the roof of a building and Harry is at the bottom of the building.



Harry throws a ball upwards. The height of his ball above the ground during its flight is given by $h(t)$, where $t, h \in \mathbb{R}$, t is in seconds, and h is in metres.

Harry throws his ball upwards when $t = 0$.
The graph of $y = h(t)$ is shown on the next page.

When $t = 1$, Gina throws her ball downwards. The balls do not collide.
The height of Gina's ball above the ground during its fall is given by $g(t)$, where $t \geq 1$ and $g \in \mathbb{R}$ is in metres:

$$g(t) = 18 + 10t - 5t^2$$

(a) **(i)** Complete the table below to show the values of $g(t)$ for the given values of t.

t	1	$1 \cdot 5$	2	$2 \cdot 5$	3	$3 \cdot 1$
$g(t)$		$21 \cdot 75$				$0 \cdot 95$

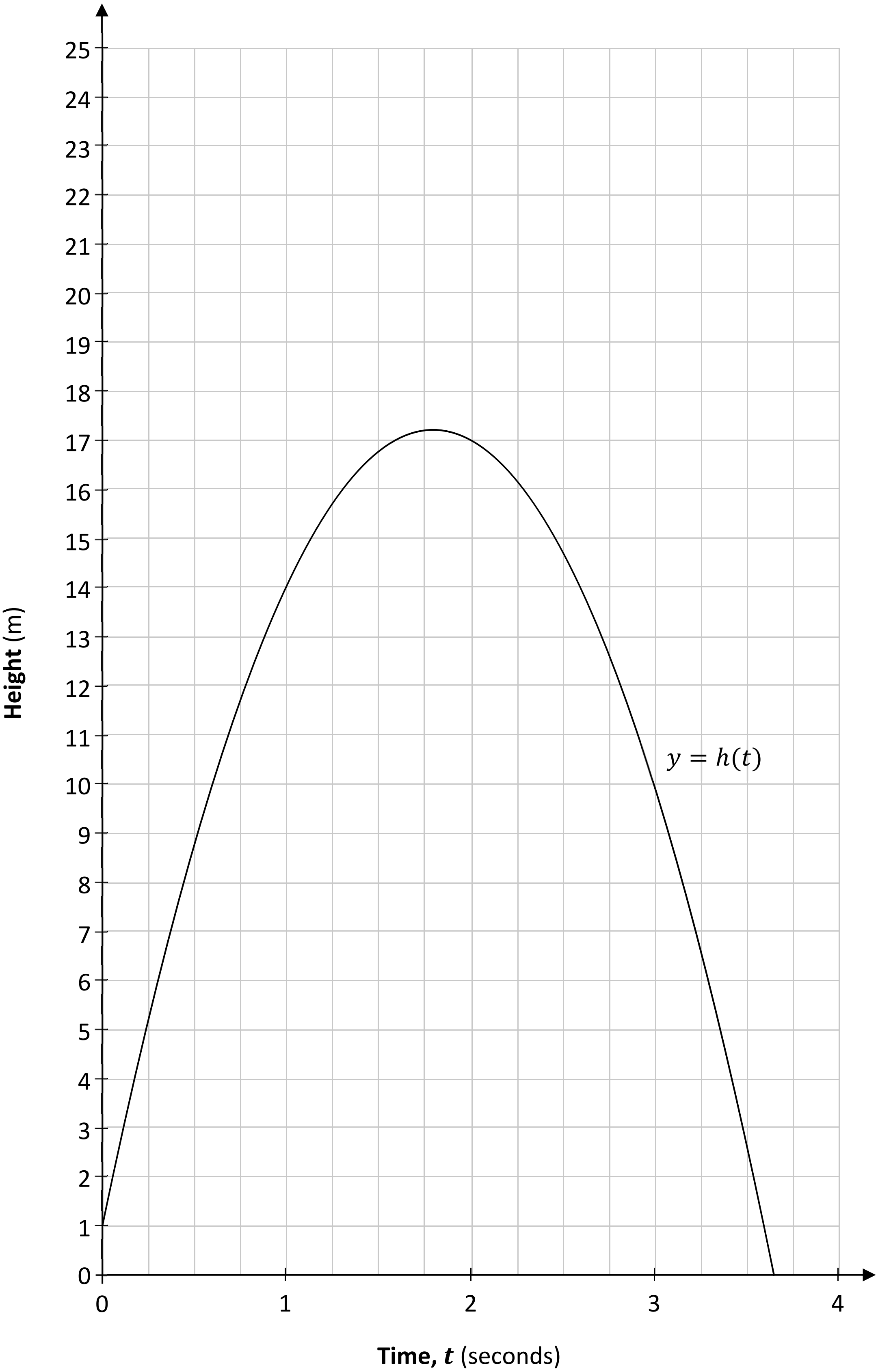
(ii) **Draw** the graph of $y = g(t)$ on the co-ordinate diagram on the next page, using the same axes and scales. **Note**: $t \geq 1$ for $g(t)$.

(b) Use the graphs of $h(t)$ and $g(t)$ on the next page to estimate the answer to each of the following questions. In each case, **show your work on the diagram** on the next page.

(i) How much higher than Harry's ball is Gina's ball, half a second after Gina drops her ball (at $t = 1 \cdot 5$)? Answer:

(ii) How long does it take Harry's ball to reach its maximum height? Answer:

(iii) At what height does Gina's ball pass Harry's ball? Answer:



This question continues on the next page.

(c) The height of Harry's ball during its fall, $h(t)$, is given by:

$$h(t) = 1 + 18t - 5t^2$$

Use this, and the fact that $g(t) = 18 + 10t - 5t^2$, to answer the following questions. These are the same questions as in **part (b)**, but here you will need to use algebra to answer them.

(i) How much higher than Harry's ball is Gina's ball, half a second after Gina drops her ball ($t = 1{\cdot}5$)? Show your working out.

(ii) Use calculus to find how long it takes Harry's ball to reach its maximum height.

(iii) By solving an equation, find the **height** at which Gina's ball passes Harry's ball.
Give your answer correct to 1 decimal place.

Question 9 **(50 marks)**

Mary is saving money.
She starts saving with 136 coins, worth a total of €51.

Each week, Mary's mother gives her €3 to add to her savings, as follows:
she gives Mary one €1 coin, two 50-cent coins, and five 20-cent coins.

(a) Use this information to complete the table below, showing the total number of coins and the total amount of money that Mary has saved as the weeks pass.
Each answer in the **last row** should be an expression in terms of n.

	Total number of coins	**Total amount of money** (€)
Start	136	51
After 1 week		
After 2 weeks		
After 3 weeks		
After 4 weeks		
After n weeks ($n \in \mathbb{N}$)		

(b) Will there ever be a time at which the total number of coins that Mary has is equal to the total amount of money (in euro) that she has saved?

If so, find when that happens; if not, explain why not.

(c) Mary keeps her money in three different money boxes.
Box 1 has only €1 coins, Box 2 has only 50-cent coins, and Box 3 has only 20-cent coins.
Each box contains the same amount of money.

Mary starts with 136 coins in total in her three money boxes, worth a total of €51.
Work out the number of coins in each money box at this time.

Money box	Box 1	Box 2	Box 3
Number of coins in this money box			

This question continues on the next page.

(d) Mary's mother pays USC at each of the three rates shown in the following table:

Band	Rate
First €12 012	$0{\cdot}5\%$
€12 012 to €20 484	2%
Above €20 484	$4{\cdot}5\%$

(i) Work out the USC that Mary's mother pays at the $0{\cdot}5\%$ rate **and** the 2% rate.

USC at $0{\cdot}5\%$ rate: ________________ USC at 2% rate: ________________

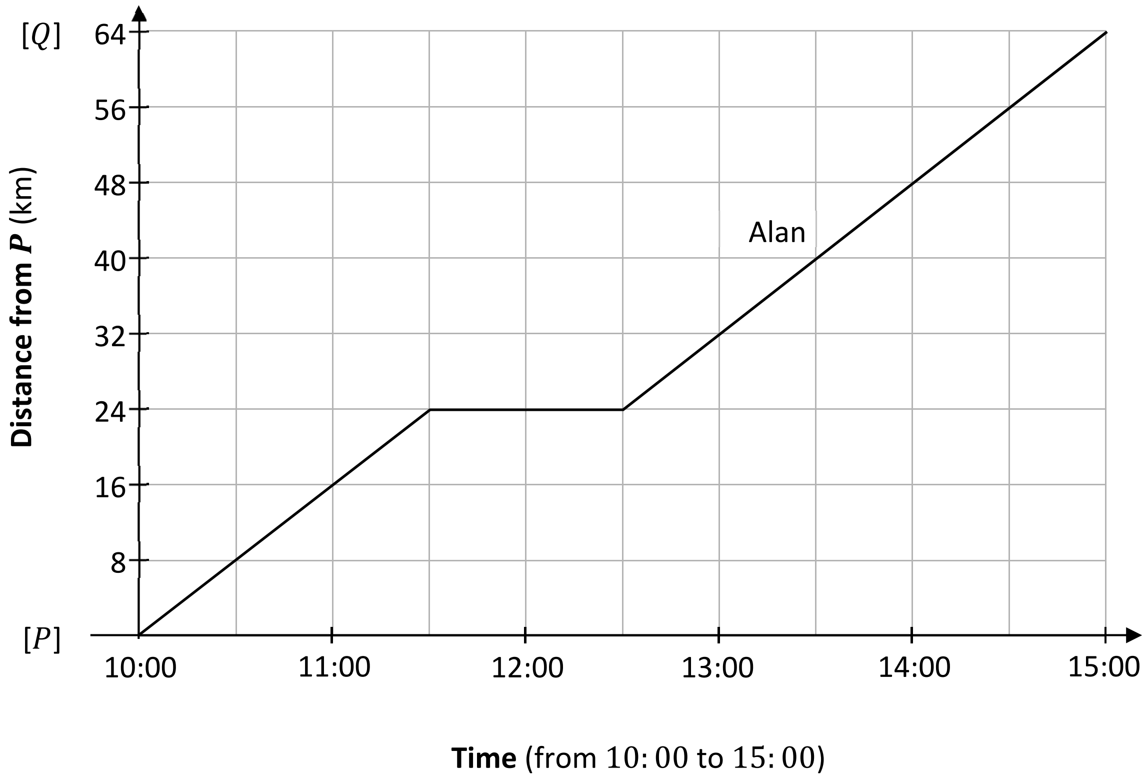
(ii) Mary's mother pays a total of €822·72 in USC.
Work out her gross income.

Question 10 **(50 marks)**

Two friends, Alan and Brendan, separately cycled a 64 km journey from P to Q.
A third friend, Colin, cycled from Q to P on the same day.

The diagram below shows the graph of Alan's journey.
Time is measured in hours, starting at time $10{:}00$.
Distance is measured in kilometres from P, along the route travelled.

Alan left P at $10{:}00$, cycled at a constant speed, stopped for an hour for a break, and then continued at the same speed to Q. He arrived at Q at $15{:}00$.



(a) At what time of the day did Alan stop for a break? Answer:

(b) Work out Alan's constant speed when he was cycling.

(c) Brendan left P at $12:00$.
He cycled at a constant speed, without stopping, until he reached Q.
He passed Alan at $14:00$.

(i) **Draw** the graph of Brendan's journey on the diagram on the previous page, using the same axes and scales. Label the graph clearly.

(ii) Work out Brendan's constant speed when he was cycling.

(d) Colin cycled in the **opposite** direction, from Q to P along the same road.
Colin left Q at $10:00$ and cycled at a constant speed, without stopping, until he reached P.
He arrived at P at $15:00$.

(i) **Draw** the graph of Colin's journey on the diagram on the previous page, using the same axes and scales. Label the graph clearly.

(ii) Use your graphs to estimate the time of day at which Colin and Brendan passed each other.

This question continues on the next page.

(e) Write a formula to represent Colin's distance from P at any given time during his journey. Your formula should be written in terms of t, where $t \in \mathbb{R}$ is the time in hours from $10:00$.

Remember that Colin left Q at $10:00$ and arrived at P, 64 km away, at $15:00$.

(f) On a different day, Alan cycles in a race. This time, his speed changes throughout the race. The distance, in km, he has travelled from the starting line during the race is given by:

$$d(t) = 6t^3 - 12t^2 + 40t$$

where t is the time in **hours** from the start of the race, and $t \in \mathbb{R}$, $0 \leq t \leq 1$.

Alan's **speed** during the race is given by $d'(t)$, the derivative of $d(t)$.
Use this to find Alan's speed 30 **minutes** after the start of the race.

Question 3 **(30 marks)**

Joe, Émile, and Wei are all PAYE workers.
Each of them has an annual tax credit of €3300.
Their tax rates and bands are shown in the table below.
Assume that no other deductions are made from their income.

Annual Income	Tax Rate
First €35 300	20%
Balance	40%

(a) Joe's gross annual income is €27 500. Joe only pays tax at the lower rate.
Work out Joe's net annual income.

(b) Émile's gross annual income is €43 450.
Work out Émile's net annual income.

(c) Wei's gross annual income is over €$35\ 300$, so she pays tax at both rates.

Wei is looking for a pay rise.
She wants her net income to increase by €80 each month.

Work out how much her **gross annual income** will need to increase by, in order for this to happen.

Question 4 **(30 marks)**

(a) $g(x) = x^3 - 7x^2 + x - 12$, where $x \in \mathbb{R}$.

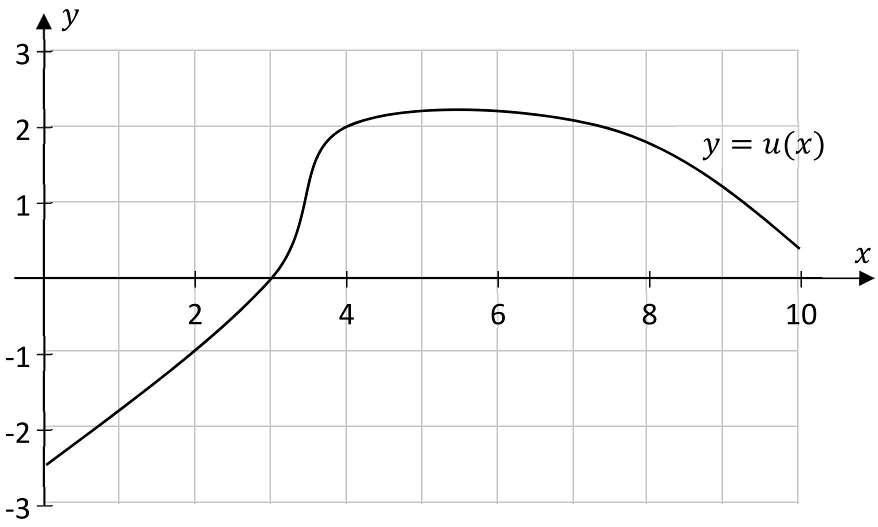
(i) Work out the value of $g(5)$.

(ii) Find $g'(x)$, the derivative of $g(x)$.

(iii) $g'(5) = 6$.

Use this to find the equation of the **tangent** to the curve $y = g(x)$ when $x = 5$.
Give your answer in the form $ax + by + c = 0$, where $a, b, c \in \mathbb{R}$.

(b) The graph of the function $y = u(x)$ is shown below, for $0 \leq x \leq 10$, $x \in \mathbb{R}$.



$u'(x)$ is the derivative of $u(x)$.

(i) Using the graph, write down a value of x for which $u'(x)$ is **negative**.

$x =$ ☐

(ii) On the diagram above, draw the tangent to $u(x)$ at the point $(4, 2)$ **and** use the tangent that you draw to work out an estimate for the value of $u'(4)$.

$u'(4) =$ ____________, approximately

Question 5 **(30 marks)**

(a) Write each of the following values in the form $a \times 10^n$ where $1 \leq a < 10$ and $n \in \mathbb{Z}$.

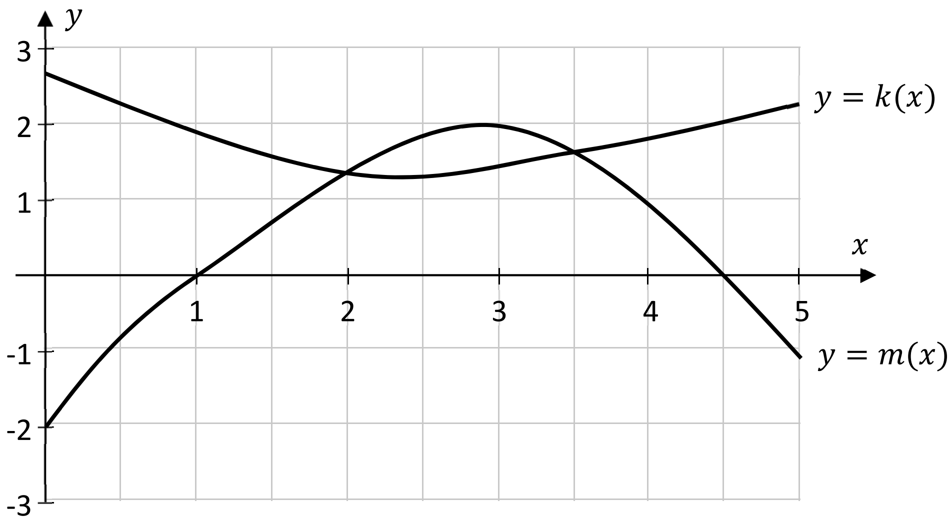
(i) 1200

(ii) $0{\cdot}27$

(b) A falcon can dive at a speed of up to 120 miles per hour.
1 mile is approximately $1{\cdot}6$ kilometres.

Use this to work out how long it would take the falcon to travel 100 metres, when diving at this speed. Give your answer in seconds, correct to one decimal place.

(c) The diagram below shows the graphs of the functions $k(x)$ and $m(x)$, for $0 \leq x \leq 5$, $x \in \mathbb{R}$.



Use the graphs to estimate each of the following, for $0 \leq x \leq 5$:

(i) the two values of x for which $m(x) = 0$

$x = \boxed{}$ or $x = \boxed{}$

(ii) the range of values of x for which $k(x)$ is less than $m(x)$.

Question 8 **(50 marks)**

(a) Jessica is a scientist. Jessica is making up a solution of acid.
She has two different bottles, each with the following concentration of the acid:

Bottle A	Bottle B
Concentration: 12%	Concentration: 5%

This means that, for example, in every 100 ml of liquid in Bottle **A**, there are 12 ml of acid.

(i) Work out how many ml of acid are in 200 ml of liquid from Bottle **A**.

(ii) Jessica mixes 200 ml of liquid from Bottle **A** with 300 ml of liquid from Bottle **B**.
Work out the overall concentration of the acid in Jessica's mixture.
Give your answer as a percentage.

(iii) Explain why Jessica could **not** make a solution with a 4% concentration of acid by mixing liquid from Bottle **A** and Bottle **B**.

This question continues on the next page.

(iv) When she is making another mixture, Jessica makes a mistake in measuring. She wants to measure out 250 ml but she measures out 260 ml instead.

Work out the percentage error in this measurement.

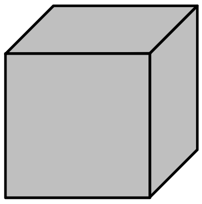
(b) If a solid is made up of faces with straight edges, then the following identity is often true:

$$C - E + F = 2$$

where: C is the number of corners,
E is the number of edges, and
F is the number of faces.

(i) Write down the values of C, E, and F for a cube, **and** show that $C - E + F = 2$ for these values.

The value for E has already been filled in.



$C =$ ☐ $E =$ 12 $F =$ ☐

(ii) Each of the faces of a **different** solid is in the shape of a triangle of area 5 cm^2.

This solid has 12 corners (C) and 30 edges (E), and $C - E + F = 2$ for this solid.

Work out the surface area of this solid, in cm^2.

(iii) The surface of a **third** solid is made up of h hexagons and p pentagons, where $h, p \in \mathbb{N}$. For this solid:

$$\frac{6h + 5p}{3} - \frac{6h + 5p}{2} + h + p = 2$$

Use this equation to find the number of pentagons in the surface of this solid (that is, the value of p).

$p =$ ____________

Section A	Concepts and Skills	120 marks

Answer **any four** questions from this section.

Question 1 **(30 marks)**

(a) A television costs €380 before VAT at 21% has been added.
Find the cost of the television after VAT has been added.

(b) When VAT at 21% is included, the price of a laptop increases by €130·20.
Find the total cost of the laptop including VAT.

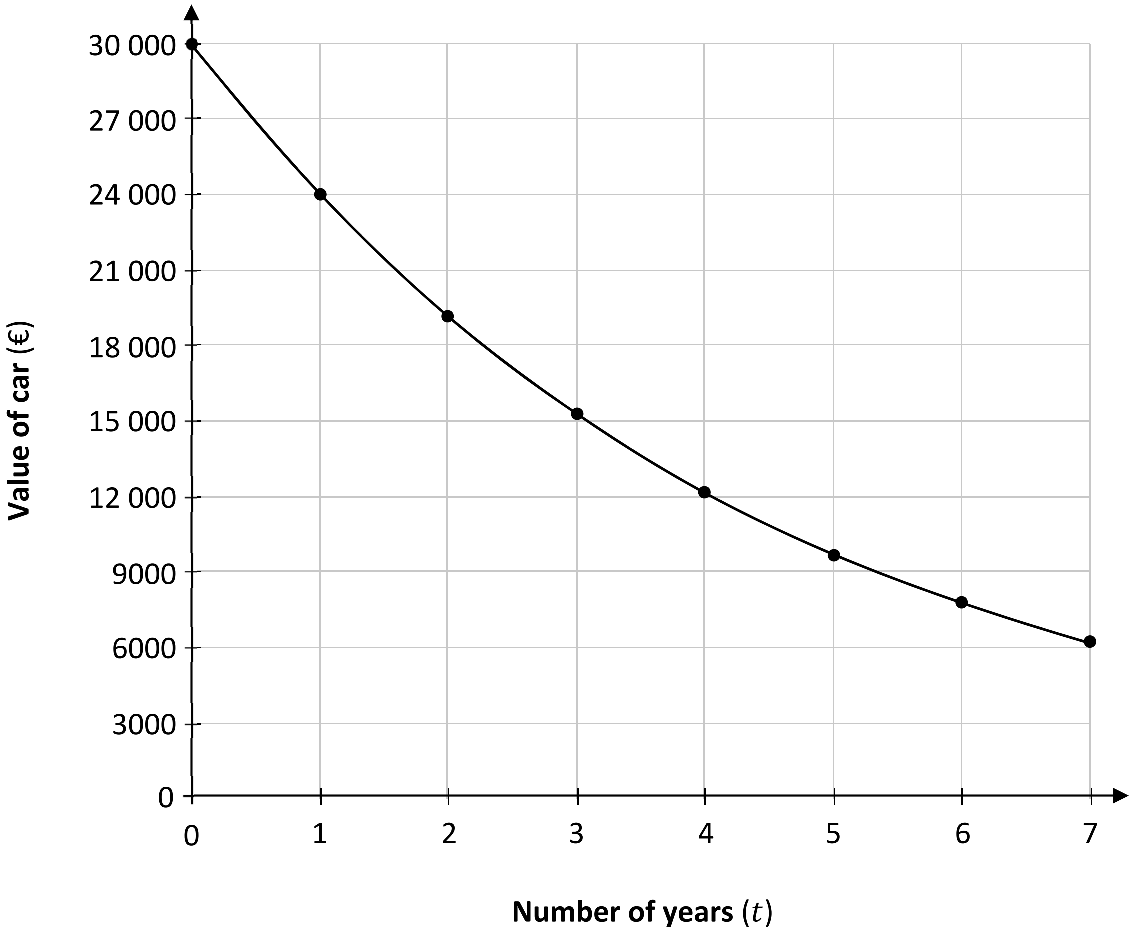
(c) A printer is priced at €290·40 including VAT at 21%.
Find how much VAT is included in the price of this printer.

(d) On September 1, 2020 the Standard Rate of VAT in Ireland was reduced from 23% to 21%.
A company bought 30 computers in September, all at the same price.
The company calculated that it saved €336 due to the reduction in the VAT rate.
Find the price of one computer before VAT had been added.

Question 9 **(50 marks)**

Brian buys a new car.

The graph below represents a model that can be used to predict the value of this car, V, for the next number of years. This model assumes that the value of the car reduces (depreciates) by a fixed **percentage** each year.

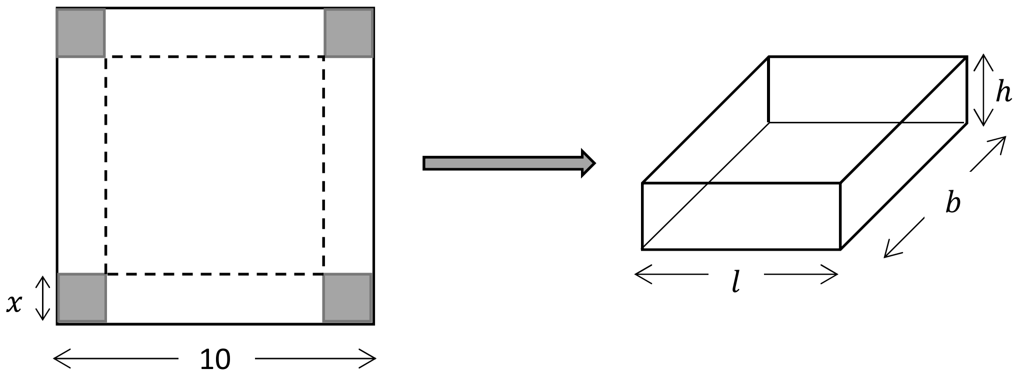


(a) **(i)** Use the graph to write down $V(0)$, the initial value of Brian's car, **and** $V(1)$, the value of Brian's car after 1 year.

$V(0) =$ € $\qquad\qquad$ $V(1) =$ €

Question 8 **(50 marks)**

A square sheet of cardboard, of side 10 units, is used to make an open box.
Squares of side x units, where $x \in \mathbb{R}$, are removed from each corner of the cardboard and it is then folded along the dotted lines, as shown in the diagram below, in order to create the box.



(a) The length (l), breadth (b) and height (h) of the box are shown in the diagram above. Write l, b, and h in terms of x.

$l =$

$b =$

$h =$

(b) Show that the volume of the box can be written as

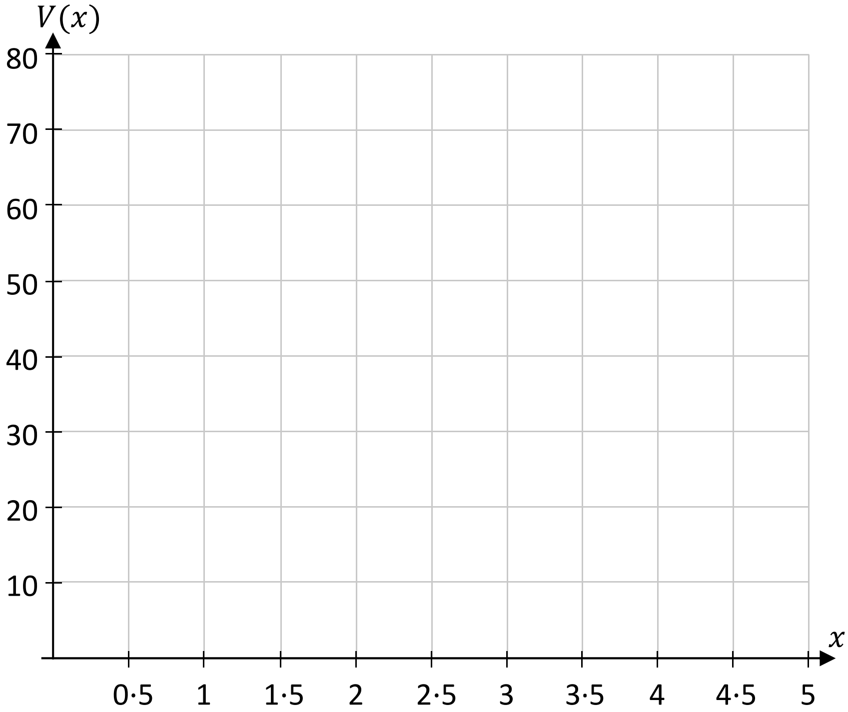
$$V(x) = 4x^3 - 40x^2 + 100x.$$

(c) Explain why a box of height 6 units cannot be made from the sheet of cardboard.

(d) Complete the table below to show the values of $V(x) = 4x^3 - 40x^2 + 100x$, where $x \in \mathbb{R}$, for the given values of x in the domain $0 \leq x \leq 5$.

x	0	0·5	1	1·5	2	2·5	3	3·5	4	4·5	5
$V(x)$		40·5								4·5	

(e) Draw the graph of the function $V(x)$ on the grid below.



(f) Use your graph to estimate each of the following values.
In each case show your work on the graph above.

(i) The maximum volume of the box.

(ii) The values of x which will create a box which has a volume of 30 units cubed.

(iii) The volume of the box when x is 2·8 units.

(ii) Show that the value of the car will reduce by 20% in its first year, according to this model.

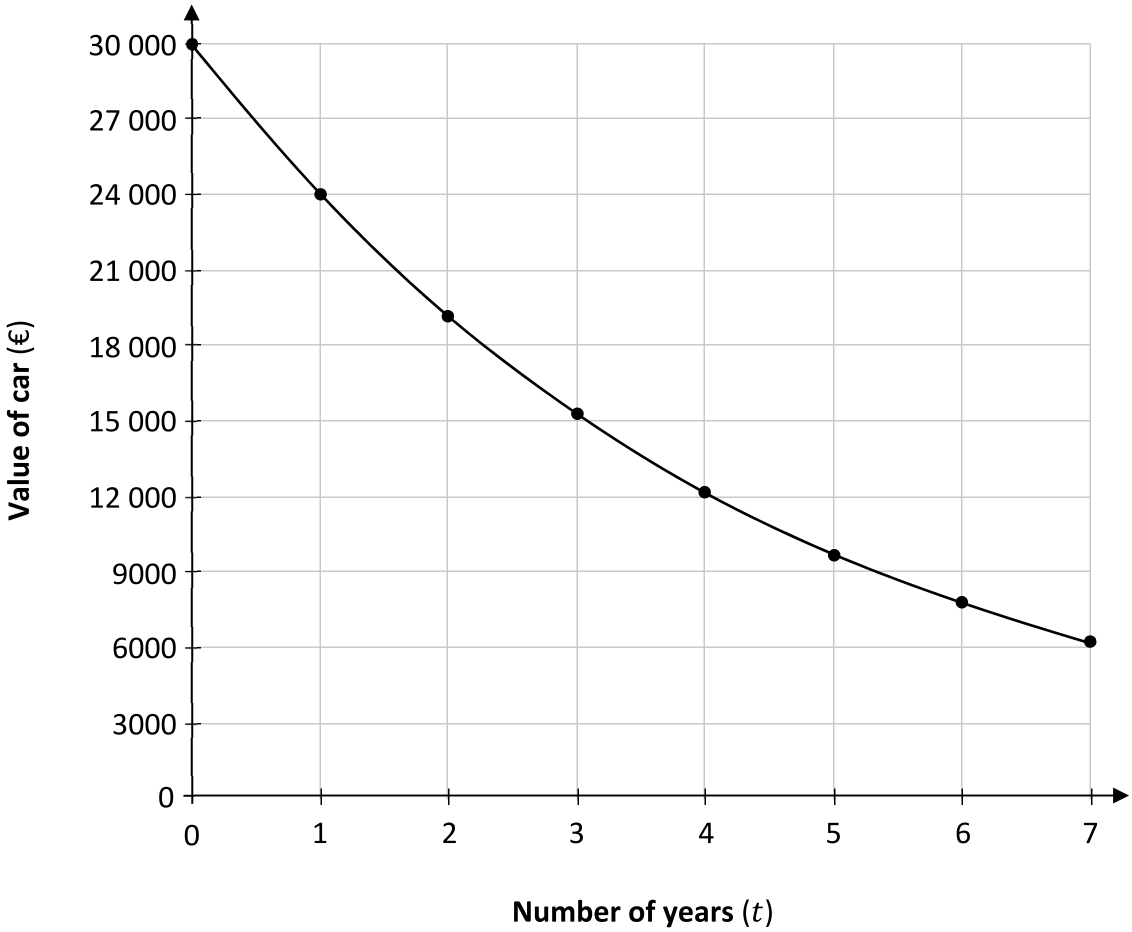
(b) **(i)** Based on this model, write a formula for $V(t)$, the value of Brian's car after t years, in terms of the age of the car (t).

Use the fact that the value decreases by 20% each year.

(ii) Hence, or otherwise, work out the value of Brian's car after 4 years, according to this model. Show your working out.

This question continues on the next page.

(c) The graph from **part (a)** is shown again below.



A different (linear) model assumes that the value of the car reduces (depreciates) by a fixed **amount** each year. The value of the car will also reduce by 20% in its first year, according to this model.

(i) Draw a line on the diagram above, passing through the first two points on the graph with whole-number values of t ($t = 0$ and $t = 1$). Continue your line until it reaches the horizontal axis.

(ii) Hence, or otherwise, estimate T, the age of Brian's car when its value would be €0, according to this new model.

(d) Eva buys a new car that has a price of €19 445.

She pays 30% of this price as a deposit and makes repayments of €206·97 each month for the following 3 years. At the end of the 3 years, she pays an additional lump sum of €7389.

Work out the total cost of the car for Eva.

(e) Eva drives her car home from the garage, a distance of 12 km.

Eva usually drives this journey at an average speed of 60 km/hr.
On this day, there are roadworks, so her average speed is only 40 km/hr for the journey.

Work out the percentage increase in the time it takes Eva to drive home, because of the roadworks.

Question 10 **(50 marks)**

Keith plays hurling.

(a) During a match, Keith hits the ball with his hurl.
The height of the ball could be modelled by the following quadratic function:

$$h = -2t^2 + 5\text{t} + 1{\cdot}2$$

where h is the height of the ball, in metres, t seconds after being hit, and $t \in \mathbb{R}$.

(i) How high, in metres, was the ball when it was hit (when $t = 0$)?

(ii) The ball was caught after $2{\cdot}4$ seconds.
How high, in metres, was the ball when it was caught?

(iii) When the ball passed over the halfway line, it was at a height of 3·2 metres and its height was decreasing.

How many seconds after it was hit did the ball pass over the halfway line?
Remember that $h = -2t^2 + 5\mathrm{t} + 1{\cdot}2$.

Answer: ___________

(iv) Find $\frac{dh}{dt}$ **and** hence find how long it took the ball to reach its greatest height.

Give your answer in seconds.

$\frac{dh}{dt} =$ ______________________________

Length of time = ______________

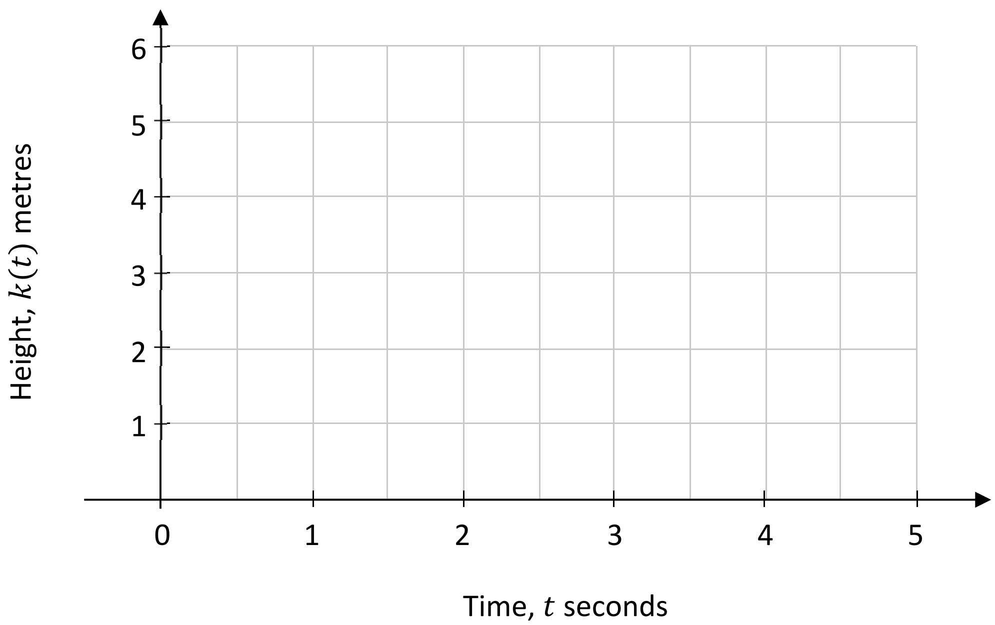
This question continues on the next page.

(b) Later in the game, Keith hit the ball again. This time, the height of the ball t seconds after it was hit could be modelled by a different quadratic function, $y = k(t)$, where k is in metres.

This time, the ball was 1 metre high when Keith hit it.
Its greatest height was 5 metres, which it reached after 2 seconds.
It hit the ground without being caught.

Using the information above, write down the co-ordinates of three points that **must** be on the graph of $y = k(t)$, **and** draw the graph of $y = k(t)$ on the axes below, from when the ball is hit until it hits the ground.

Points: $(\quad , \quad)$, $(\quad , \quad)$, and $(\quad , \quad)$



(c) **(i)** Keith buys a new hurl. It usually costs €33.
Keith gets a student discount of 15%.
Work out the price Keith pays for the hurl.

(ii) Keith also buys a jersey. This costs €$49{\cdot}50$, including VAT at 23%.
Work out the **VAT** on this jersey. Give your answer correct to the nearest cent.

Question 10 **(50 marks)**

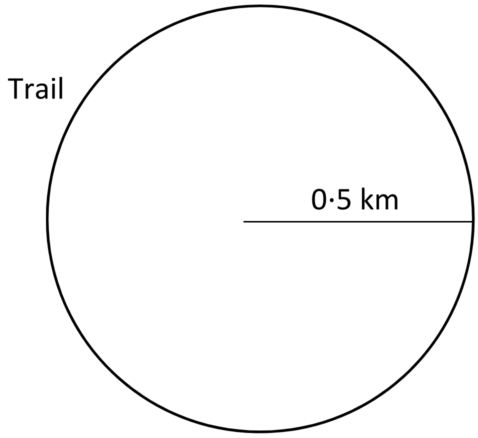
(a) The water behind a dam is normally released at a rate of 250 000 litres per second.

(i) Find how long it takes to release 1 million cubic metres (1 000 000 m^3) of water.
Note 1 m^3 = 1000 litres.
Give your answer correct to the nearest minute.

(ii) Due to heavy rainfall, the operators of the dam decide to increase the flow by 10% for 24 hours. Find how many m^3 of water were released in that 24 hour period.
Give your answer in the form $a \times 10^n$, where $1 \leq a < 10$, and $n \in \mathbb{N}$.
Give the value of a correct to 3 significant figures.

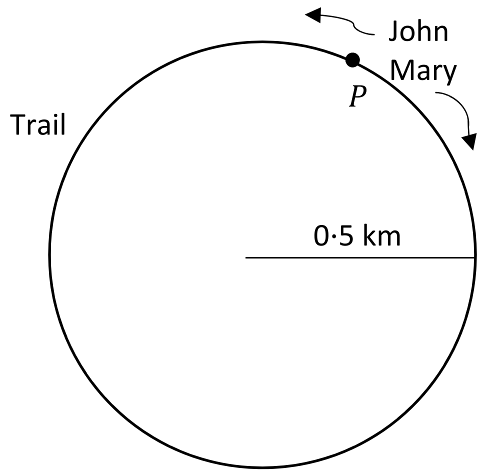
This question continues on the next page

(b) **(i)** John walks around a circular trail of radius 0·5 km at a steady speed of 6 km/h.
How long will it take him to complete 3 full circuits of the trail?
Give your answer correct to the nearest minute.



(ii) Mary decides to walk every day over a 5 day period.
She walks a distance of 3 km on day one.
She increases the length of her walk by 15% each day for the next four days.
Her average speed on day 5 is 4 km/h.
Find how long it will take her to complete her walk on day 5.
Give your answer in minutes, correct to the nearest minute.

(iii) One day, during John's walk he meets Mary at point P on the trail.
Mary is walking in the opposite direction at a steady speed of 4 km/h.
John continues walking at 6 km/h.
How far will he travel until he meets Mary again?
Give your answer correct to the nearest metre.



Section B	Contexts and applications	150 marks

Answer **all three** questions from this section.

Question 7 **(35 marks)**

(a) Pat buys a new car for €32 000.
He trades in his old car and is given an allowance of €20 000 by the garage.
He borrows the balance of the money from the credit union.
His fixed monthly repayment over three years is €443·66 per month.

(i) How much money does Pat pay in total to the credit union for the loan?

(ii) Show the amount that Pat repays as a percentage of the amount that he borrows from the credit union is 133·1%, correct to one decimal place.

(b) A sum of money is invested at r% per annum compound interest for 3 years.
At the end of the 3 years the value of the investment has increased by 33·1%.
Find the value of r.

(c) **(i)** It is estimated that the value of cars depreciates at a compound rate of 20% per year. Use this percentage to find the value of Pat's car after three years (original price €32 000).

(ii) Pat's friend Caitlín bought a new car three years ago. Its value also depreciated by 20% per year. It is now worth €17 920. Find the original value of the car.

Question 8 **(55 marks)**

A swimmer is on a starting block at the beginning of a race. When she dives off the block until she resurfaces, the level of the swimmer relative to the level of the water is given by the function:

$$h(x) = \frac{1}{60}x^2 - \frac{1}{4}x + \frac{3}{5}.$$

In the function, x is the horizontal distance in metres of the swimmer from the block, $0 \leq x \leq 12$, where $x \in \mathbb{R}$ and $h(x)$ is measured in metres.

(a) Find the height of the block above the water.

(b) **(i)** Show that the swimmer is on the surface of the water (i.e. $h(x) = 0$) when she is 12 metres from the starting block.

(ii) Find the horizontal distance, in metres, from the starting block to the point where the swimmer enters the water.

(c) **(i)** Find $h'(x)$, the derivative of $h(x) = \frac{1}{60}x^2 - \frac{1}{4}x + \frac{3}{5}$.

(ii) Use your answer to **Part (c)(i)** to find the horizontal distance (x), in metres, from the starting block to the point at which the swimmer reaches her greatest depth.

(iii) **Hence** find this greatest depth.

This question continues on the next page.