Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2022

Physics

Unit 1

Higher Tier

GPY12

[GPY12]
TUESDAY 7 JUNE, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Question **2(b)**.

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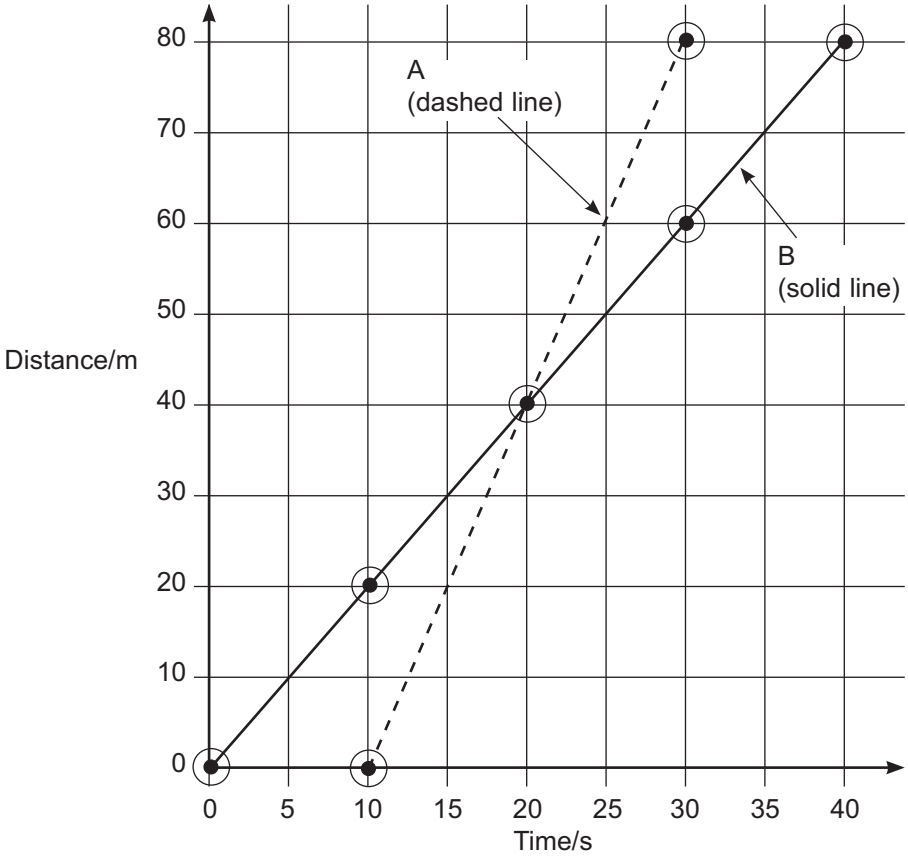
1 Two friends, A and B, have a race over a distance of 80 metres.
On the grid below are their distance–time graphs.



Source: Chief Examiner

(a) (i) How far in front is B when A begins to run?

_____ m [1]

(ii) For how many seconds has B been running when he is overtaken by A?

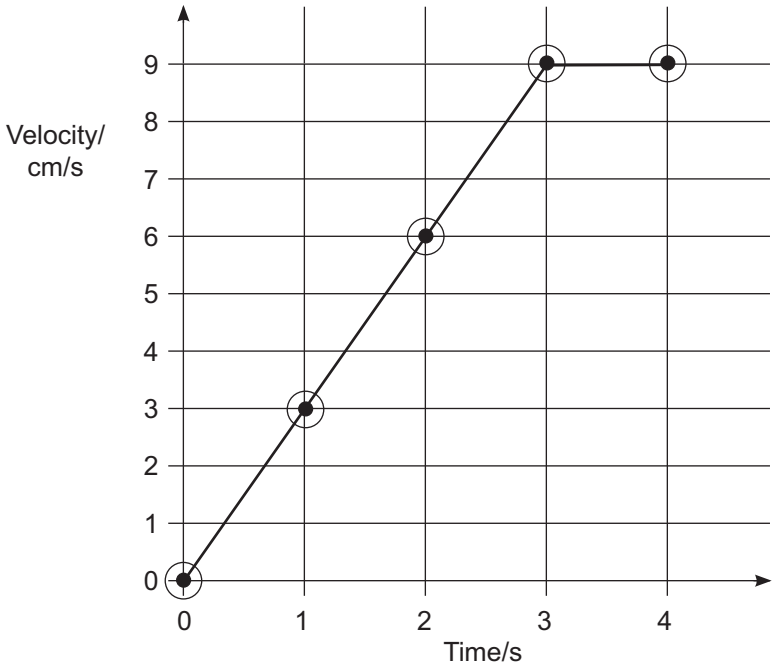
_____ s [1]

(iii) Calculate the speed of A during the race.
Show clearly how you get your answer, starting with the equation you plan to use.

Speed of A = _____ m/s [4]

[Turn over

(b) As a marble rolls from rest down a slope, it accelerates.
The velocity–time graph for the marble is shown below.



Source: Chief Examiner

(i) Calculate the total displacement of the marble in the 4 seconds of its motion.
Show clearly how you get your answer.

Total displacement = _____ cm [4]

(ii) Calculate the acceleration of the marble as it rolls down the slope in the first 3 seconds.
Show clearly how you get your answer, starting with the equation you plan to use.

Acceleration = _____ cm/s^2 [3]

(c) (i) Explain the difference between a vector and a scalar.

_____

_____

State one example of a vector and one example of a scalar.

Example of a vector: _____

Example of a scalar: _____ [3]

(ii) The world record for a Formula 1 racing car to complete 1 lap of the Silverstone Racing Circuit is 90.6 s.
The distance around the track is 5.89 km.
Explain why the car's average velocity was 0 m/s.

_____

_____ [1]

[Turn over

(d) A ball bounces and then begins to rise vertically from the ground with a velocity of 6 m/s.

(i) Calculate the time taken for the ball to reach its maximum height.
Show clearly how you get your answer, starting with the equation you plan to use.

Time = _____ s [3]

(ii) Using your answer to part **(i)**, or otherwise, calculate the maximum height reached by the ball.
Show clearly how you get your answer, starting with the equation you plan to use.

Maximum height = _____ m [4]

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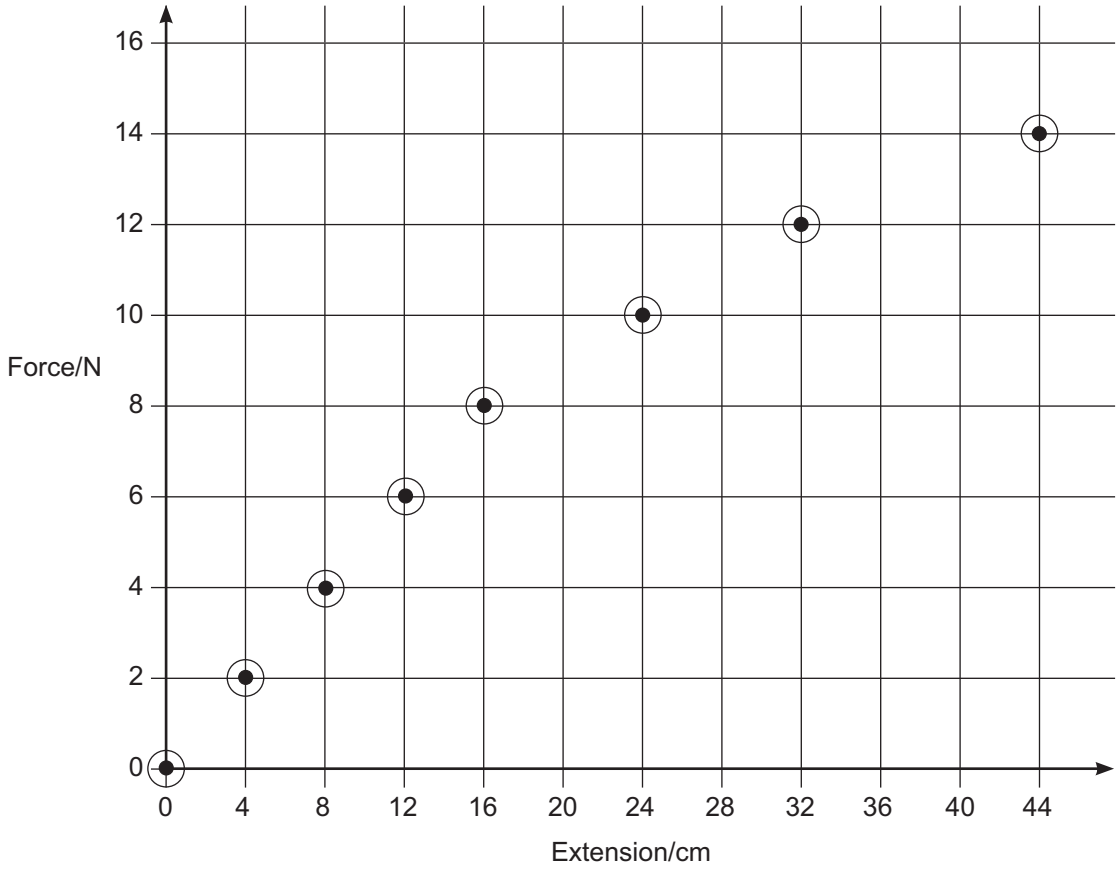
(Questions continue overleaf)

[Turn over

2 **(a)** During an experiment to investigate the stretching of a spring, values of the force and the extension were recorded and plotted on the grid below.



Source: Chief Examiner

(i) Draw a line through all the points and use it to estimate the force that corresponds to the limit of proportionality for the spring.

Force = _____ [2]

(ii) Using the data shown in the graph, calculate the spring constant for the spring.
State the unit of the spring constant with your answer.
Show clearly how you get your answer.

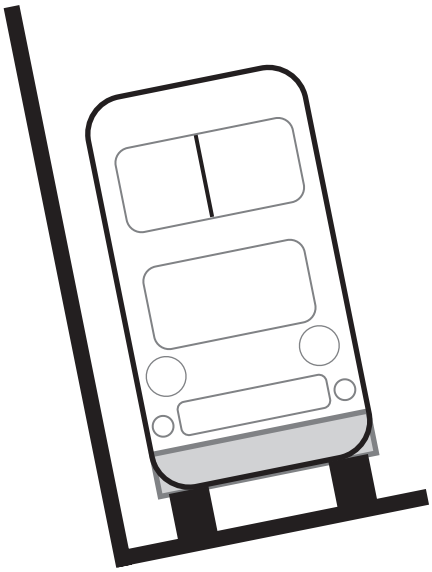
Spring constant = _____

Unit = _____ [4]

(iii) On the grid opposite draw the graph that would be obtained for a spring with a spring constant half the value of the one shown.
Stop your graph at 8 N. [2]

[Turn over

(b) The diagram shows a double-decker bus undergoing a tilt test.
The centre of gravity is an important concept when dealing with the stability of an object such as a double-decker bus.



Source: Chief Examiner

Describe the role the centre of gravity and other factors play in the stability of the double-decker bus.
In your answer you should state:

- the meaning of centre of gravity;
- how the position of the centre of gravity affects stability;
- another factor affecting stability;
- why standing on the upper deck of such a bus is not allowed;
- what causes the bus to fall over if it is tilted beyond a certain angle.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

Write your answers on the opposite page.

Centre of gravity _____

_____

_____

Centre of gravity and stability _____

_____

_____

_____

Other factor affecting stability _____

_____

_____

_____

Standing on the upper deck _____

_____

_____

_____

Cause of the bus falling over _____

_____

_____

_____

_____ [6]

[Turn over

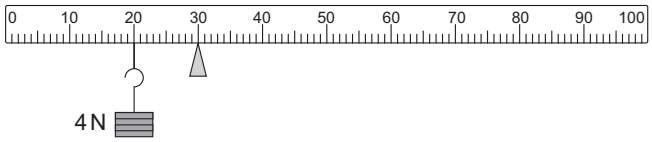
(c) The forces acting on a car of mass 2000 kg are shown in the diagram below.

Source: © Getty Images

The acceleration of the car is 0.4 m/s^2.
Calculate the size of the resistive force.
Show clearly how you get your answer, starting with the equation you plan to use.

Resistive force = _____ N [4]

(d) A uniform metre rule is pivoted at the 30 cm mark.
It is balanced by a 4 N force at the 20 cm mark.

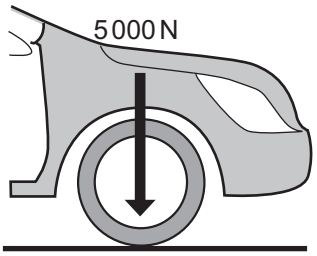


Source: Chief Examiner

Calculate the weight of the metre rule.
Show clearly how you get your answer.

Weight of the metre rule = _____ N [4]

(e) The diagram shows one tyre of a car in contact with the road.
The downward force on the road is 5000 N and the pressure that the tyre exerts on the road is 2.5×10^5 Pa.



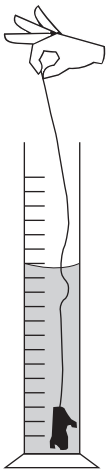
Source: Chief Examiner

Calculate the area of the tyre in contact with the road.
Show clearly how you get your answer, starting with the equation you plan to use.

Area = _____ m^2 [3]

[Turn over

3 **(a)** An experiment is carried out by a student to find the density of a metal.
The metal object to be used has an irregular shape.



Source: Chief Examiner

(i) Briefly describe how the student would accurately measure the volume of water in the measuring cylinder.

_____

_____ [1]

(ii) The metal object is placed in a measuring cylinder which initially contained 220 cm^3 of water. The metal object has a volume of 28 cm^3.
What would the reading on the measuring cylinder be after the metal object is added?
Show clearly how you get your answer.

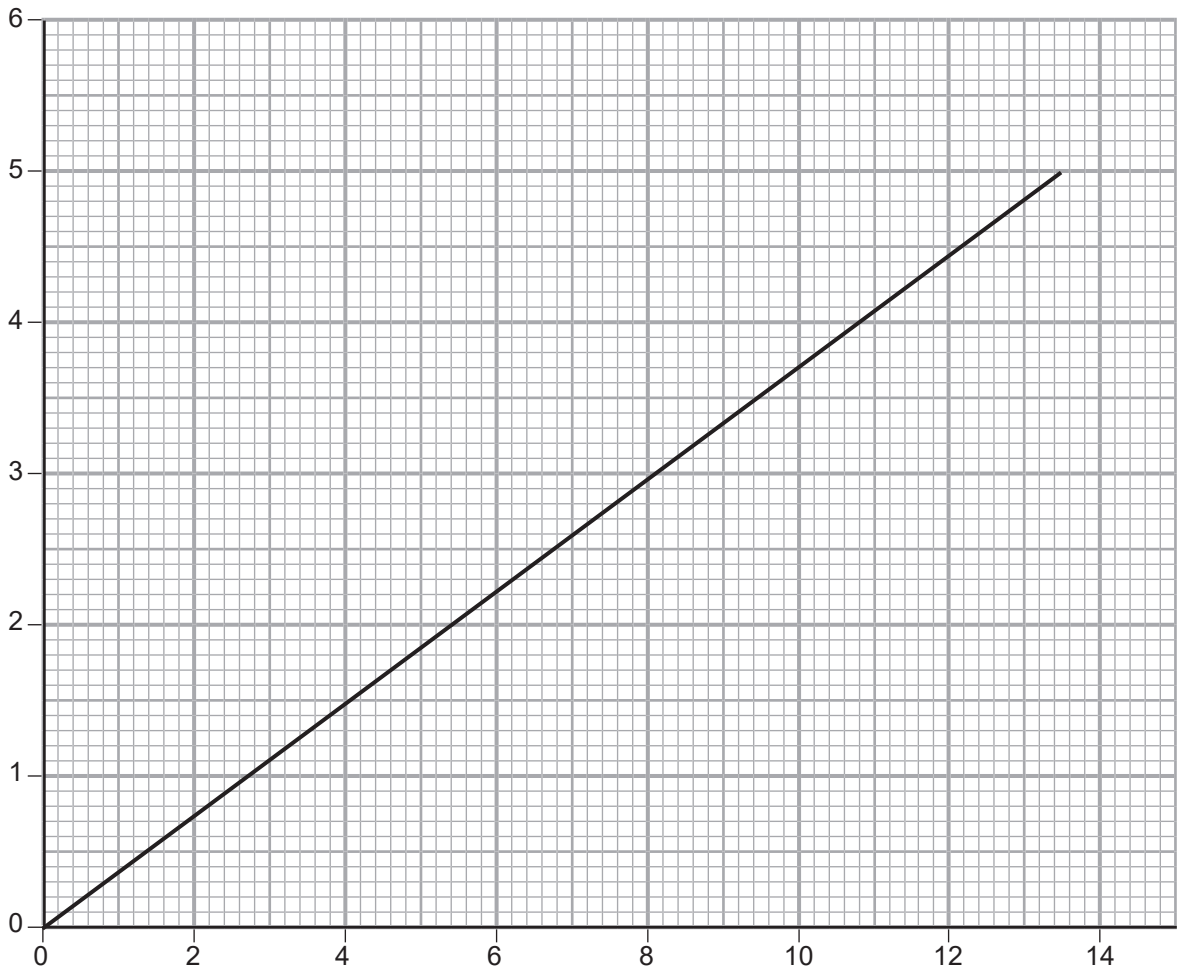
Reading on the measuring cylinder = _____ cm^3 [1]

(iii) The density of the metal is found to be 2.7 g/cm^3.
Using the information in part **(ii)** calculate the mass of the metal object.
Show clearly how you get your answer, starting with the equation you plan to use.

Mass = _____ g [3]

[Turn over

(iv) The graph below shows how the volume of a metal of density 2.7 g/cm^3 varies with mass.
Label each axis with the quantity and unit. [2]



(b) (i) The metal has a density of 2.7 g/cm^3 and water has a density of 1.0 g/cm^3. Use the kinetic theory of matter to explain why water has a lower density than the metal.

_____

_____ [1]

(ii) The kinetic theory describes matter as a large number of particles. The following statements are about the particles that are found in solids, liquids and gases.

In each box, state whether the statement relates to the particles in a solid, a liquid or a gas.

Statement	**Solid, Liquid or Gas**
The particles have large gaps between them and are entirely free to move.	
The particles are mainly touching but have small gaps between them.	
The particles have strong forces between them.	

[3]

[Turn over

4 **(a)** **(i)** The table below lists a number of energy resources.
Tick (✔) the appropriate box to classify them as renewable or non-renewable.

Energy resource	Renewable	Non-renewable
Coal		
Nuclear Fission		
Sunlight		
Geothermal		

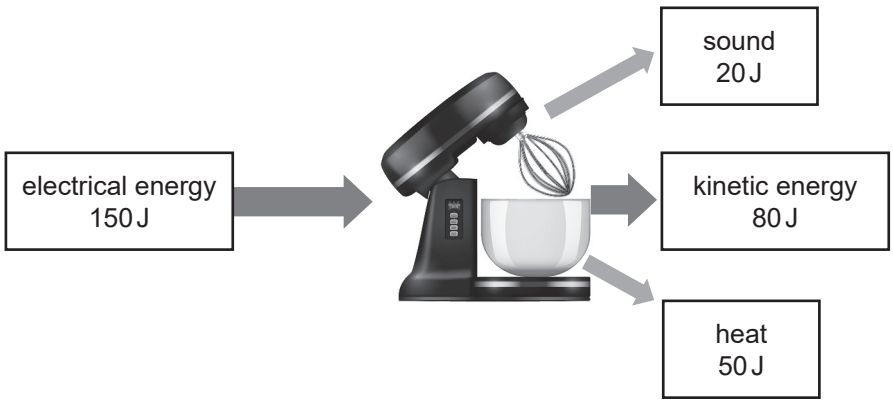
[2]

(ii) In what way does coal pollute the atmosphere? Explain your answer.

_____

_____ [1]

(b) The energy flow diagram for a food mixer is shown below.



Source: © Getty Images

Using the data in the diagram, calculate the efficiency of the food mixer.
Show clearly how you get your answer, starting with the equation you plan to use.

Efficiency = _____ [4]

(c) A car of mass 500 kg is travelling at a velocity of 20 m/s.

Source:
© Getty Images

(i) Calculate the kinetic energy of the car.
Show clearly how you get your answer, starting with the equation you plan to use.

Kinetic energy = _____ J [3]

The driver applies the brakes and brings the car to a stop in 50 m.

(ii) How much work is done by the brakes in stopping the car?

Work done = _____ J [1]

(iii) The car has a brake on each of its four wheels.
Calculate the average force provided by **each** brake in stopping the car.
Show clearly how you get your answer, starting with the equation you plan to use.

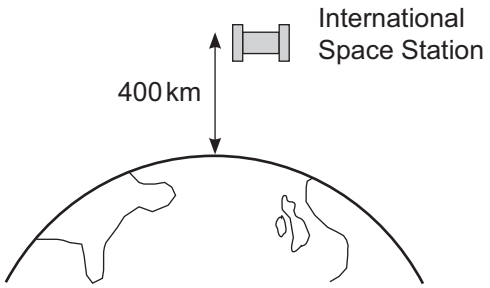
Average force = _____ N [4]

(iv) What two forms of energy is the kinetic energy of the car changed into while braking?

_____ and _____ [1]

[Turn over

(d) The International Space Station orbits the Earth at a distance of 400 km.



Source: Chief Examiner

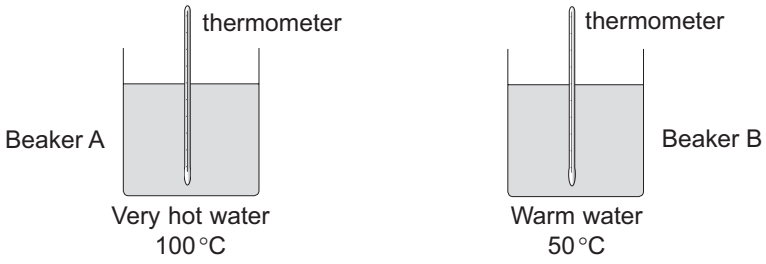
(i) The International Space Station has a mass of 4.2×10^5 kg.
Show that the gravitational potential energy of the International Space Station is 1.68×10^{12} J.
Assume the acceleration of free fall is the same at a height of 400 km as it is on the surface of the Earth.
Show clearly how you get your answer, starting with the equation you plan to use.

[3]

(ii) The International Space Station is regularly supplied by rockets.
When a supply rocket reaches the Space Station it has a potential energy of 0.3×10^{11} J and a kinetic energy of 2.0×10^{11} J.
The rocket takes 600 s to reach the Space Station.
Calculate the average power developed by the engines of the supply rocket.
Show clearly how you get your answer, starting with the equation you plan to use.

Average power = _____ W [3]

(e) To investigate how quickly hot water cools, the apparatus shown below was used. Each identical beaker contains the same volume of water. The initial temperature of the water in one beaker was 100 °C and in the other beaker the initial temperature was 50 °C. The temperature of the water in each beaker was recorded at one-minute intervals for five minutes.
The graphs below show the results of the investigation.



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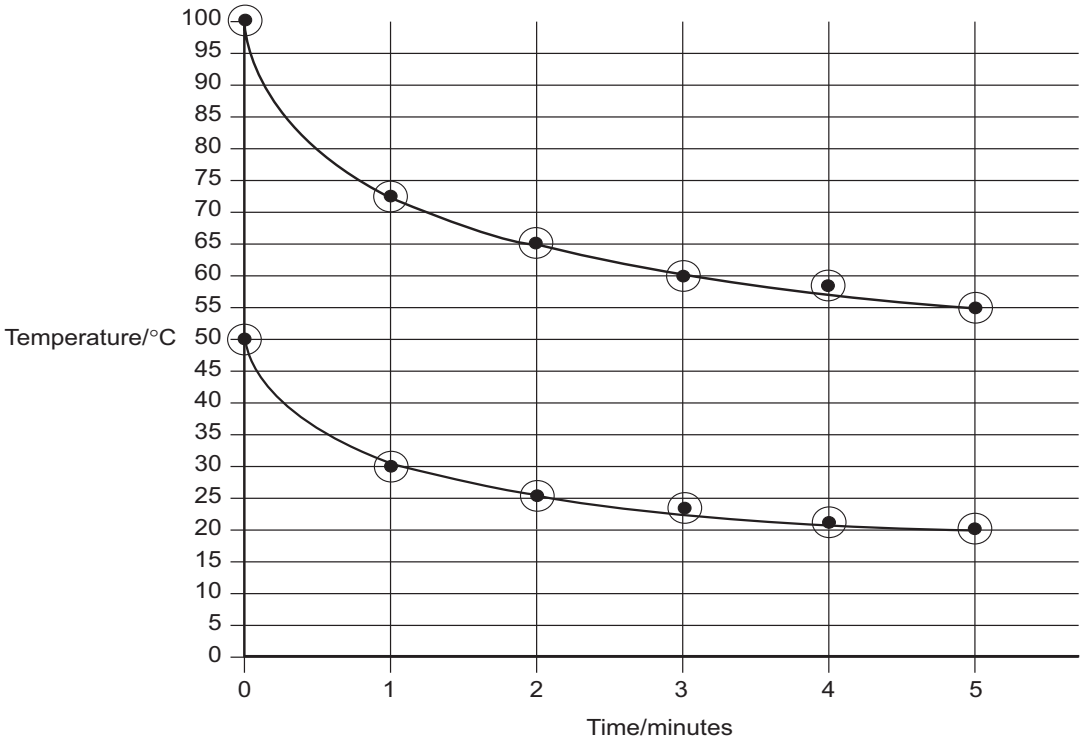

Which beaker has cooled more quickly in the 5 minutes?
Support your answer with two appropriate calculations.

Beaker _____

Calculation 1. _____

Calculation 2. _____ [2]

[Turn over

5 **(a)** Radiocarbon dating is a method for determining the age of a wooden object.
All wood contains an isotope of carbon which is radioactive.

(i) Complete the decay equation for this isotope of carbon.
Write the appropriate numbers and symbol in the boxes provided.

$$^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + \square\ \square \qquad [3]$$

(ii) A piece of wood from an ancient spear has an activity of 4 disintegrations per minute recorded due to the decay of this isotope of carbon.
A fresh piece of wood of the same mass has an activity of 32 disintegrations per minute. This is also due to the decay of this isotope of carbon.
The half-life of this isotope of carbon is 5730 years.
Calculate the age of the wood from the ancient spear.
Show clearly how you get your answer.

Age of the wood from ancient spear = _____ years [3]

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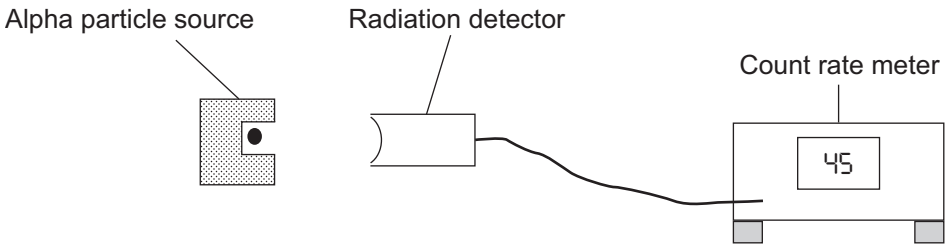
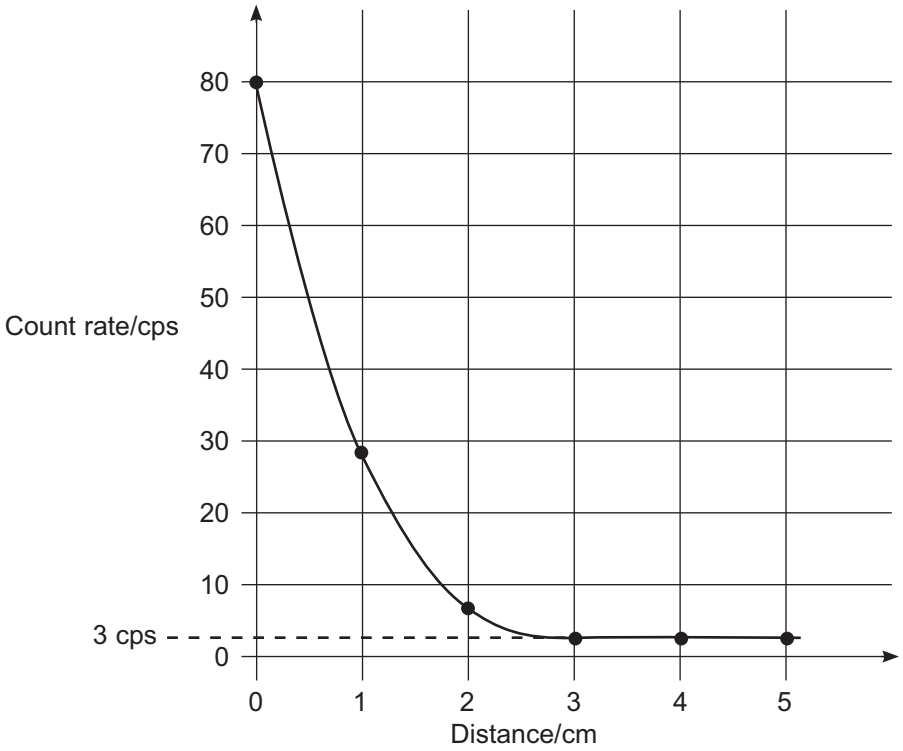
[Turn over

(b) The range of alpha particles in air may be investigated using the equipment shown below.



Source: Chief Examiner

The distance between the alpha source and the radiation detector is changed. The reading on the count rate meter is noted in counts per second (cps) for each distance.
A graph of the count rate against the distance was plotted as shown below.



You will notice that the graph never shows a reading of less than 3 cps.

(i) What name is given to this constant reading?

_____ [1]

(ii) What is the source of this constant reading?

_____

_____ [1]

(iii) Using the graph, estimate the range of the alpha particles in air.

Range = 0 cm to _____ cm [1]

(c) Nuclear radiation can present danger to living organisms.
Explain why nuclear radiation is dangerous to living cells and state what damage it can cause.

_____

_____

_____

_____ [2]

[Turn over

(d) Nuclear fusion is a possible source of energy for the future.

(i) The nuclei of which three isotopes could be used as fuel in a fusion reactor?

_____

_____

_____ [3]

(ii) We have an almost limitless supply of fusion fuel here on earth. Where can it be found?

_____ [1]

(iii) Name the element that is the major by-product of nuclear fusion.

_____ [1]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
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Examiner Number