OCR
Oxford Cambridge and RSA

Friday 7 June 2024 – Afternoon

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/08 Combined Science (Higher Tier)

Time allowed: 1 hour 45 minutes

H

You must have:
- a ruler (cm/mm)
- the Data and Equation Sheet for GCSE (9–1) Combined Science B (inside this document)

You can use:
- an HB pencil
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **75**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

1 Doctors select radioactive isotopes for imaging scans and for treatments very carefully.

The table shows the radiation emitted and half-lives of 6 radioactive samples.

Sample	Radiation Emitted	Half-life
A	Alpha	10 days
B	Alpha	1600 years
C	Beta	8.0 days
D	Beta	2.7 days
E	Gamma	5.3 years
F	Gamma	8 days

(a) Which sample is suitable to be used as a radioactive tracer for an imaging scan?

Explain your answer.

Use data from the table.

Sample .....

Explanation .....

.....

.....

.....

.....

[3]

(b) Samples A and B emit alpha radiation.

Suggest **two** precautions that should be taken by hospital staff when handling samples A and B.

1 .....

2 .....

[2]

(c) One of the samples in the table is radium-226.

Determine the number of neutrons in a nucleus of a radium-226 atom.

Use the Data and Equation Sheet.

Number of neutrons = ... **[2]**

(d) How many outer shell electrons does each radium-226 atom have?

Explain your answer.

Use the Data and Equation Sheet.

Number of outer-shell electrons .....

Explanation .....

.....

.....

[2]

(e) Another of the radioactive isotopes in the table is iodine-131.

Which element will most readily react with iodine-131 to form a salt?

Tick (✓) **one** box.

Copper ☐

Gold ☐

Neon ☐

Sodium ☐

[1]

2 Some students are learning about radioactivity and radioactive half-life.

(a) What is the definition for the activity of a radioactive source?

Tick (✓) **one** box.

The current produced by the particles. ☐

The purpose the radioactive sample is used for. ☐

The number of decay events per second. ☐

The type of radiation that the substance emits. ☐

[1]

(b) What is the definition of half-life?

Tick (✓) **one** box.

Half of the original activity of a sample. ☐

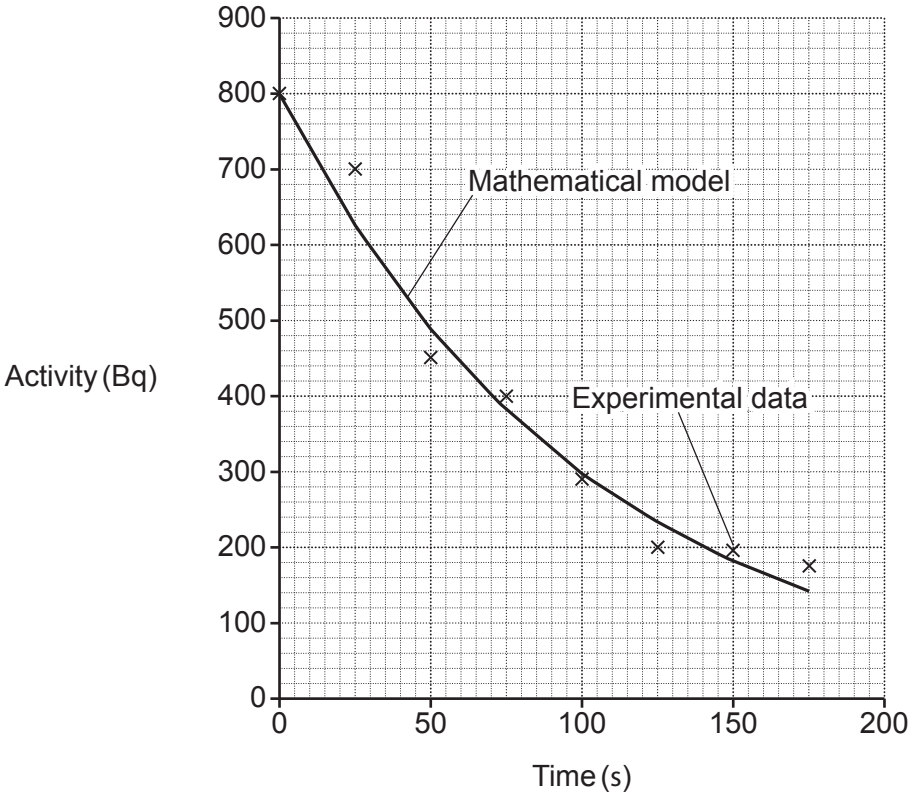
Half the lifetime of a radioactive substance. ☐

The time for half of a decay to happen. ☐

The time for the activity to fall to half. ☐

[1]

(c) The graph shows experimental data from a radiation detector, and a separate mathematical model of decay.



Complete the sentences about radioactive decay.

Use words from the list.

complete	**match**	**random**	**replace**	**selective**	**trend**

Radioactive decay is a ..... process.

Experimental data may not ..... the model results due to chance

but the overall ..... will be the same.

[3]

3 An antibiotic sensitivity test can help researchers to develop new antibiotics.

The test procedure is:

1. Spread bacteria on an agar plate.

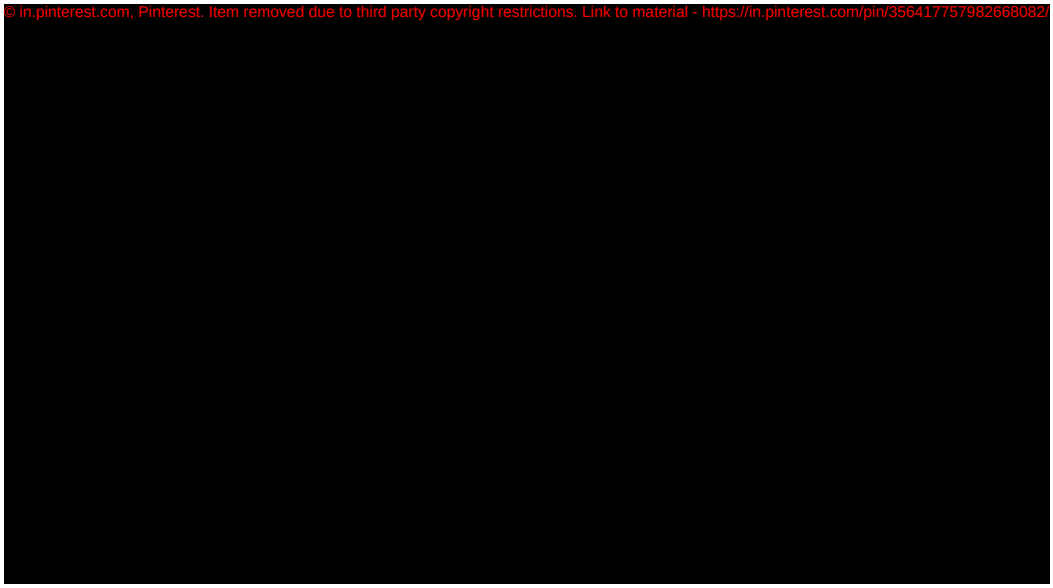
2. Soak discs of paper in different antibiotics.

3. Place the discs of paper on an agar plate.

4. Incubate the agar plate so that the bacteria can grow.

There is a clear zone around each disc where no bacteria grow. This shows how effective an antibiotic is against the type of bacteria that is on the agar plate.

The image shows some test results. Some of the paper discs have been labelled **B**, **C** and **D**.



(a) Draw a line to the least effective antibiotic disc and label it **A**. **[1]**

(b) Measure the diameter of the clear zone for antibiotic disc **B**.

Give your answer in **mm**.

Diameter = ... mm **[1]**

(c) Calculate the area of the clear zone for antibiotic disc **B**.

Use the equation: area = $3.14 \times r^2$

Area = ... mm^2 **[3]**

(d) The area of the clear zone for disc **C** is 52 mm^2.
The area of the clear zone for disc **D** is 113 mm^2.

Calculate the percentage difference in area of the clear zones for disc **D** compared to disc **C**.

Give your answer to **2** significant figures.

Percentage difference = ... % **[3]**

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4 At school, some students are studying rates of reaction.

(a) They use this method to investigate how temperature affects the rate of reaction:

- Add 50 cm^3 of sulfuric acid to calcium carbonate ($CaCO_3$) powder in a conical flask, at room temperature.
- Measure the change in mass of the reactants every 30 seconds for five minutes.
- Repeat the experiment at 80 °C.

(i) Name **one** piece of equipment the students can use, instead of a Bunsen burner, to heat the reactants and conduct the experiment at 80 °C.

Explain your answer.

Equipment .....

Explanation .....

.....

.....

[2]

(ii) Suggest **two** improvements to this method.
Explain each suggestion.

Suggestion 1 .....

.....

Explanation 1 .....

.....

Suggestion 2 .....

.....

Explanation 2 .....

.....

[4]

(b) Carbon dioxide gas (CO_2) is produced in the reaction and escapes from the conical flask.

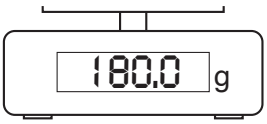
(i) Calculate the relative formula mass of carbon dioxide.

Use the Data and Equation Sheet.

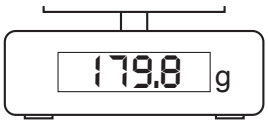
Relative formula mass = ... **[2]**

(ii) The reading on the balance at the start of the experiment and after two minutes is shown.

Start



After two minutes



Calculate the number of moles of carbon dioxide produced in two minutes.

Use the equation: number of moles = $\frac{\text{mass of substance}}{\text{relative formula mass}}$

Number of moles = ... mol **[3]**

(iii) In another experiment, 0.006 moles of carbon dioxide is produced.

Calculate the number of molecules in 0.006 moles of carbon dioxide.

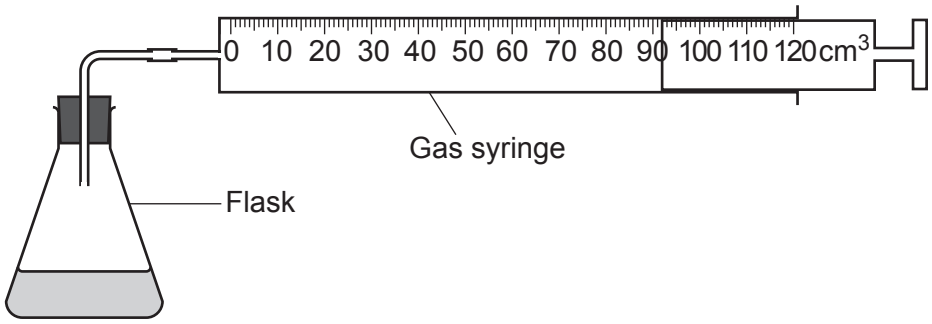
1 mole of a substance contains 6.0×10^{23} molecules.

Molecules of carbon dioxide = ... **[2]**

(c) The student repeats the experiment again using a gas syringe to measure the volume of carbon dioxide gas produced.

They measure 92 cm^3 of carbon dioxide which is equal to 0.184 g.

1 cm^3 of carbon dioxide = 0.002 g.



(i) If this 0.184 g of carbon dioxide was weighed on the balance shown in part **(b)(ii)**, what would the balance display?

Tick (✓) **one** box.

0.18 g ☐

0.2 g ☐

0.20 g ☐

0.184 g ☐

[1]

(ii) Suggest **one** reason why the gas syringe method will give a more accurate number of moles of carbon dioxide than the balance method.

.....

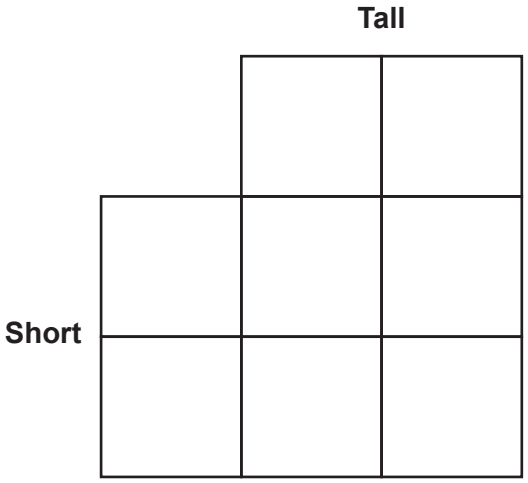
..... **[1]**

5 In the 1860s Gregor Mendel studied inheritance by crossing together pea plants with different characteristics.

(a) Complete the Punnett square to show the possible genotypes when Mendel crossed **homozygous** tall pea plants with **homozygous** short pea plants.

The dominant allele causes plants to be tall.

Use **T** for the dominant allele.
Use **t** for the recessive allele.



[2]

(b) A student makes a statement about the genetic cross:

"If 100 pea plants were produced from this cross, then 50 of them should be tall pea plants."

Explain why the student's statement is **incorrect**.

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.....

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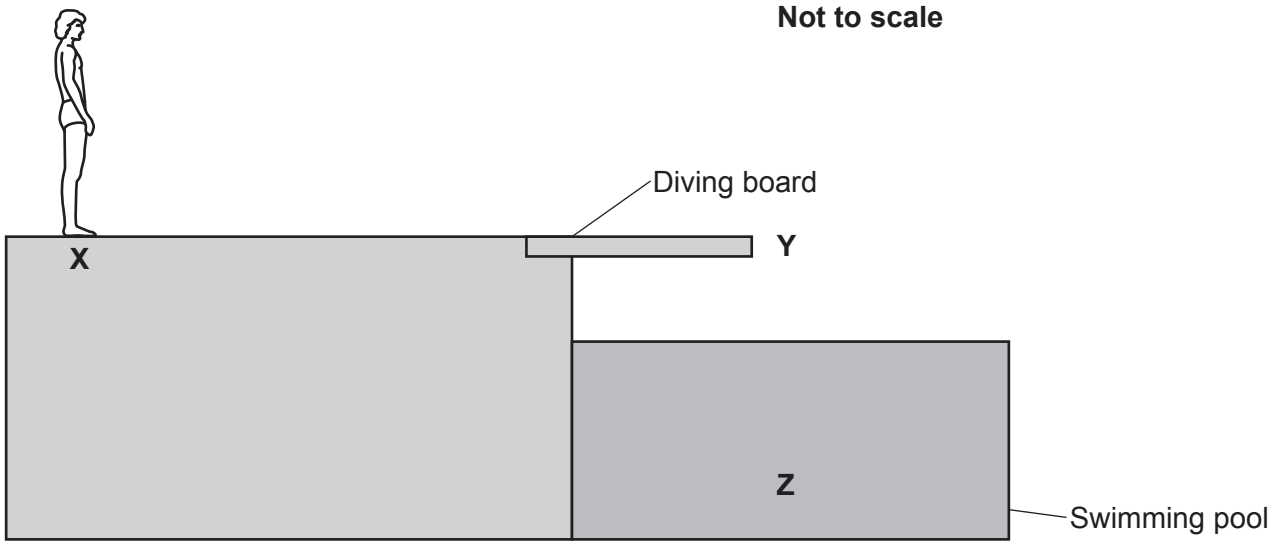
..... **[2]**

6 The diagram shows a diver standing stationary at **point X**, several metres away from the diving board.



(a) The diver takes a run up to the diving board.

The diver's speed when they reach the diving board is 2.7 m/s. It takes 2.5 s for the diver to reach the diving board.

Calculate the acceleration between **point X** and the diving board.

Use the equation: acceleration = $\frac{\text{change in speed}}{\text{time taken}}$

Acceleration = ... m/s^2 **[2]**

(b) At **point Y**, the diver is no longer in contact with the diving board and is in free fall. At **point Z** under water, the diver has reached a constant speed.

Calculate the difference in acceleration between **point Y** and **point Z**.

Difference in acceleration = ... m/s^2 **[1]**

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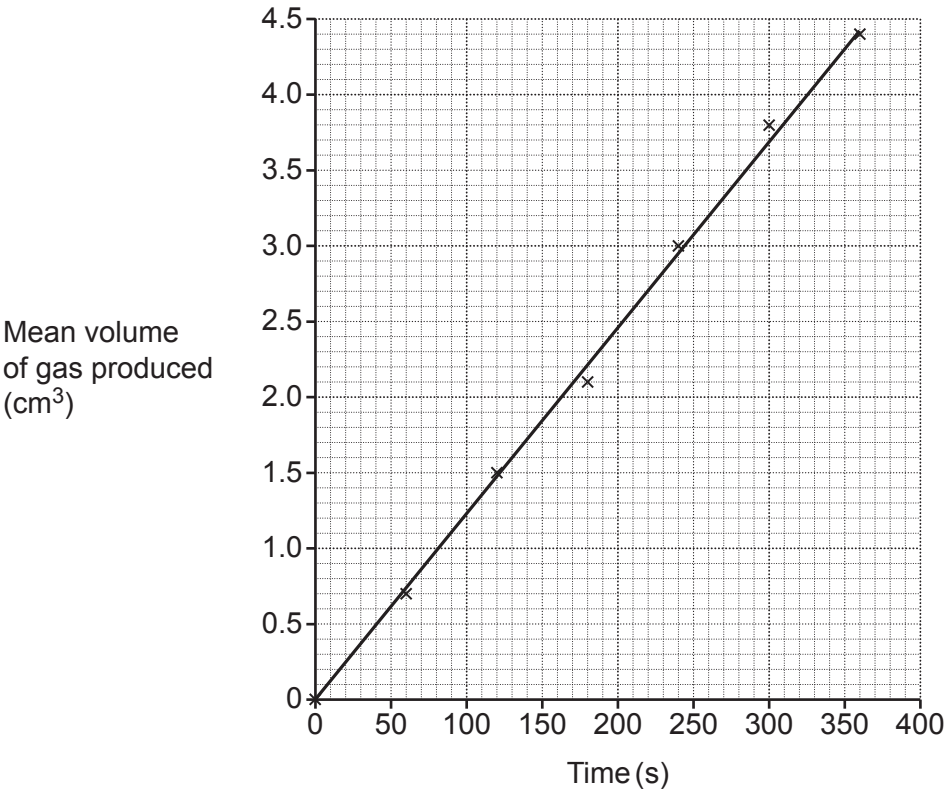
7 Some students are investigating photosynthesis.

(a) They measure the volume of gas produced by pondweed every 60 seconds.

Fig. 7.1 shows their results.

Fig. 7.1



(i) Calculate the rate of reaction.

Rate of reaction = ... cm^3/s **[3]**

(ii) Describe the chemical test that the students can do to prove that the gas produced is oxygen.

.....

.....

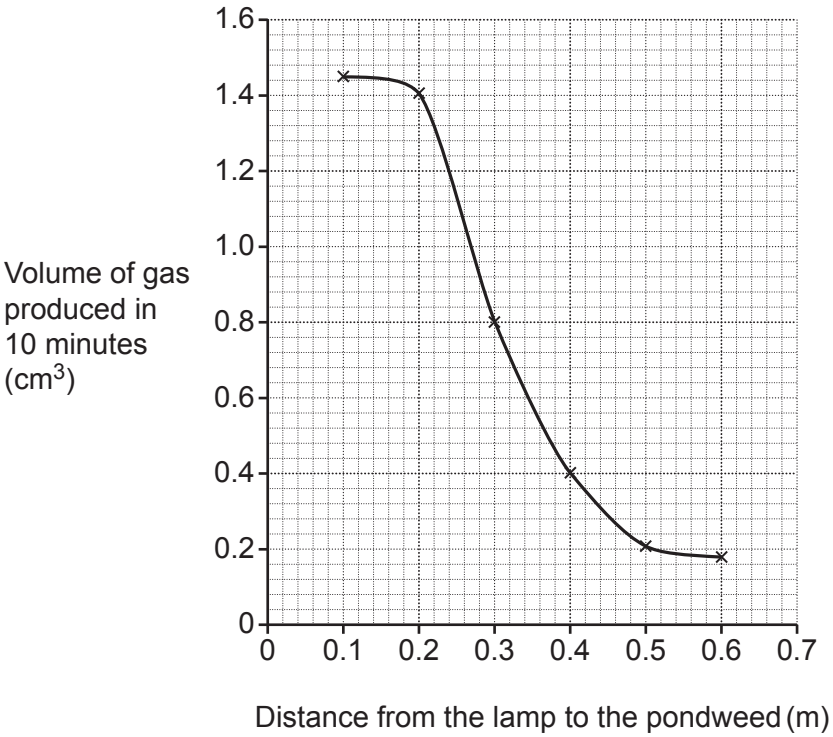
.....

..... **[2]**

(b) The teacher gives the students the data shown in **Fig. 7.2**.

It shows how the intensity of light affects the volume of gas produced by pondweed in 10 minutes. The light intensity is varied by moving the lamp further away from the pondweed.

Fig. 7.2



(i) A student writes:

"The greater the distance of the lamp from the pondweed the slower the rate of photosynthesis."

Evaluate the student's statement.

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.....

..... **[2]**

(ii) State **two** factors that need to be controlled in this light intensity experiment.

Factor **1** .....

Factor **2** .....

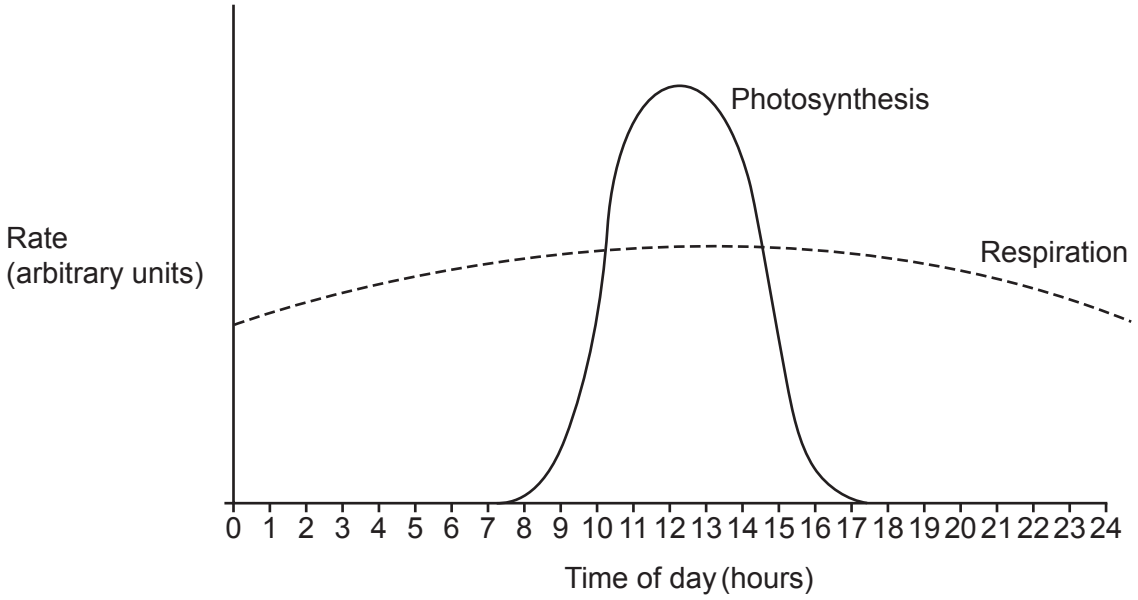
[2]

(iii) Calculate the rate of photosynthesis when the lamp is 0.30 m from the beaker.

Rate of photosynthesis = ... cm^3 / min **[2]**

(c) **Fig. 7.3** shows how the rates of photosynthesis and respiration for a plant vary over a 24 hour period during the **winter**.

Fig. 7.3



(i) At which times of the day are the rate of respiration and the rate of photosynthesis equal in **winter**?

Use **Fig. 7.3**.

..... **[1]**

(ii) In the summer the hours of daylight are longer and the temperature is warmer.

Sketch a curve on **Fig. 7.3** for the rate of photosynthesis over a 24 hour period in the **summer**. **[2]**

8 Bungee jumping is an extreme sport that involves jumping off a high platform while attached to an elasticated 'bungee' cord.

(a) A person's weight needs to be measured before a bungee jump so that appropriate equipment can be used.

Describe how weight is measured.

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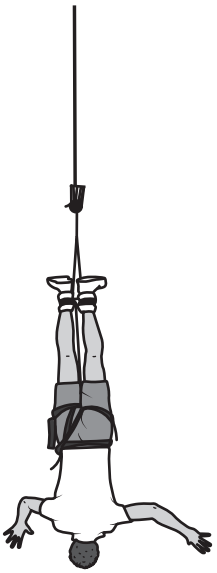
..... **[1]**

(b) In **Fig. 8.1**, the bungee cord is stretching.

Fig. 8.1



Describe **two** forces that cause the **cord to stretch**.

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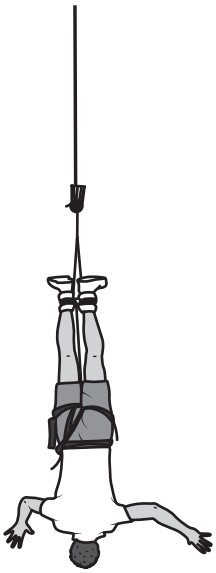
.....

[2]

(c) In **Fig. 8.2**, the bungee jumper is at rest.

Draw **two** labelled arrows on **Fig. 8.2** to represent the interaction pair of forces between the person and the bungee cord.

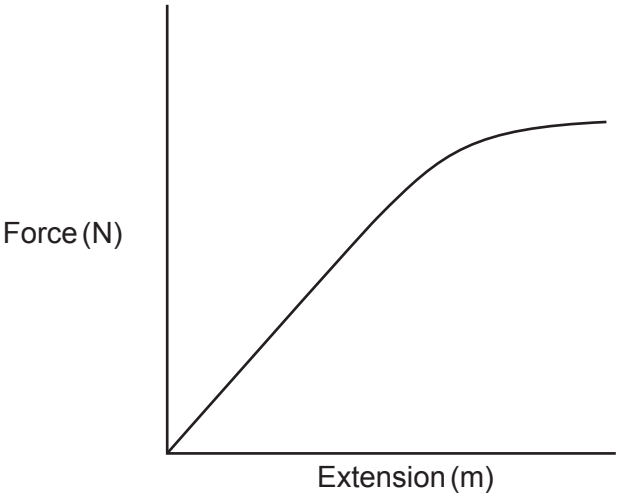
Fig. 8.2



[2]

(d) **Fig. 8.3** shows the force-extension graph for a bungee cord at forces up to and beyond the forces experienced during a bungee jump.

Fig. 8.3



Describe the relationship between force and extension in **Fig. 8.3**.

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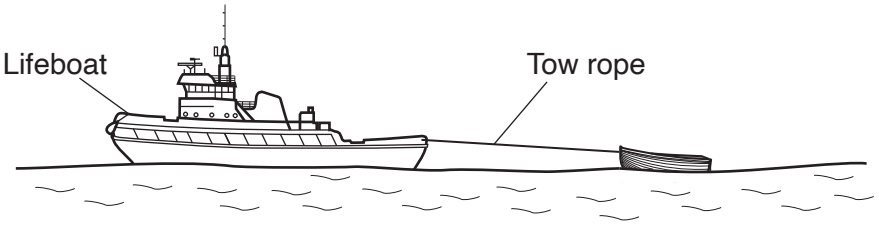
..... **[2]**

9 Lifeboats sometimes use tow ropes during rescues.



(a)* A lifeboat organisation wants to buy a new tow rope.

The tow rope must:

- have a breaking force greater than 88 MN
- stretch easily to store energy as the boats go over waves
- sink in sea water.

The table shows some properties of three polymer ropes which all have the same dimensions.

The density of sea water is 1.02 g / cm^3.

Polymer	Breaking force (MN)	Spring constant (MN / m)	Density (g / cm^3)
Aramid	560	21.5	1.44
Nylon	170	0.8	1.14
Polypropylene	110	0.4	0.91

Explain which polymer is the most suitable to use for the tow rope.

Include in your answer:

- why you have **not** chosen the other polymers
- any other factors that may be considered when choosing the most suitable polymer.

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..... **[6]**

(b) Explain why carbon atoms can form a large variety of polymer ropes.

Use ideas about bonding.

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..... **[3]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.