

8300

GCSE MATHEMATICS

Foundation and Higher tier – Questions by Topic

Ratio, proportion and rates of change

Calculating with rates

v1.0

Name _____

Materials

For this paper you must have:

- Mathematical instruments

Information

- The marks for questions are shown in brackets

Advice

- In all calculations, show clearly how you work out your answer

For questions 1 to 8 you must **NOT** use a calculator.



Q1.

A helicopter blade does 3206 full turns in 7 minutes.
Work out the number of full turns per minute.

(Total 2 marks)

Q2.

Last week, Erik worked for 10 hours.
He paid no tax and received £90

- (a) This week, Erik works for 15 hours.
He assumes he will be paid at the same rate and pay no tax.
How much does he expect to receive this week?

(3)

- (b) In fact, **this week**, Erik
is paid an extra 50p per hour
pays £8.90 tax.
What does this tell you about the amount he receives?
Tick **one** box.

☐

It is less than he expected

☐

It is the same as he expected

☐

It is more than he expected

Show working to support your answer.

(2)

(Total 5 marks)

Q3.

2 people working at the same rate will take 6 hours to paint a room.

- (a) Assuming that they **all** work at this rate,
how long will it take 3 people to paint the room?

(2)

- (b) In fact, the **third** person works at a faster rate.
How does this affect the time to paint the room?

(1)

(Total 3 marks)

Q4.

Harry is tiling a wall of area 25 m^2
A tub contains 15 kg of tile cement.
The instructions say 2 kg of tile cement will tile 1 m^2 of wall.

- (a) How many tubs does Harry need to buy?

(3)

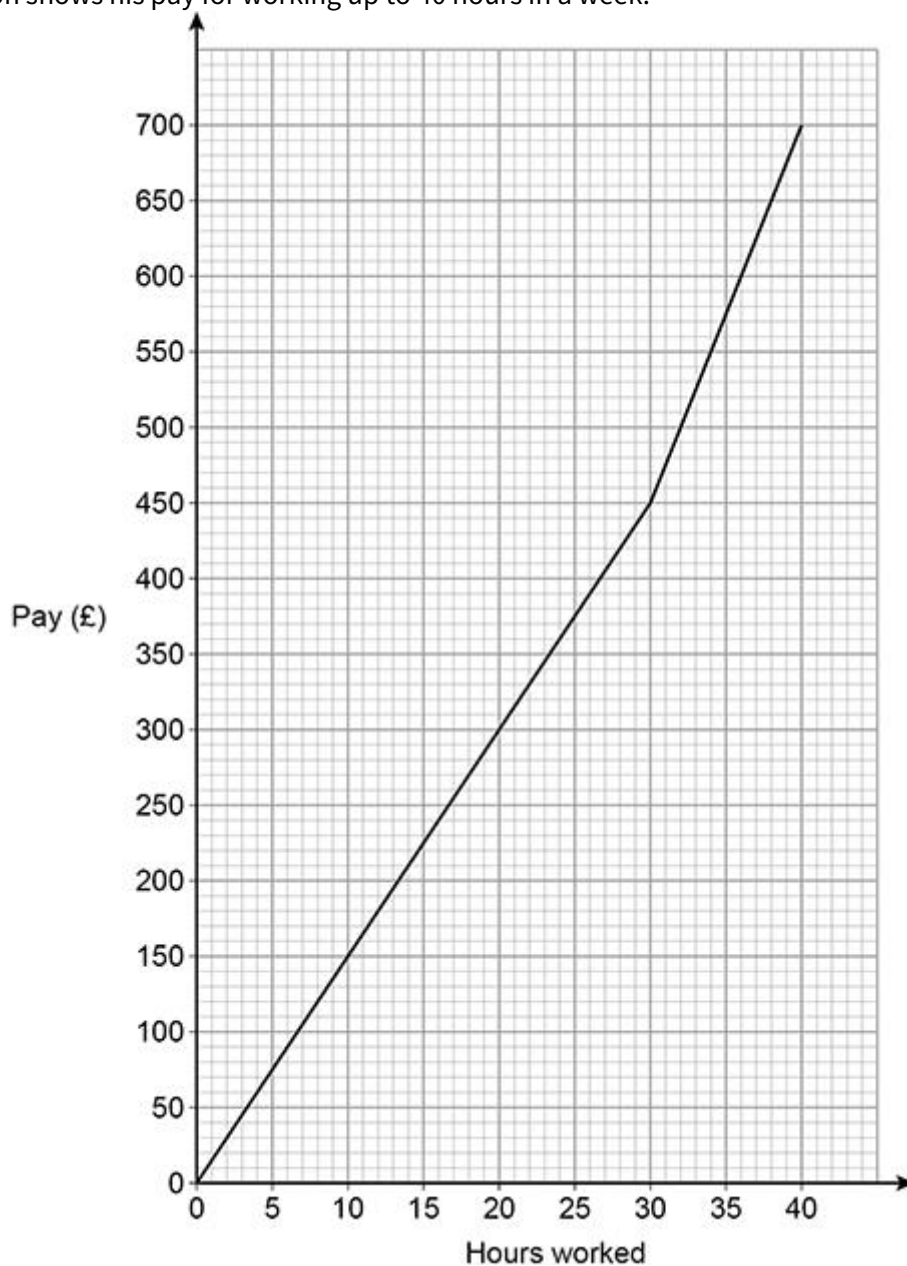
- (b) In fact, Harry uses more than 2 kg of tile cement per m^2
Without need to buy more tubs,
what is the maximum amount he could use per m^2 ?

(2)

(Total 5 marks)

Q5.

In a week, Samir is paid
a basic hourly rate for the first 30 hours worked
an overtime hourly rate for any extra hours worked.
The graph shows his pay for working up to 40 hours in a week.



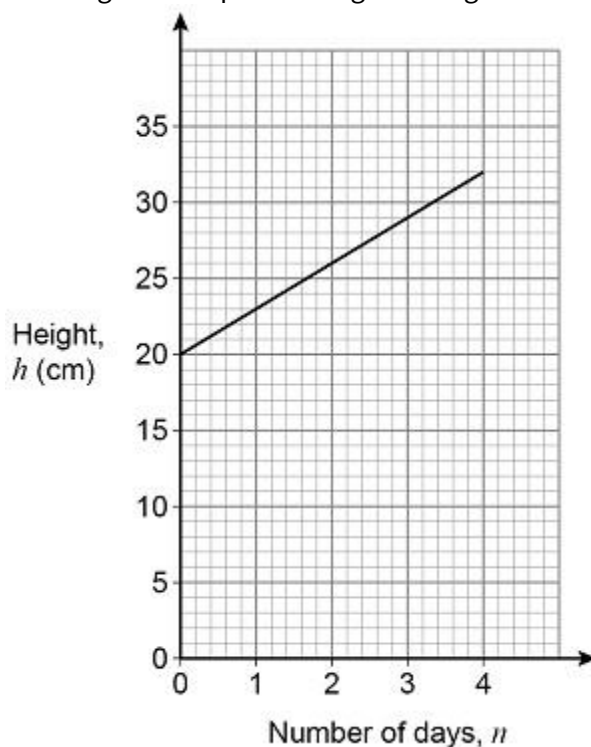
Work out the ratio basic hourly rate : overtime hourly rate
Give your answer in its simplest form.

(Total 3 marks)

Q6.

Jim buys a plant of height 20 cm

The graph shows how the height of the plant changes during the next 4 days.



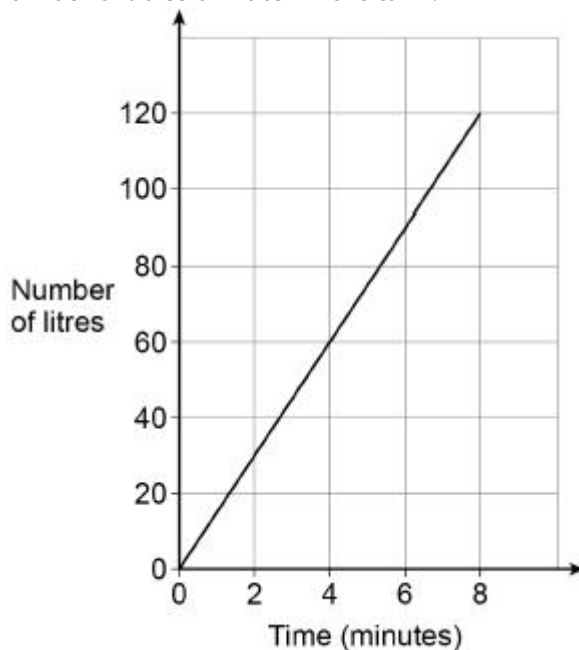
Work out a formula for h in terms of n .

(Total 3 marks)

Q7.

Water is poured into a tank.

The graph shows the number of litres of water in the tank.



How much water is poured into the tank each minute?

1.5 litres

15 litres

30 litres

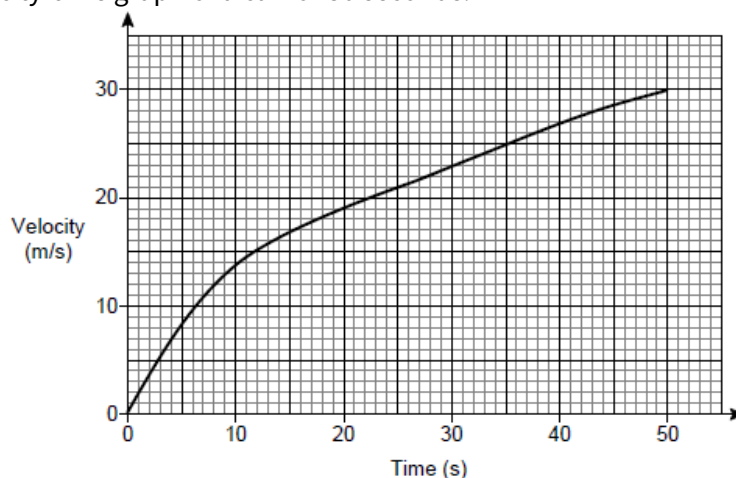
120 litres

(Total 1 mark)

Questions 8 is **higher** tier only.

Q8.

Here is the velocity-time graph of a car for 50 seconds.



- (a) Work out the average acceleration during the 50 seconds.
Give the units of your answer. (2)
- (b) Estimate the time during the 50 seconds when
the instantaneous acceleration = the average acceleration
You **must** show your working on the graph. (2)

(Total 4 marks)

For the rest of the questions, you may use a calculator



Q9.

An exhibition
was open for 240 hours
and
had 29 760 visitors.

For $\frac{2}{5}$ of the time the exhibition was open, there were 172 visitors per hour.
For the remaining time, how many visitors per hour were there?

(Total 4 marks)

Q10.

Ang's pay is £390 per week.

They work for $37\frac{1}{2}$ hours per week.

- (a) Work out their **hourly** rate of pay. (2)

- (b) Ang wants to work out their pay for **March**.

They say,

“There are 4 weeks in March, so I will multiply £390 by 4
 $£390 \times 4 = £1560$ ”

Does their method give the correct amount for their monthly pay?

Tick a box.

☐

No, the pay for
March is more

☐

Yes

☐

No, the pay for
March is less

Show working to support your answer.

(2)
(Total 4 marks)

Q11.

A house is being built.

8400 bricks will be laid.

Three bricklayers will each

lay 350 bricks per day

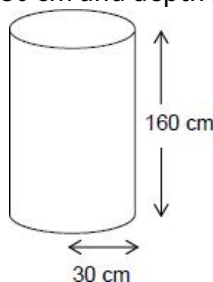
be paid £175 per day.

How much **in total** will they be paid?

(Total 3 marks)

Q12.

A water tank is a cylinder with radius 30 cm and depth 160 cm.



It is filled at the rate of 0.1 litres per second.

1 litre = 1000 cm³

Does it take longer than 1 hour to fill the tank?

You **must** show your working.

(Total 4 marks)

Q13.

Sam types a constant number of words per minute.

He takes 8 minutes to type a report of 416 words.

How long does it take him to type an essay of 1534 words?

Give your answer in minutes and seconds.

(Total 3 marks)

Q14.

The speed of the International Space Station is 27 576 kilometres **per hour**.

(a) The station travels 42 600 kilometres in one orbit.

Work out the number of **full** orbits the station does in **one day**.

(3)

(b) Convert 27 576 kilometres per hour into metres per second.

(3)

(Total 6 marks)

Q15.

A company makes and sells boxes of washing powder.



The company wants to increase the amount of money it receives **per kg** of powder.

To get the required increase it can

increase the price to £5.88

or

reduce the mass of powder in the box by $x\%$

Work out the value of x to 2 decimal places.

(Total 4 marks)

Q16.

Concrete from a truck is poured at 10.9 kg **per second** for 30 minutes.

$$1000 \text{ kg} = 1 \text{ tonne}$$

Is more than 20 tonnes of concrete poured?

Tick **one** box.

Yes

☐

No

☐

You **must** show your working.

(Total 4 marks)

Q17.

A tank contains 40 litres of water.

- (a) Water leaks out of the tank at a rate of 1.2 litres per minute.

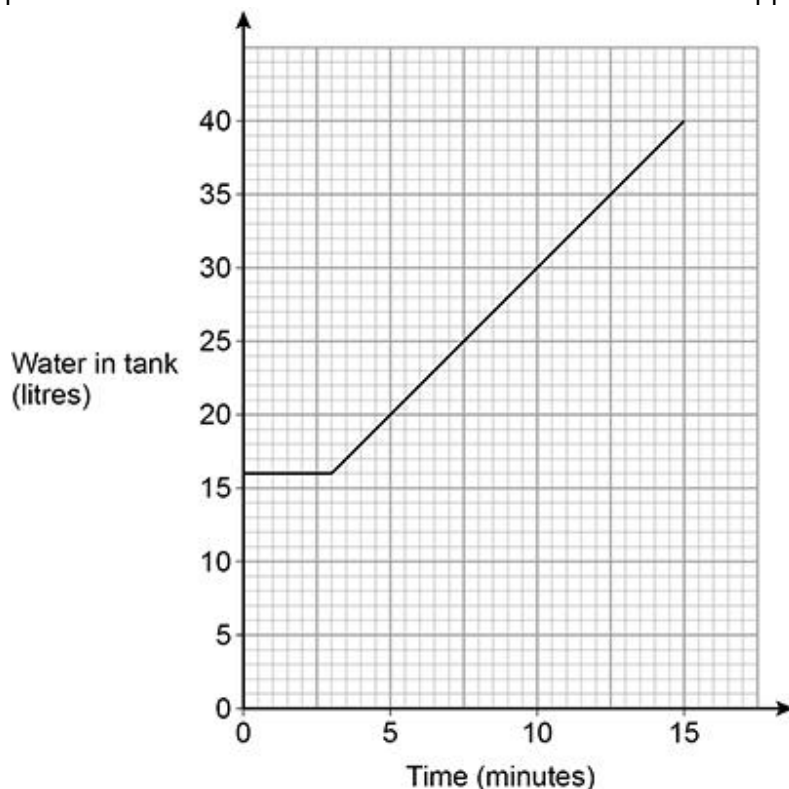
The leak is stopped after 20 minutes.

Show that, when the leak is stopped, the tank contains 16 litres of water.

(1)

- (b) The tank is refilled with water from a tap.

The graph shows the amount of water in the tank **after** the leak is stopped.



Complete this report by writing a number in each answer space.

Report

_____ minutes after the leak is stopped, the tap starts to refill the tank.

The rate at which the tank refills is _____ litres per minute.

(3)

(Total 4 marks)

Q18.

A factory packs x boxes of teabags per hour.

Each box contains 80 teabags.

Show that the factory packs $\frac{4x}{3}$ teabags per minute.

(Total 2 marks)

Q19.

Kay hires a digger.

The cost per day is

- £24.50 for the first 5 days
- reduced by 20% for day 6
- the same as day 6 for day 7 onwards.

The **total** cost is £259.70

For how many days did Kay hire the digger?

You **must** show your working.

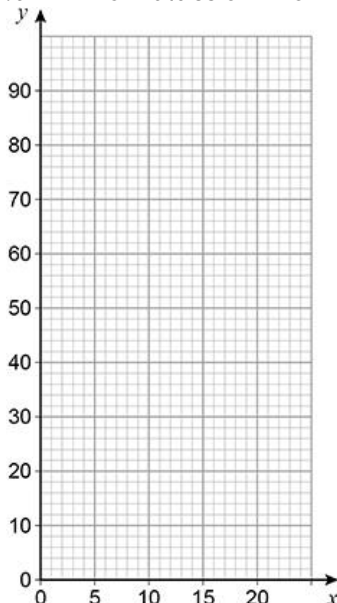
(Total 5 marks)

Q20.

Here is a formula.

$$y = 3.6x$$

- (a) Draw the graph of $y = 3.6x$ for values of x from 0 to 20



(2)

In the formula $y = 3.6x$

y is speed in kilometres per hour (km/h)

x is speed in metres per second (m/s)

- (b) Convert 50 km/h to m/s
Give your answer to the nearest whole number.

(1)

- (c) Convert 30 m/s to miles per hour.
Use 1 mile per hour = 1.61 km/h

(3)

(Total 6 marks)

Q21.

The table shows the cost of hiring a concrete mixer for up to 5 days.

Number of days	1	2	3	4	5
Cost	£14	£24	£34	£44	£54

Eva hires the concrete mixer for 5 days.

She says,

“The rate is £14 per day because the cost for 1 day is £14”

Is she correct?

Give a reason for your answer.

(Total 2 marks)

Q22.

The diagrams show the position of a tap when off and fully on.
The tap is fully on when the angle of turn is 180°



When fully on, water flows out of the tap at 14 litres per minute.
The rate at which water flows out is in direct proportion to the angle of turn.
The tap is turned 135°



The water flows into a tank with a capacity of 79.8 litres.

Will it take **less than** $7\frac{1}{2}$ minutes to fill the tank?
You **must** show your working.

(Total 4 marks)

Q23.

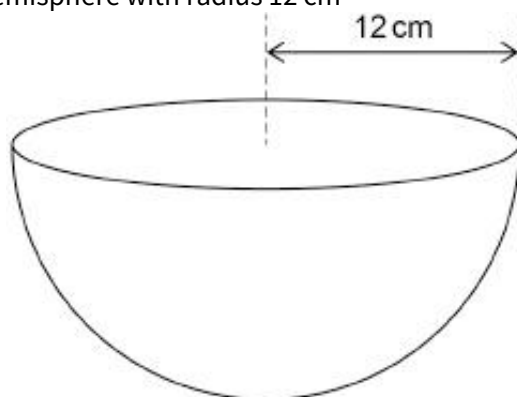
Lucy works for 37 hours per week.
Her weekly wage is £303.40
She receives a pay increase of 25p per hour.
Work out her new weekly wage.

(Total 2 marks)

Q24.

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

A bowl is a hemisphere with radius 12 cm



Not drawn
accurately

Water is poured into the bowl
at a rate of 325 cm^3 per second
for 8 seconds.

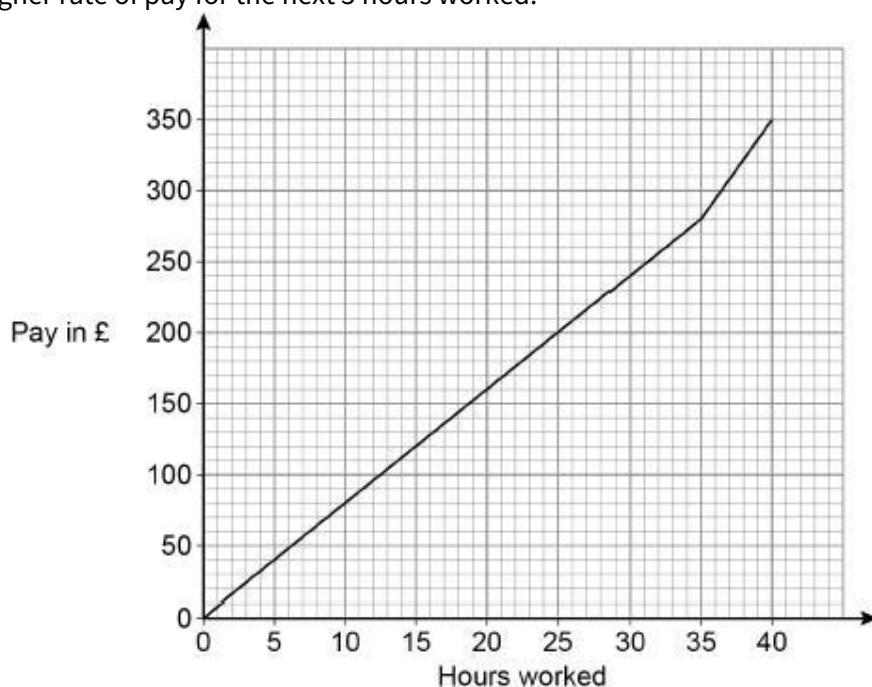
Does the water fill **more than** 70% of the bowl?
You **must** show your working.

(Total 4 marks)

Q25.

The graph shows how much Molly is paid for working for up to 40 hours.
She receives

- a basic rate of pay for the first 35 hours worked
- a higher rate of pay for the next 5 hours worked.

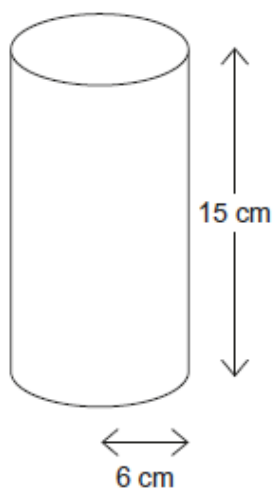


Work out the difference between the higher rate of pay and the basic rate of pay.
Give your answer in £ per hour.

(Total 3 marks)

Q26.

(a) The diagram shows a cylinder.



The radius of the base is 6 cm
The height is 15 cm
Work out the volume.

(3)

- (b) $1000 \text{ cm}^3 = 1 \text{ litre}$
A tank contains $45\,000 \text{ cm}^3$ of water.
The tank leaks at $0.75 \text{ litres/minute}$.
How long does the tank take to empty?

(4)

(Total 7 marks)

Q27.

Tom earns £9.20 per hour.

He works for

24 hours each week

48 weeks each year.

He pays tax if he earns more than £10 000 per year.

Does Tom pay tax?

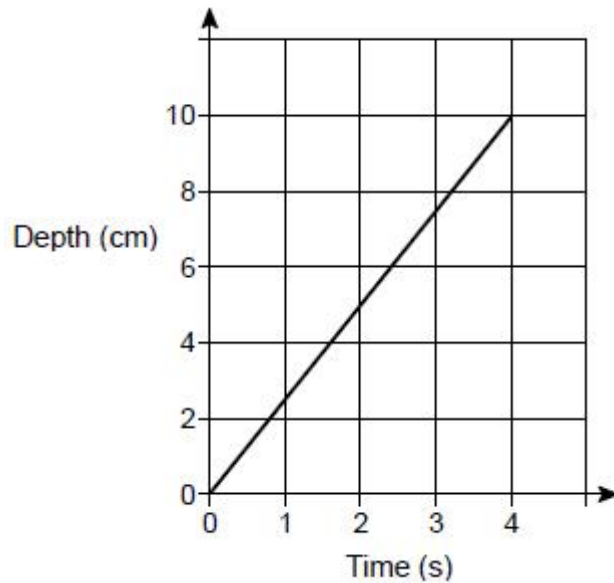
You **must** show your working.

(Total 2 marks)

Q28.

Water is poured into a glass for 4 seconds.

The graph shows the depth of the water in the glass.



What is the rate of change of the depth of the water?

Circle your answer.

0.4 cm/s

1.25 cm/s

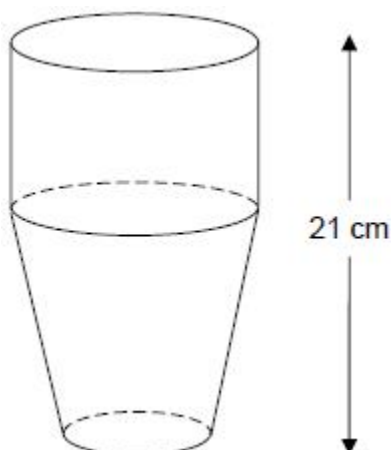
2.5 cm/s

10 cm/s

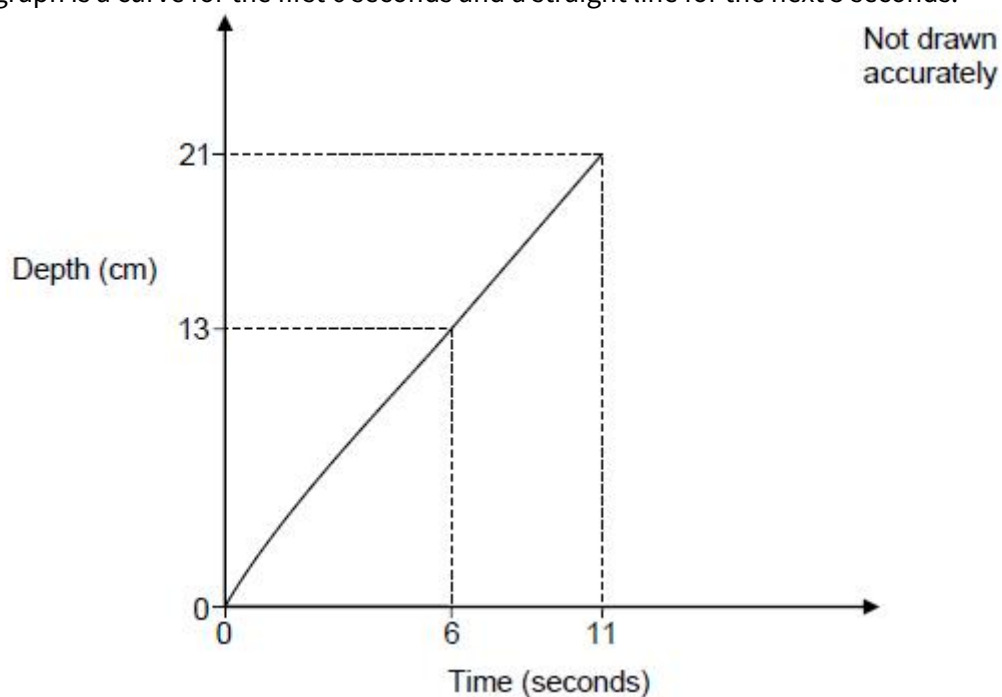
(Total 1 mark)

Q29.

The diagram shows an empty container of height 21 cm
The container consists of a cylinder on a frustum of a cone.



Water is added to the container at a constant rate for 11 seconds.
The sketch graph shows the depth of the water as the container fills.
The graph is a curve for the first 6 seconds and a straight line for the next 5 seconds.



- (a) Circle the height of the cylinder.

8 cm 10.5 cm 13 cm 21 cm

(1)

- (b) Work out the rate of increase of the depth of the water between 6 seconds and 11 seconds.

State the units of your answer.

(3)

(Total 4 marks)

Q30.

A ball contains 5000 cm^3 of air.

More air is pumped into the ball at a rate of 160 cm^3 per second.

The ball is full of air when it becomes a sphere with radius 15 cm



$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3 \quad \text{where } r \text{ is the radius}$$

Does it take **less than** 1 minute to fill the ball?

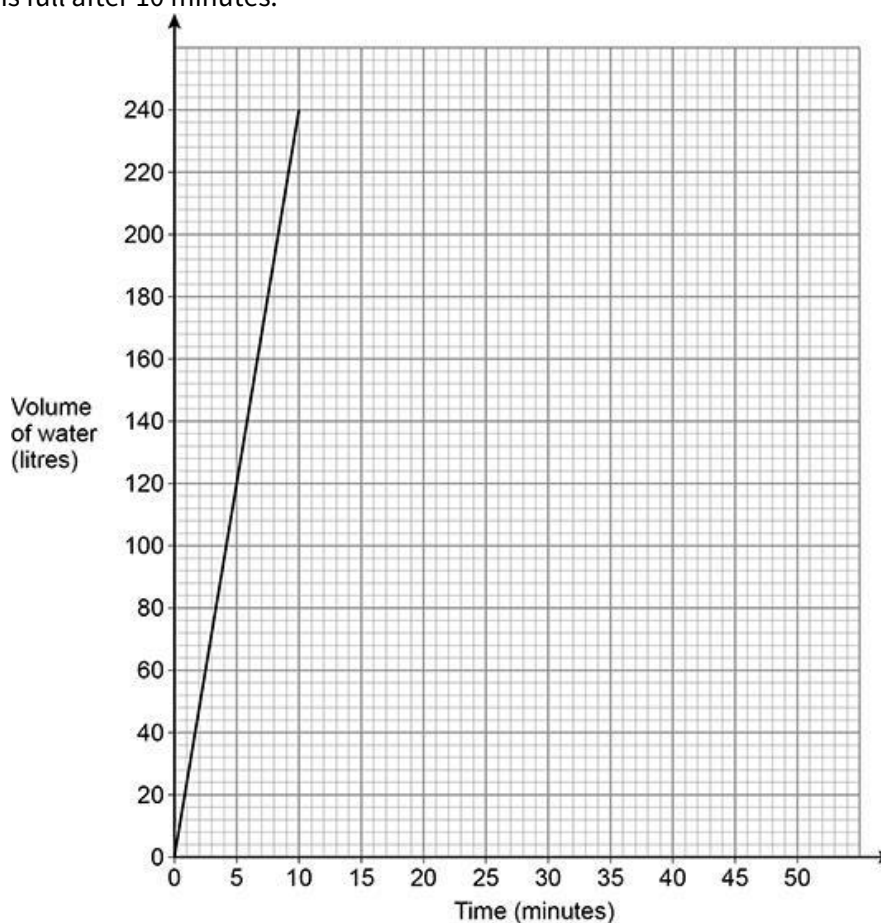
You **must** show your working.

(Total 4 marks)

Q31.

The graph represents the volume of water in a bath.

The bath is full after 10 minutes.



- (a) Work out the rate at which the bath is filled.

State the units of your answer.

(2)

- (b) After the bath is full,
the volume of water stays constant for 20 minutes
then
all the water empties out at a constant rate in 12 minutes.
Show this information on the graph.

(2)

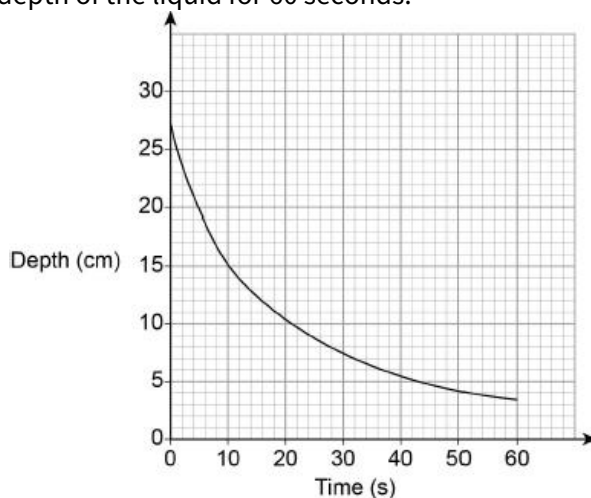
(Total 4 marks)

Questions 32 to 36 are **higher** tier only.

Q32.

Liquid is leaking out of a container.

The graph shows the depth of the liquid for 60 seconds.



Use the graph to work out an estimate of the rate of decrease of depth at 10 seconds.

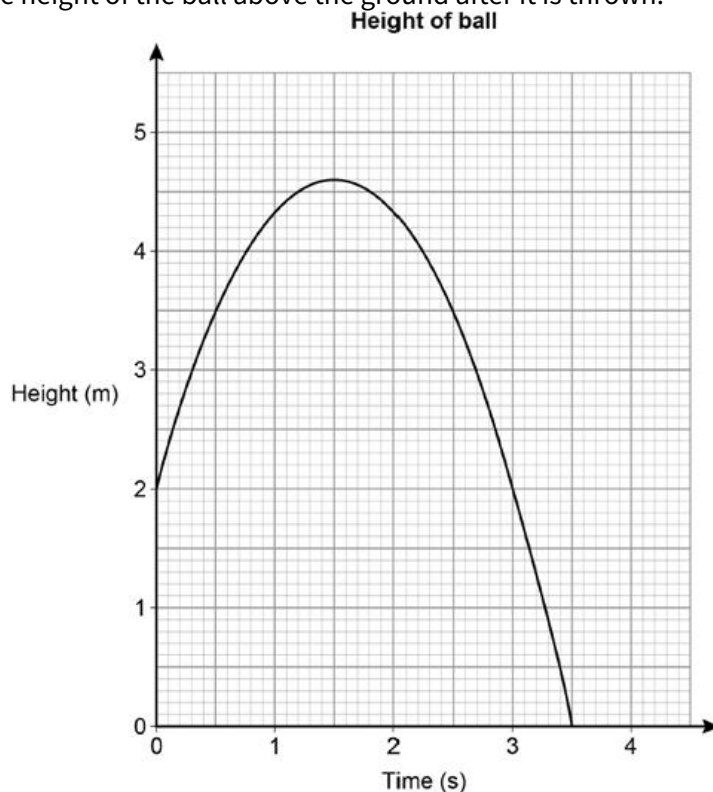
You **must** show your working.

(Total 3 marks)

Q33.

A ball is thrown vertically upwards.

The graph shows the height of the ball above the ground after it is thrown.



(a) For how many seconds is the ball at a height of **more than** 2 metres?

(1)

(b) After how many seconds is the ball at instantaneous rest when it is in the air?

(1)

(c) Work out the average speed of the ball when it is moving downwards.

(2)

(Total 4 marks)

Q34.

Liam drives his car.

He drives the first 9 miles in 9 minutes.

He then drives at an average speed of 70 miles per hour for 1 hour 36 minutes.

He finds this information about his car.

Average speed	Miles travelled per gallon
65 miles per hour or less	50
More than 65 miles per hour	40

Use the information to show that his car uses less than 3 gallons of petrol for the drive.

(Total 5 marks)

Q35.

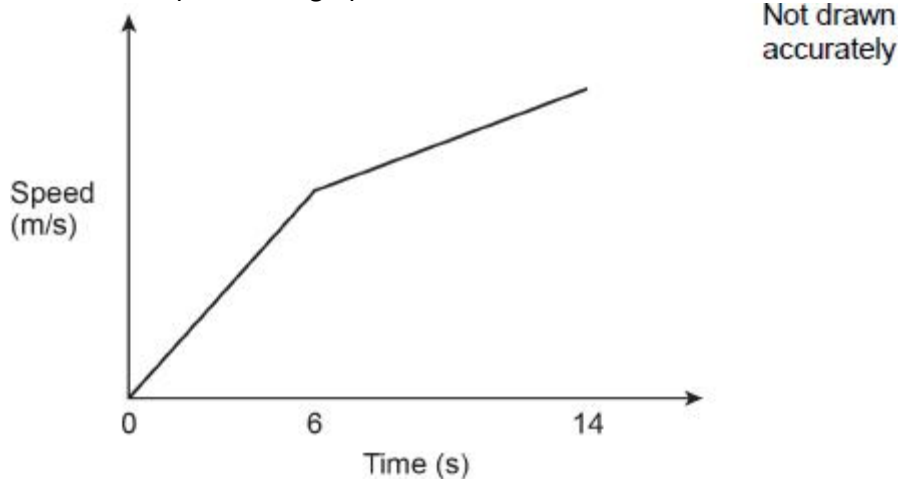
Izzy runs an 80-metre race in 14 seconds.

During the first 6 seconds her speed increases at a constant rate.

During the last 8 seconds her speed increases at a different constant rate.

Her speed at 14 seconds is 2 m/s more than her speed at 6 seconds.

Here is a sketch of her speed-time graph.



- (a) Work out her acceleration during the last 8 seconds.

State the units of your answer.

(2)

- (b) When Izzy finishes the 80-metre race, her speed is v m/s

Work out the value of v .

(4)

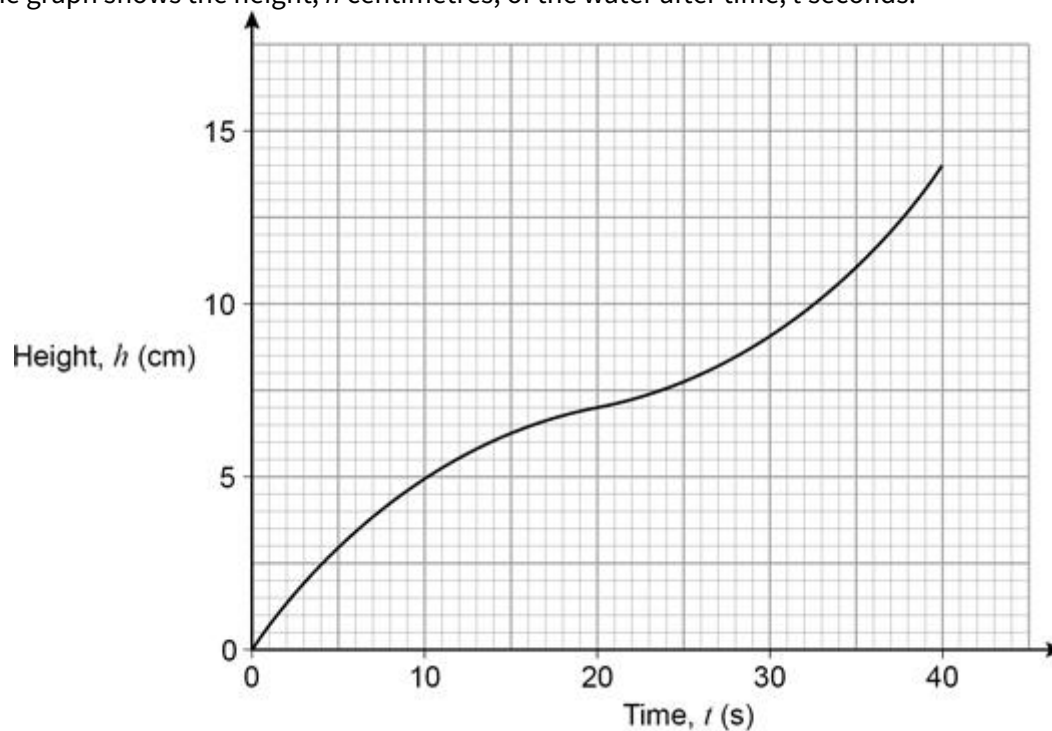
(Total 6 marks)

Q36.

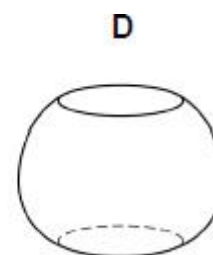
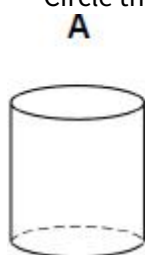
Water flows from a tap at a constant rate.

A container is filled with water from the tap in 40 seconds.

The graph shows the height, h centimetres, of the water after time, t seconds.



- (a) The container is one of these shapes.
Circle the letter of the correct shape.



(1)

- (b) By drawing a tangent on the graph,
estimate the rate at which the height is increasing when $t = 10$

(2)

(Total 3 marks)