SURNAME:

FIRST NAME:

PRESENT SCHOOL:

Stowe

2025 Entry

ROXBRUGH SCHOLARSHIP PAPER: SCIENCES

Time Allowed: 1 hour 30 minutes

Total Marks: 100 marks

There are three parts to this examination:

Section A: Biology (34 marks) – 30 minutes

Section B: Chemistry (33 marks) – 30 minutes

Section C: Physics (33 marks) – 30 minutes

Please write answers in the spaces provided.

Candidates are allowed access to a calculator.

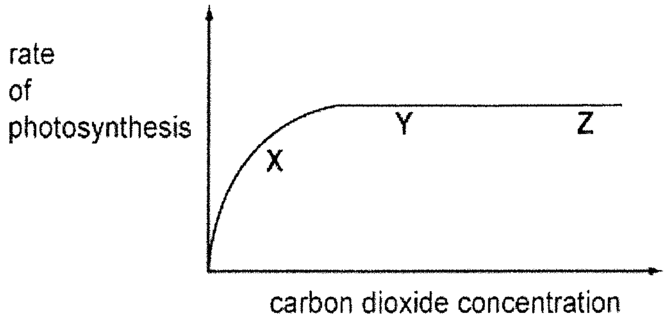
Section A

Biology

(34 Marks)

You are advised to spend no more than 30 minutes on this section

a) The graph shows the effect of carbon dioxide concentration on the rate of photosynthesis



Where on the graph is carbon dioxide a limiting factor?

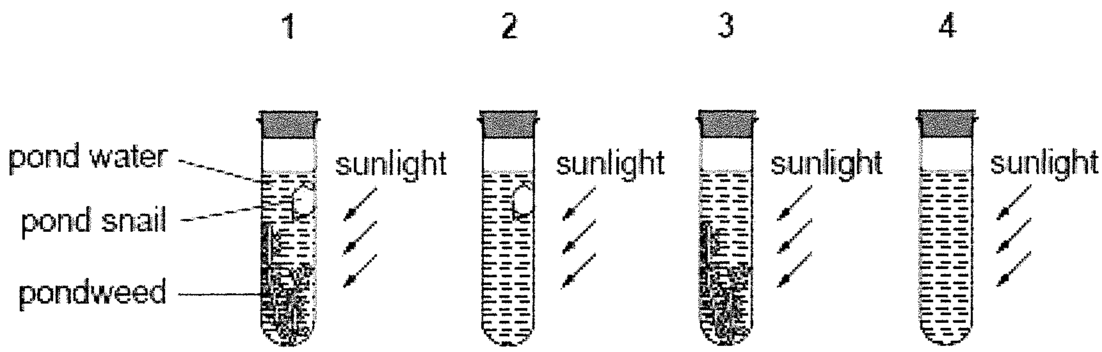
(a) X only
(b) X and Y
(c) Y and Z
(d) Z only

b) Which does not contain DNA?

(a) Cell membrane
(b) Chromosome
(c) Nucleus
(d) Gene

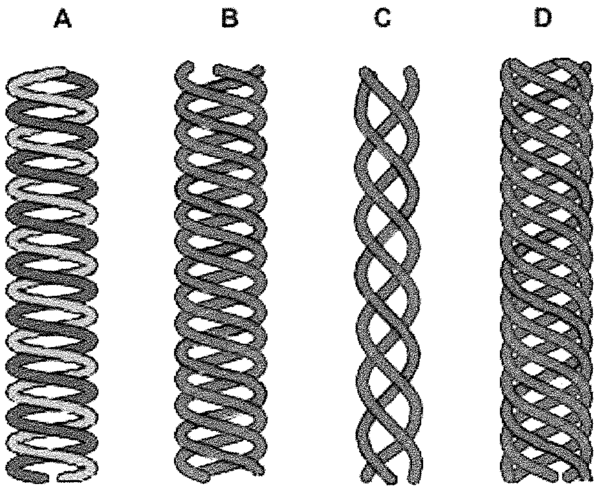
c) Pond snails and pondweed are living in water in sealed test tubes.
Carbon dioxide dissolves in water and forms an acid called carbonic acid.

In which test tube would the water become the most acidic?



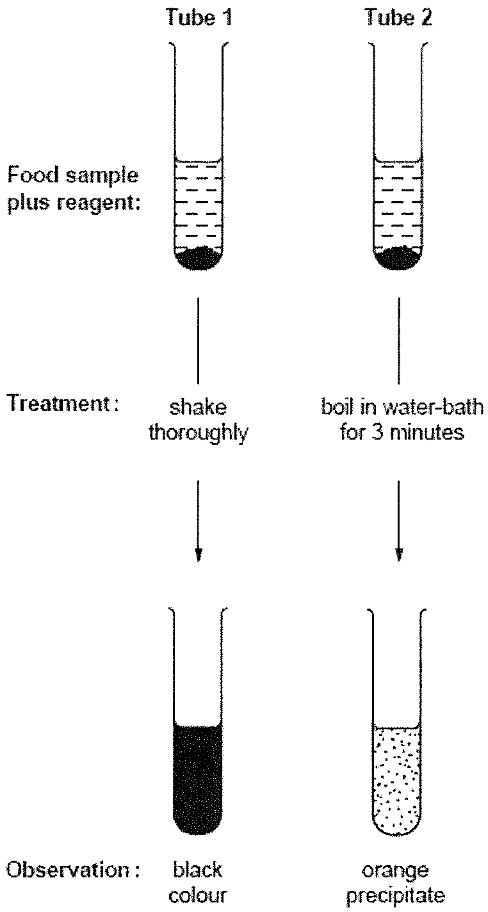
(a) 1 (b) 2 (c) 3 (d) 4

d) Which structure most closely resembles DNA?



(a) A (b) B (c) C (d) D

e) The diagram shows positive results in two different food tests.



What do the results show in each tube?

	Tube 1	Tube 2
A	sugar	lipid
B	starch	sugar
C	protein	sugar
D	starch	protein

ⓐ A ⓑ B ⓒ C ⓓ D

f) A human cell has 10 000 mitochondria and a yeast cell has 10

By how many orders of magnitude are there more mitochondria in a human cell than in a yeast cell?

- (a) 2
- (b) 3
- (c) 10
- (d) 10 000

g) What are cells called if they are adapted to perform a certain job?

- (a) Specific
- (b) Functional
- (c) Unique
- (d) Specialised

h) Look at the table.

It shows the death rates from coronary heart disease (CHD) in the UK in 2008

Death rates from CHD per 100,000 population			
Age 55–64		Age 65–74	
Men	Women	Men	Women
175	47	443	179

In 2008 the total number of deaths per 100,000 in both age ranges was 844. What percentage of these deaths were women?

- (a) 5.6%
- (b) 21.2%
- (c) 22.6%
- (d) 26.8%

i) Tears and stomach juices are important in the body's response to pathogens.

	Tears	Stomach juices
A	Acid	Antibiotics
B	Antibiotics	Antibodies
C	Antibodies	Lysozyme
D	Lysozyme	Acid

Which row of the table correctly describes what substances are found in tears and stomach juices?

(a) A (b) B (c) C (d) D

j) A scientist was studying a population of snails

He caught 60 snails in the first sample. He marked them and released them.

He caught 50 snails in the second sample. 20 of the snails were marked.

Use this equation: $$\text{estimated population} = \frac{\text{number caught in first sample} \times \text{number caught in second sample}}{\text{number in second sample that are marked}}$$

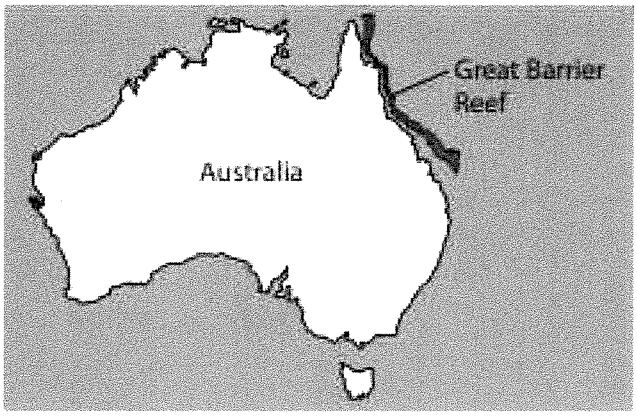
What is the estimated population?

(a) 150 (b) 240 (c) 300 (d) 3000

2. Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

Global warming and the Great Barrier Reef

The Great Barrier Reef is found in the sea off the North-East coast of Australia. It is the largest coral reef in the world.



Coral reefs are underwater ecosystems. Coral grows best on rock found in shallow, clear moving water. The coral is made from a hard calcium shell that contains small animals. Inside the bodies of these animals there are microscopic organisms called algae. These animals and algae have a mutualistic relationship. In a mutualistic relationship, both species benefit by living together.

A scientific study found that higher sea temperatures in 2016 caused the worst destruction of corals ever recorded on Australia's Great Barrier Reef. Many scientists believe that the increase in sea temperature is the result of an increase in carbon dioxide in the atmosphere.

About 70% of coral died in the northern section of the reef. One of the worst-hit areas was around Lizard Island in North Queensland, where almost 90% of the coral died. The situation was better in the central section, where only about 5% died. The southern section of the reef was healthy. Scientists warn that recovery of the coral reefs will be difficult if climate change continues.

Some coral death is the result of overheating. However, far more coral has been lost through bleaching. Coral bleaching happens when sea temperatures rise for a long period of time. The algae cannot survive so the coral starves. The pigments in the algae give coral its colour. After bleaching, the coral appears white because it is now without the colourful algae that provide its main source of energy.

Some coral survives the higher sea temperatures. However, another study has found that this coral has now come under increased threat from predators such as snails and the crown-of-thorns starfish.

Scientists are hopeful that the reef is capable of recovery, but fear it may not have an opportunity as sea temperatures continue to rise. The Australian Government has published recommendations in a long-term sustainability plan for the coral reef.

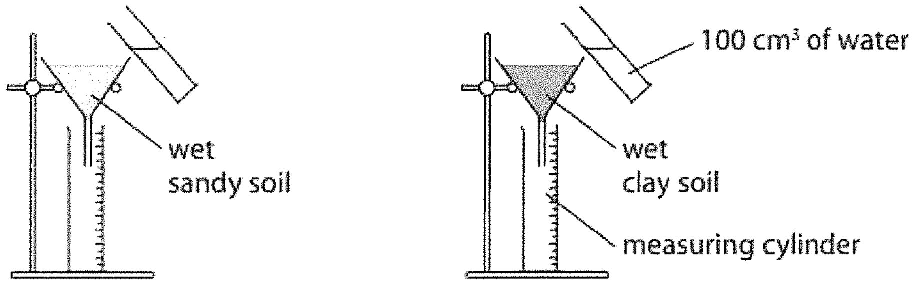
What are coral reefs and what type of environment do they thrive in? (2)

What caused the destruction of coral, through coral bleaching on the Barrier Reef in 2016? (1)

Suggest why coral bleaching caused the coral to die. (2)

What threats do surviving corals face after bleaching? (2)

3 The diagram shows the apparatus used to investigate how quickly water passes through two different types of soil.



Each funnel contained 200 g of dry soil. Water was poured into each funnel to make the soil completely wet.

Then 100 cm^3 of water was poured on to the wet soil in each funnel and allowed to drain into the measuring cylinders. The volume of water collected in the cylinders was measured every two minutes until all 100 cm^3 had been collected. The table shows the results.

Time in minutes	Volume of water collected in cm^3	
	sandy soil	clay soil
2	70	20
4	100	36
6	100	52
8	100	68
10	100	84
12	100	97
14	100	100

(a) (i) Soil type is an independent variable in this investigation.

What is meant by the term **independent variable**?

(1)

....

....

(ii) What is the **dependent variable** in this investigation?

(1)

....

....

(iii) Tick the box to show the correct controlled variable in this investigation.

(1)

Variable	Tick
mass of dry soil	
size of measuring cylinder	
volume of water collected	

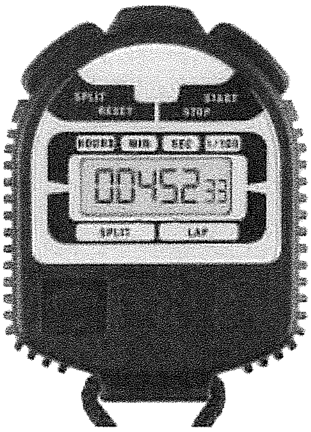
(iv) Calculate the average rate in cm^3 per minute at which water drained through the clay soil. Show your working.

(2)

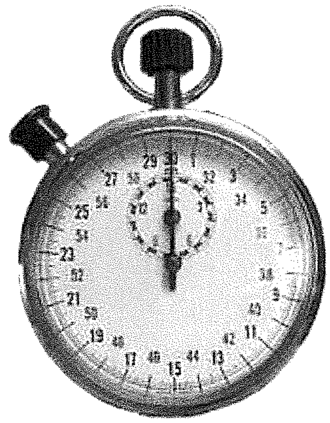
Answer .... cm^3 per minute

(v) The photographs show two stop clocks, A and B, that could be used to measure the time taken for water to drain through the soil in this investigation.

stop clock A



stop clock B



Which of these two stop clocks would give a more precise reading?
Explain your answer.

(1)

....

....

(b) Sandy soil contains large soil particles with big air spaces between them.

Clay soil contains very small soil particles with small air spaces between them and most of these air spaces are filled with water.

(i) Suggest why many plants may find it difficult to grow in sandy soil.

(2)

(c) Plot a graph to show the volume of water collected in the two soil samples. You will need to use a key to distinguish between sandy and clay soils. (6)

Use a ruler to join the points with straight lines.

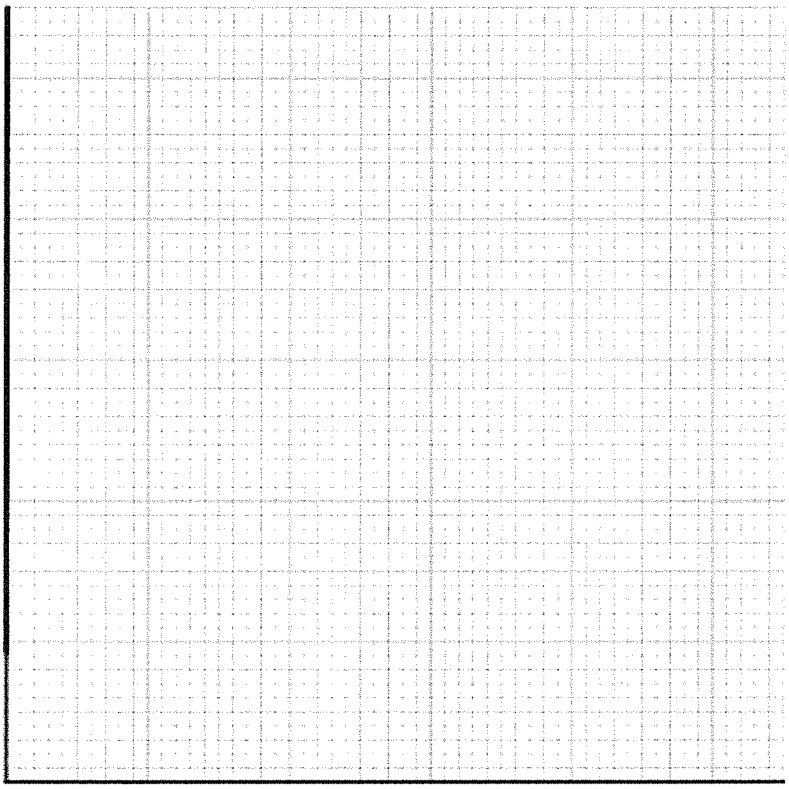


Figure 4.1 shows a fruit fly (*Drosophila melanogaster*). Compare and contrast a human with a fruit fly.

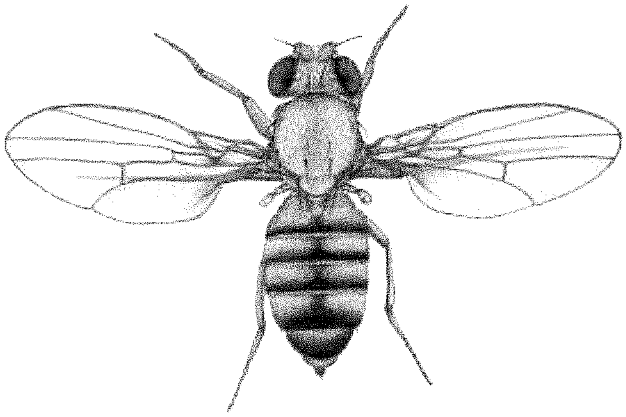


Fig 4.1 *Drosophila melanogaster* © Joana Carvalho.

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Section B

Chemistry

(33 Marks)

You are advised to spend no more than 30 minutes on this section

QUESTION ONE - Multiple Choice Questions

(a) Acid and alkali combined will give a salt and water, if they are mixed in the right amounts. What name is given to this type of reaction?

- (a) Oxidation
- (b) Neutralisation
- (c) Combustion
- (d) Thermal decomposition

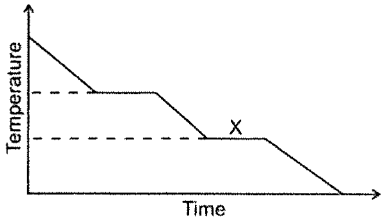
(b) Approximately what percentage of the Earth's atmosphere is made up of carbon dioxide?

- (a) 4%
- (b) 1%
- (c) 0.4%
- (d) 0.04%

(c) Which of these statements about the periodic table is **incorrect**?

- (a) All the elements in Groups 2 and 7 are quite reactive
- (b) Elements in Group 0 are gases that hardly ever take part in chemical reactions
- (c) The groups of the periodic table contain elements that are completely different from each other
- (d) Elements in the same period of the periodic table have the same number of occupied electron shells

(d) The graph shows the temperature of water as it is cooled from 150 °C to -20 °C.



What process is happening at point X?

- (a) boiling
- (b) melting
- (c) condensing
- (d) freezing

(e) Which of these lists shows the metals in order from most reactive to least reactive?

- (a) Potassium, magnesium, zinc, iron, copper
- (b) Zinc, potassium, magnesium, copper, iron
- (c) Magnesium, potassium, iron, zinc, copper
- (d) Potassium, zinc, magnesium, iron, copper

(f) Which of the following substances is **not** an element?

- (a) air
- (b) carbon
- (c) nitrogen
- (d) helium

(g) Which of the following sentences best describes a pure substance?

ⓐ A substance made up of one type of element

ⓑ A substance made up of only elements

ⓒ A substance made up of only one type of element or only one type of compound

ⓓ A substance made up of only one type of element and only one type of compound

(h) Saucepans are normally made of metal because metals are good at conducting heat. What is another property of metals that makes them suitable materials for making saucepans?

ⓐ shiny

ⓑ magnetic

ⓒ high melting point

ⓓ sonorous

(i) Which of the following statements about chemical reactions is **incorrect**?

ⓐ No mass is lost when the reactants turn into the products during a chemical reaction

ⓑ The temperature during a chemical reaction will only go up

ⓒ Reaction mixtures can undergo visible changes

ⓓ Atoms are rearranged during a chemical reaction

(j) Which of these pH values shows the pH of a weak alkali?

ⓐ pH 1 ⓑ pH 4 ⓒ pH 10 ⓓ pH 13

QUESTION TWO

Magnesium is an element. It is solid at room temperature.

(a) (i) State why solid magnesium cannot be compressed. (1 mark)

____

(ii) Explain why solid magnesium cannot flow, but liquid magnesium can flow. (3 marks)

.

____

____

____

____

(iii) Explain why magnesium gas completely fills any container it is put in. (2 marks)

____

____

____

(b) Magnesium reacts with water. Magnesium hydroxide, $Mg(OH)_2$, and hydrogen, H_2, are made.
Write a balanced symbol equation for this reaction. (2 marks)

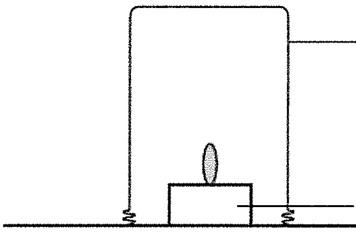
____

(c) Magnesium nitrate has the formula $Mg(NO_3)_2$.

How many atoms are there in the formula $Mg(NO_3)_2$? (1 mark) ______________

QUESTION THREE

Kiran lit a candle.
She placed a 100 cm^3 glass jar over the candle.
The candle flame went out after 2 seconds.



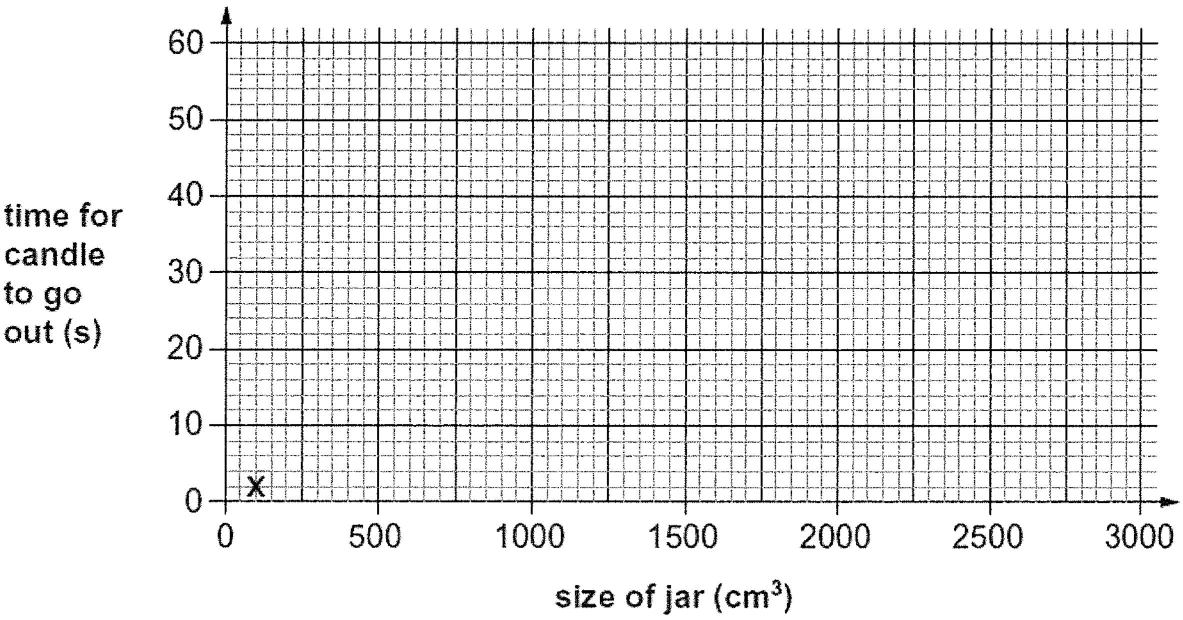
(a) Why did the flame go out? (1 mark)

(b) Kiran put different sized jars over a lit candle.
She measured the time it took for the flame to go out each time.
She recorded her results in a table.

size of jar (cm^3)	time for candle to go out (s)
100	2
250	5
500	9
1000	22
2000	37
3000	60

(i) Plot Kiran's results on the graph paper below.
The first one has been done for you. (1 mark)

(ii) Draw a line of best fit. (1 mark)



(iii) What conclusion can you make from her results? (1 mark)

____

____

(c) What should Kiran keep the same in this experiment to make it a fair test? (1 mark)

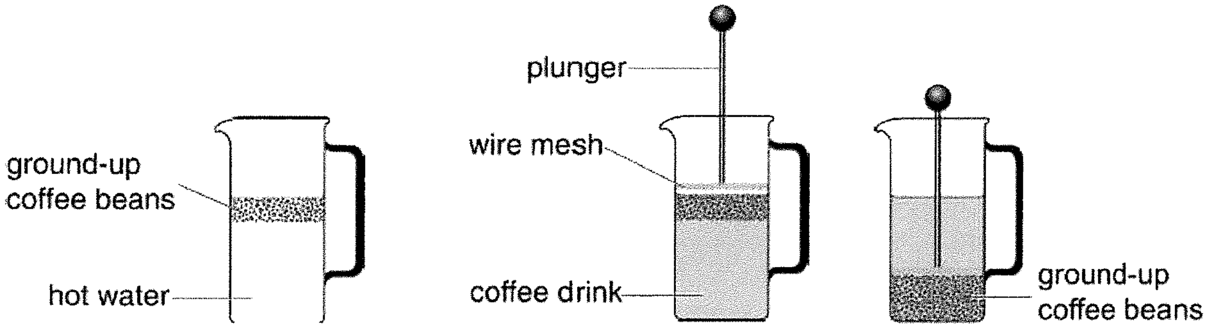
____

(d) Suggest one way for Kiran to make her results more reliable. (1 mark)

____

QUESTION FOUR

Russell put ground-up coffee beans in a coffee maker and added hot water.

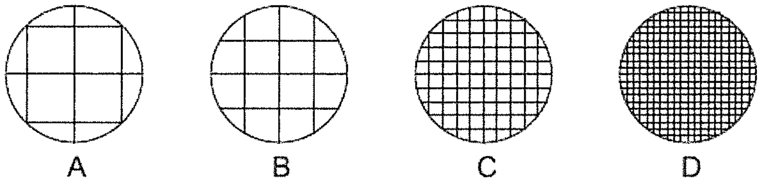


He pushed the plunger down. This separated the coffee drink from the ground-up coffee beans.

(a) How could Russell see that some coffee had dissolved in the water? (1 mark)

___

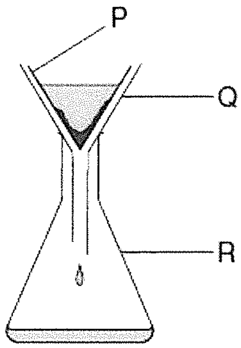
(b) The end of the plunger is a circle of wire mesh.



(i) Which mesh would be best to separate the coffee drink from all the ground-up coffee beans?

Write the letter. (1 mark) ___

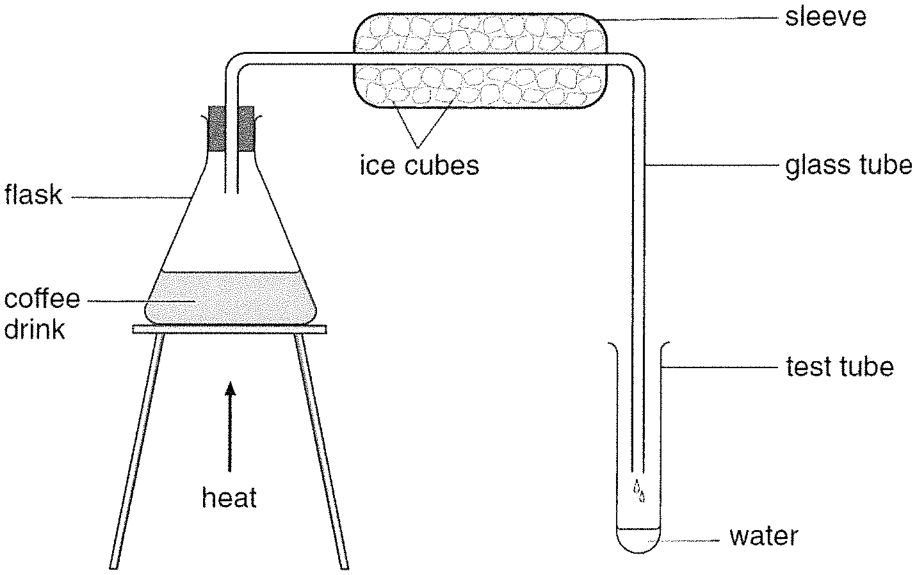
(ii) This method of making coffee uses a type of filter.
The apparatus used for filtration in a school laboratory is drawn below.



Which part of the apparatus above works in the same way as the wire mesh?

Write the letter. (1 mark) ___

(c) Russell wanted to separate the water from the coffee drink. He set up the apparatus shown below.



(i) Why did Russell put ice cubes around the glass tube? (1 mark)

____

(ii) Choose words from the box below to fill the gaps in the following sentences. (4 marks)

an acid	a gas	a liquid	a solid
condensation	crystallisation	evaporation	filtration

Russell heats the water. Water in the drink changes from

____________________ into ____________________.

This change of state is called ____________________.

Water vapour changes into liquid. This change of state is called

____________________.

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Section C

Physics

(33 Marks)

You are advised to spend no more than 30 minutes on this section

1. Which of the following is an example of a contact force? Select the correct answer.

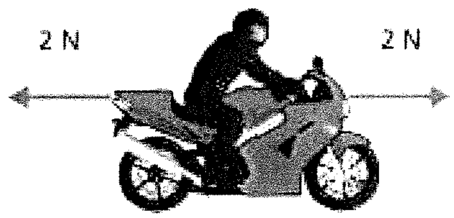
(a) gravity

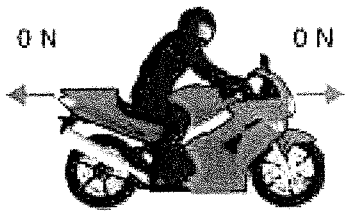
(b) magnetic force

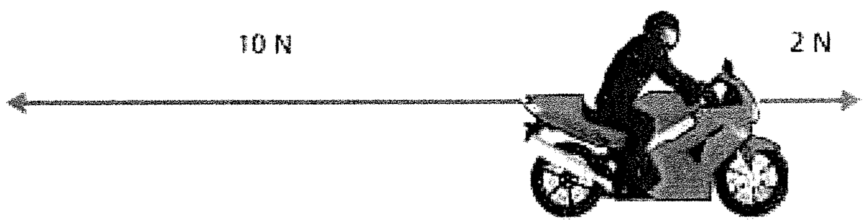
(c) electrostatic force

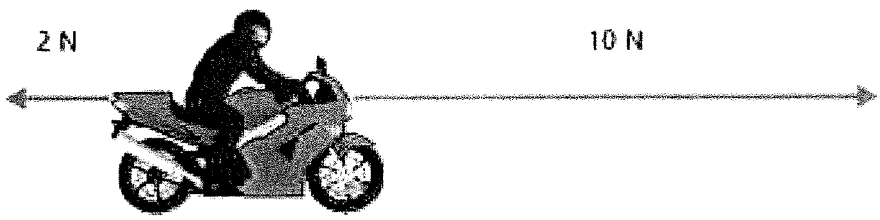
(d) drag

2. Which force diagram shows a bike travelling forward, with the engine on and at a steady speed? Select the correct answer.

(a) 

(b) 

(c) 

(d) 

3. A horse runs 2 km in 120 seconds. What is the average speed of the horse, to 2 significant figures? Select the correct answer.

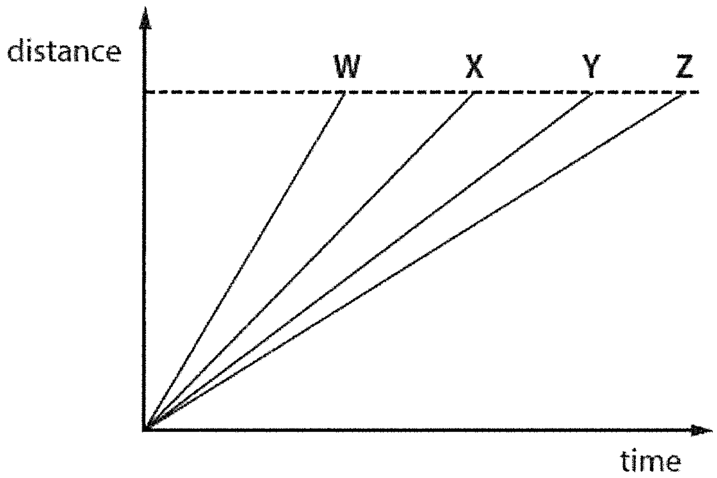
(a) 0.10 m/s

(b) 60 m/s

(c) 17 m/s

(d) 240 m/s

4. The diagram shows the distance-time graph for four people, W, X, Y and Z, in a race.
They each travel the same distance.
Which person ran the race at the highest speed?



(a) person W

(b) person X

(c) person Y

(d) person Z

5. Which of these gives the two pieces of equipment that could be used to determine the speed of the ball?

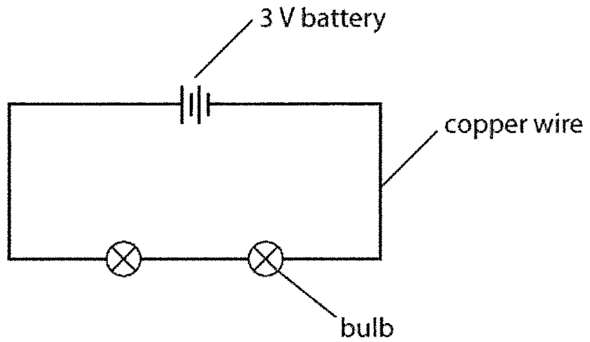
(a) ammeter and stopwatch

(b) balance and ruler

(c) stopwatch and ruler

(d) ruler and ammeter

6. The diagram shows an electric circuit with two bulbs in series.



The bulbs in the circuit have electrical resistance.
Which statement about electrical resistance is correct?

(a) **A** copper wire has no resistance

(b) **B** copper wire has a high resistance

(c) **C** the higher the resistance of a circuit, the higher the current that flows

(d) **D** the lower the resistance of a circuit, the higher the current that flows

7. What are the units for electrical current?

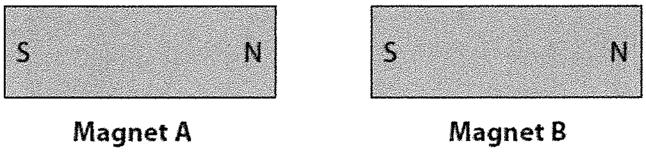
(a) **A** amps

(b) **B** joules

(c) **C** ohms

(d) **D** volts

8. The diagram shows two magnets, A and B.



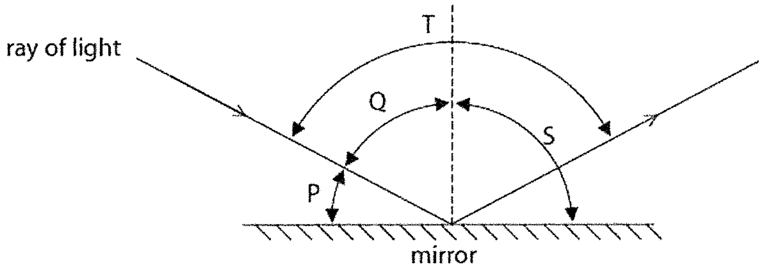
Which phrase completes the sentence?
There will be .... between Magnet A and Magnet B.

- (a) a contact force
- (b) a force of attraction
- (c) a force of repulsion
- (d) no force

9. A solar eclipse occurs when the Moon blocks light from the Sun. This causes a shadow on the Earth.What shape is the shadow on the Earth?

- (a) a square
- (b) a circle
- (c) a triangle
- (d) a star

10. The diagram shows a ray of light shining on to a plane mirror.

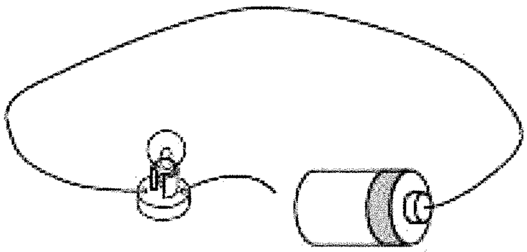


Which angle is the **angle of incidence**?

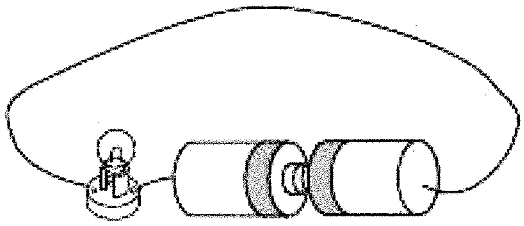
(a) P (b) S (c) Q (d) T

Q11. In which circuit will the bulb light up?

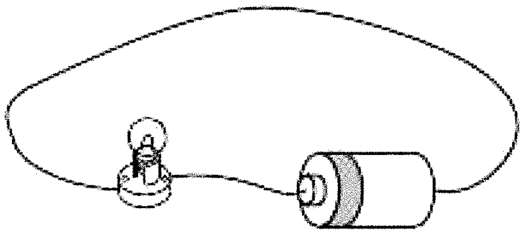
ⓐ **A**



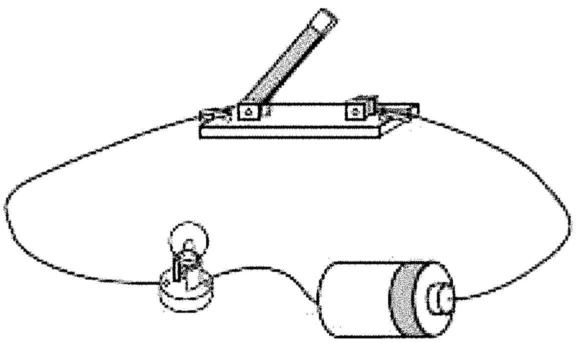
ⓑ **B**



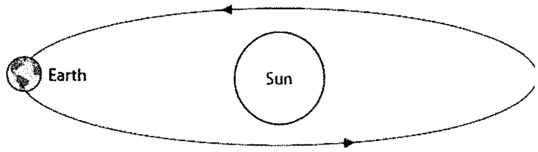
ⓒ **C**



ⓓ **D**



Q12. The diagram shows the orbit of the Earth around the Sun.



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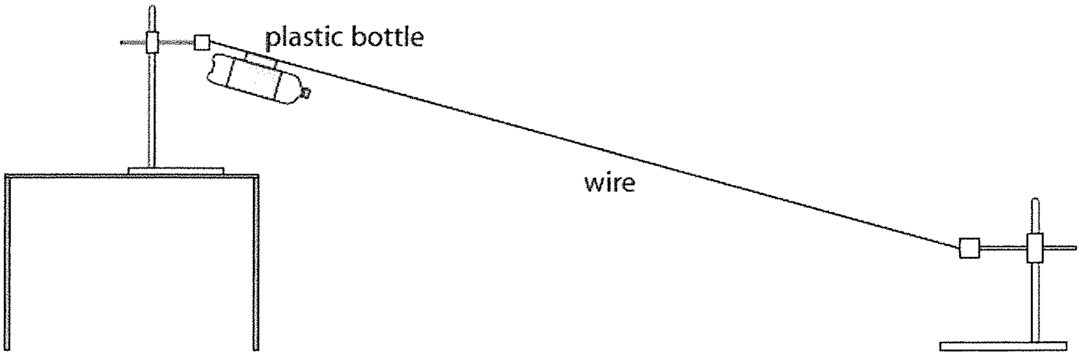
How long does it take for the Earth to make one full orbit around the Sun?

- a **A.** one day
- b **B** one week
- c **C.** one month
- d **D.** one year

Q12. A class investigates how the mass of an object affects the time it takes to slide down a wire.
They use a plastic bottle and a five metre length of wire.
The diagram shows their apparatus.



This is the method the class uses.
Step 1: measure the mass of the empty plastic bottle
Step 2: attach the plastic bottle to the top end of the wire
Step 3: release the bottle and measure the time taken for it to reach the end of the wire
Step 4: put 40 g of sand in the bottle and repeat the experiment
(a) Name two pieces of measuring equipment needed for this investigation and state their units of measurement

(3)

Name of piece of equipment	Unit of measurement
....	....
....	....

(b) Describe what the class must do to make their results more reliable.

....

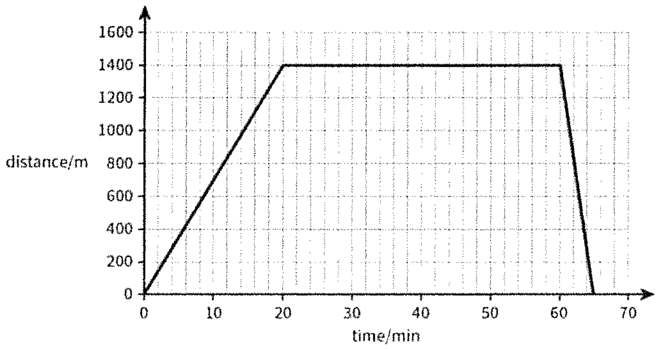
.... (1)

(c) Which other scientific questions would it be sensible to test using the same apparatus?
Tick the boxes in the table to show your answers. (2)

Scientific question	Yes	No
Does the thickness of the wire affect the speed the bottle goes down the wire?		
Does the shape of the bottle affect the speed the bottle goes down the wire?		
Does the time of year affect the speed the bottle goes down the wire?		
Does the type of material the wire is made from affect the speed the bottle goes down the wire?		

(Total for question = 6 marks)

Q13. A girl walks from her house to a coffee shop. She has a drink, then catches the bus back home. Her journey is shown in the graph.



a. The first section shows the girl walking.
i. Give the equation you need to calculate speed.

.... (1)

ii. Use the graph to calculate the speed of the girl walking in metres per minute.

____

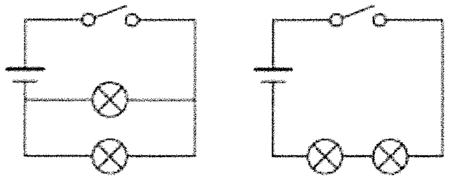
____

speed = ____________ metres per minute

b. Determine how long the girl spends at the coffee shop.

____ (1)

Q14 Christmas tree lights can be connected in series or in parallel, as shown in the diagram.



Circuit A **Circuit B**

a. Which circuit, A or B, shows a parallel circuit? Explain your choice.

____

____

____ (2)

b. Connecting Christmas tree lights in parallel has some advantages.
i. Explain why it is more difficult to repair a broken bulb in a series circuit with many bulbs than in a parallel circuit with many bulbs.

____

____

____ (2)

ii. Explain why the battery in a series circuit needs to have a much higher potential difference than the battery in a parallel circuit to produce the same brightness output.

____

____

____(2)

iii. State one disadvantage of using the battery-power parallel circuit instead of the battery-powered series circuit.

____

____(1)

Q15. Our solar system includes the Sun, planets and moons.
(a) Complete the sentence.
Choose the answer from the box.

Andromeda	Milky Way	Pinwheel	Whirlpool

Our solar system is part of the ______________ galaxy. (1)

(b) Planets orbit the Sun.
What force causes planets to orbit the Sun? (1)

____

The table below shows data about five planets.

Planet	Mean distance from the Sun in millions of kilometres	Mean surface temperature in °C
Earth	150	+22
Mars	228	–48
Jupiter	778	X
Saturn	1430	–178
Uranus	2870	–200

(c) How does the mean surface temperature of the planets in the table change as the mean distance from the Sun increases?

____

____

(1)

(d) Predict the mean surface temperature of Jupiter (X) in the table above.

Mean surface temperature of Jupiter = __________ °C (1)