FORM TP 2023026

TEST CODE **01238020**

JANUARY 2023

CARIBBEAN EXAMINATIONS COUNCIL

CARIBBEAN SECONDARY EDUCATION CERTIFICATE® EXAMINATION

PHYSICS

Paper 02 – General Proficiency

2 hours 30 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in TWO sections. Answer ALL questions.
2. Write your answers in the spaces provided in this booklet.
3. Do NOT write in the margins.
4. Where appropriate, ALL WORKING MUST BE SHOWN in this booklet.
5. You may use a silent, non-programmable calculator to answer questions, but you should note that the use of an inappropriate number of significant figures in answers will be penalized.
6. If you need to rewrite any answer and there is not enough space to do so on the original page, you must use the extra lined page(s) provided at the back of this booklet. **Remember to draw a line through your original answer.**
7. **If you use the extra page(s) you MUST write the question number clearly in the box provided at the top of the extra page(s) and, where relevant, include the question part beside the answer.**

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SECTION A

Answer ALL questions.

1. (a) Define the 'period of a simple pendulum'.

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(2 marks)

(b) Table 1 shows the results of an experiment to find the relationship between the length of a string, l, and the period of the pendulum, T.

TABLE 1: LENGTH OF STRING, l, AND CORRESPONDING PERIOD VALUES OF A SIMPLE PENDULUM, T

Length of String, l (m)	Period, T (s)	Period^2, T^2 (s^2)
0.15	0.77	
0.25	0.99	
0.35	1.15	
0.45	1.34	
0.55	1.48	
0.65	1.62	
0.75	1.75	

(i) State the independent (manipulated) variable in this experiment.

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(1 mark)

(ii) Complete Table 1 by inserting the Period^2, T^2 values in Column 3. **(4 marks)**

(iii) Using the grid provided in Figure 1 **on page 5**, plot a graph of Period^2, T^2 versus length, l. **(8 marks)**

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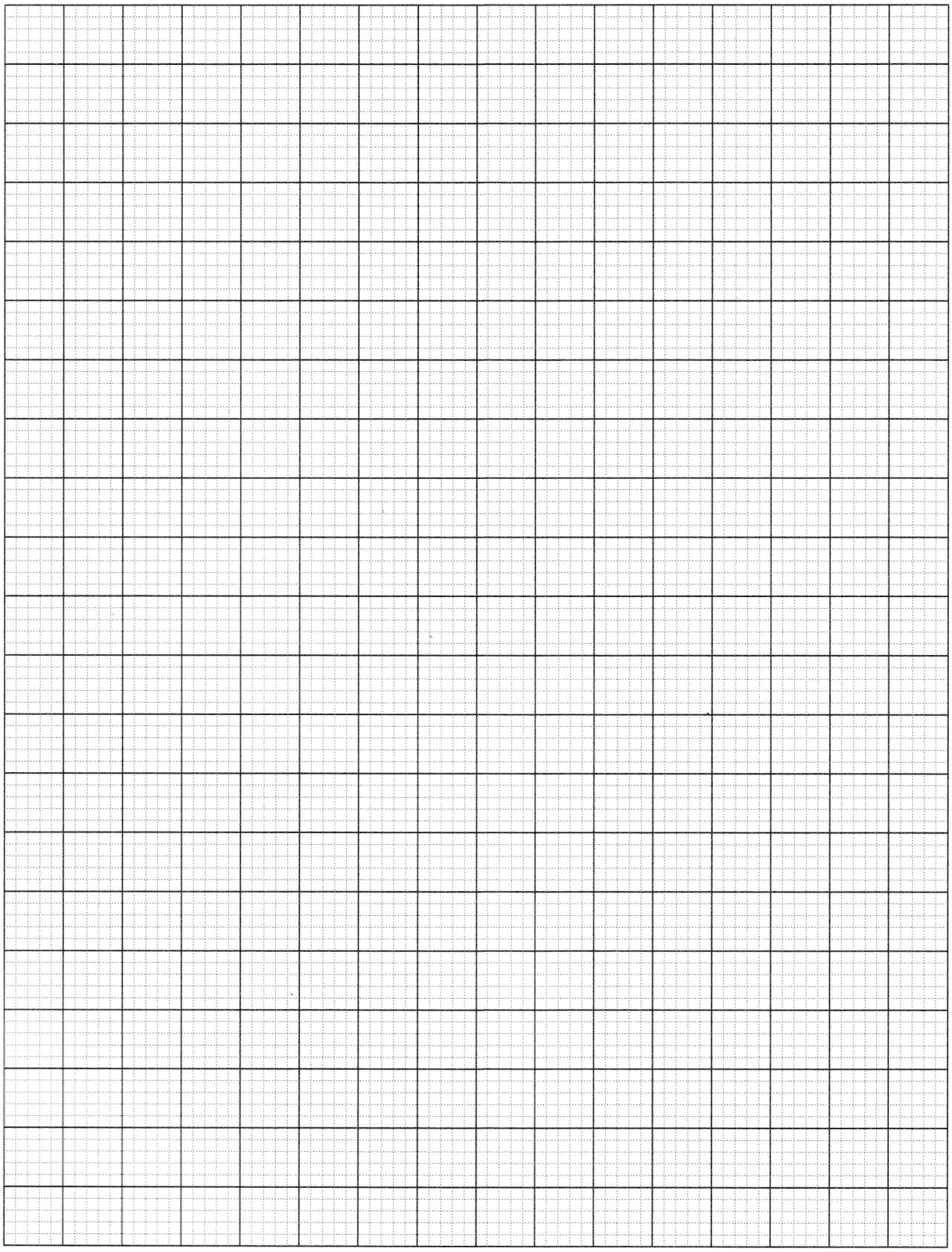

Figure 1. Graph of Period^2, T^2 versus length, l

(c) Calculate the gradient, S, of the graph **on page 5**.

(6 marks)

(d) Given that $S = 4\pi^2 / g$, calculate the acceleration due to gravity, g.

(4 marks)

Total 25 marks

2. (a) Complete the following statements by filling in the blanks with the correct word or phrase.

(i) The formula for pressure is given by ..... .

Its SI unit is ..... or ..... .

(ii) In fluids, pressure at all points on the same horizontal level is .....

..... and pressure increases as the

..... increases.

(iii) An object will float in a fluid when the .....

on the object is equal to the ..... of the object.

(7 marks)

(b) Figure 2 shows a shipwreck which is fully submerged at the bottom of the Caribbean Sea. The liquid pressure on the top surface of the shipwreck is 430 kPa.

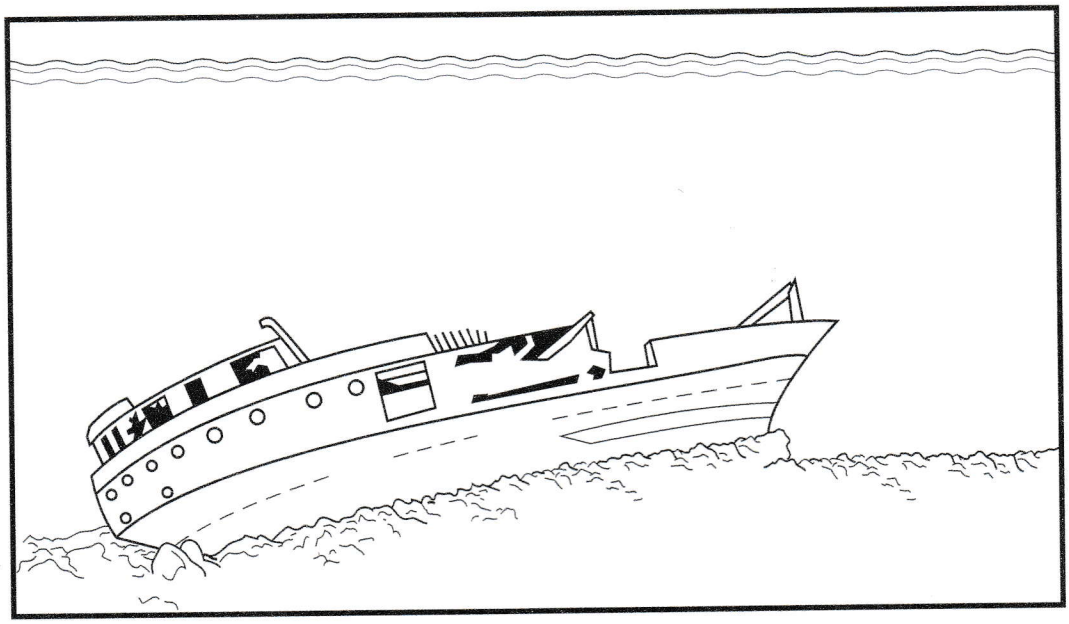

Figure 2. Shipwreck submerged in the Caribbean Sea

(i) Calculate the depth of the shipwreck below the surface of the sea, given that $g = 10$ N kg^{-1}, atmospheric pressure is 100 kPa and the density of sea water is 1025 kg m^{-3}.

(4 marks)

(ii) Calculate the total pressure on the top surface of the shipwreck.

(1 mark)

(iii) A hatch door on the top surface of the shipwreck has an area of 0.60 m^2.

Calculate the downward force on the hatch door due to the **total** pressure on the top surface of the shipwreck.

(3 marks)

Total 15 marks

3. Figure 3 shows the section of a white plastic pipe through which water is flowing. The water in the pipe is heated by the sun.

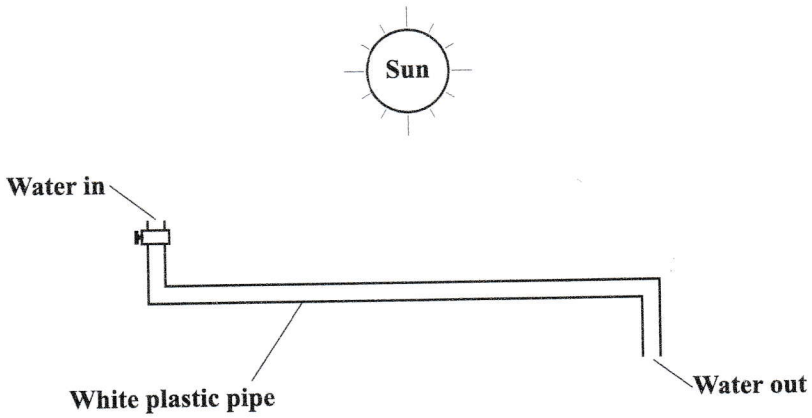

Figure 3. Device for heating water

(a) (i) Describe how thermal energy is transferred from the sun to the water inside the pipe.

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(2 marks)

(ii) Suggest TWO ways in which the efficiency of the thermal energy absorbed by the water in the pipe may be increased.

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(2 marks)

(b) Rachelle used a metal spoon to stir a hot liquid in a cup as shown in Figure 4.

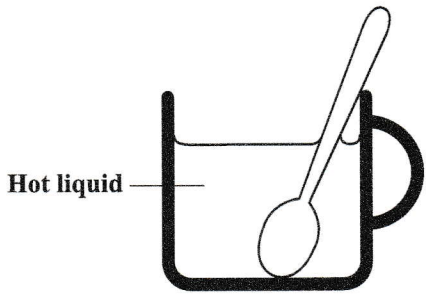

Figure 4. Metal spoon in a cup containing a hot liquid

(i) After a short time, Rachelle observed that the metal spoon felt hot. Describe the TWO ways in which thermal energy is conducted through the metal spoon at the molecular level.

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(3 marks)

(ii) The metal spoon was replaced by a wooden spoon. Rachelle observed that the wooden spoon did not feel hot. Explain why the wooden spoon did not feel hot.

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(2 marks)

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(c) A thermometer is placed in a plastic cup containing 200 g of water and gives a reading of 22 °C. Small pieces of ice at 0°C are added to the water one by one. The mixture is stirred after each addition until the ice melts. The process was repeated until the temperature recorded by the thermometer was 0 °C. The total mass of ice added to the water was 60 g.

(i) Calculate the thermal energy lost by the original volume of water in the beaker, given that the specific heat capacity of water is 4.2 J g^{-1} $°C^{-1}$.

(3 marks)

(ii) Assume that all the thermal energy lost by the original volume of water in the beaker is transferred to the ice. Calculate the specific latent heat of fusion of ice.

(3 marks)

Total 15 marks

SECTION B

Answer ALL questions.

4. (a) Name the electromagnetic waves in EACH of the regions labelled A, B and C in the electromagnetic spectrum shown in Figure 5.

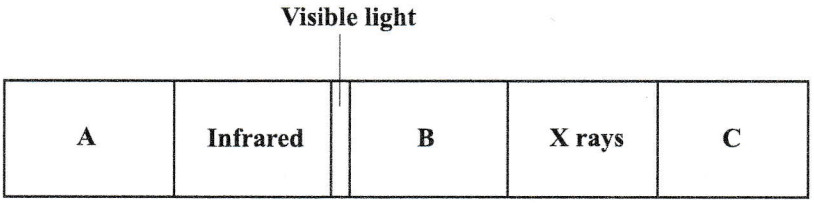

Figure 5. Electromagnetic Spectrum

A .....

B .....

C .....

(3 marks)

(b) Figure 6 represents some wavefronts approaching a barrier with a narrow gap, which is smaller than the wavelength of the wave. On Figure 6, draw THREE wavefronts after they have passed through the narrow gap.

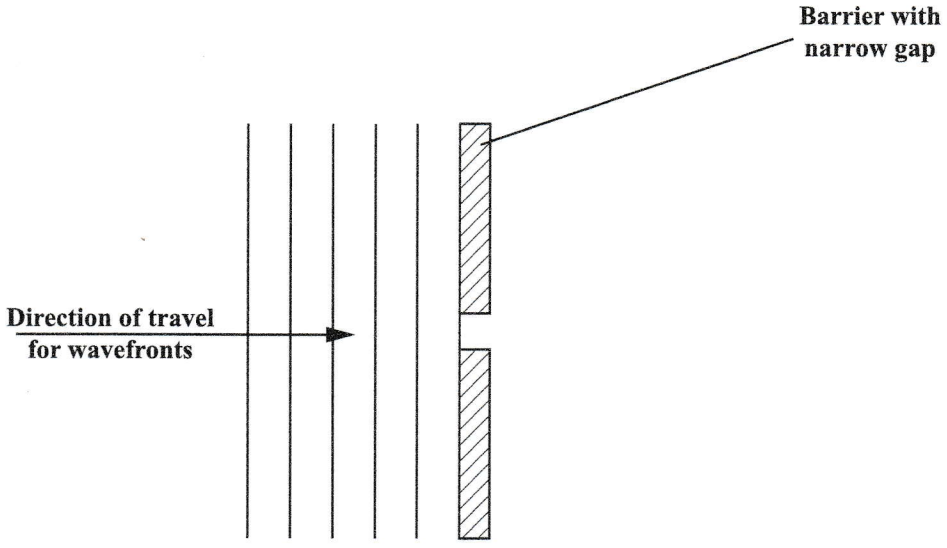

Figure 6. Wavefronts approaching a barrier with a narrow gap

(2 marks)

(c) Define the term 'refractive index' of glass.

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(3 marks)

(d) Figure 7 shows a ray of red light incident on the face XY of a glass prism at point S. The path of the ray is shown in the diagram. The refractive index, n, of the glass for red light is 1.5.

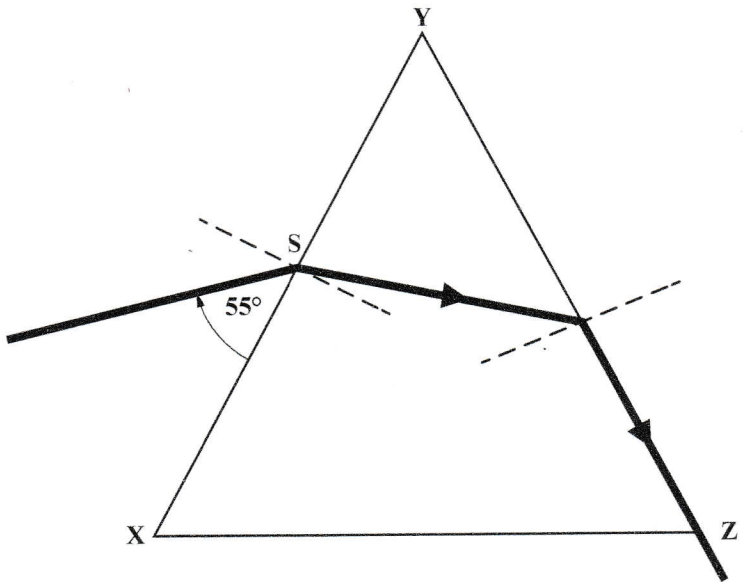

Figure 7. Ray of red light passing through a glass prism

(i) Calculate the angle of refraction in the glass at S.

(3 marks)

(ii) Calculate the critical angle, c, for glass to air.

(3 marks)

(iii) Identify the critical angle, c, in Figure **7 on page 14**. **(1 mark)**

Total 15 marks

5. (a) Define the term 'electric field'.

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(2 marks)

(b) (i) Figure 8 shows a positively charged sphere which is attached to an insulated stand. Draw arrows to indicate the pattern and direction of the electric field in the region surrounding the sphere.

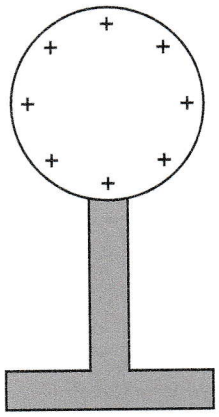

Figure 8. Positively charged sphere

(2 marks)

(ii) A smaller, uncharged metal sphere, Q, is suspended by a cotton thread and brought close to the positively charged sphere as shown in Figure 9.
Draw the distribution of charge on Sphere Q.

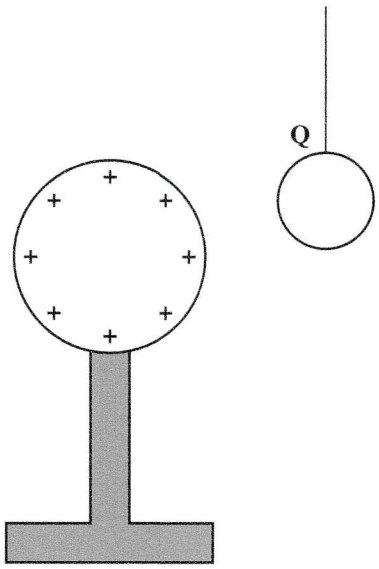

Figure 9. Positively charged sphere and metal sphere, Q

(2 marks)

(iii) An earth wire was briefly brought into contact with Sphere Q, as shown in Figure 10, and then removed.

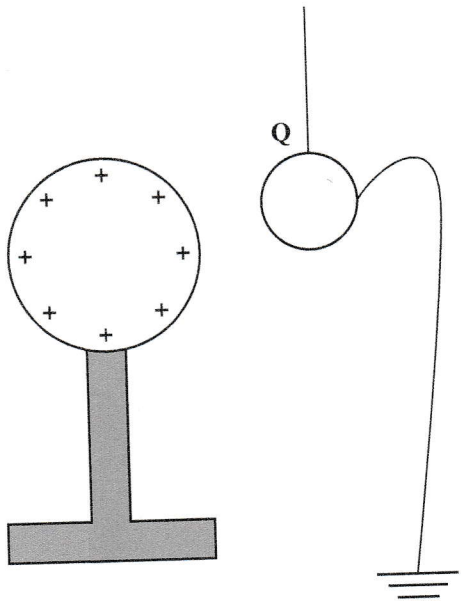

Figure 10. Positively charged sphere and metal sphere, Q, with earth wire

Describe what happens in the wire and state the final charge on Q.

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(2 marks)

(c) (i) The battery in an electric car can be charged by passing a current of 11 A through it. Calculate the charge stored in the battery after 8 hours.

(4 marks)

(ii) Calculate the resistance of the battery given that the voltage used is 220 V.

(3 marks)

Total 15 marks

6. (a) Complete Table 2 by inserting the types of radioactive emissions and their properties.

TABLE 2: RADIOACTIVE EMISSIONS AND PROPERTIES

Radioactive Emissions	Properties		
	Nature	Range in Air	Stopped By
.....	Electromagnetic radiation	Several kilometres	.....
.....	Helium nucleus	.....	1 sheet of paper
.....	Electron	A few metres	.....

(3 marks)

(b) Define the term 'isotopes'.

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(3 marks)

(c) The structure of the atom of an element Y, showing the number of neutrons (n), protons (p) and electrons (e), is represented in Figure 11.

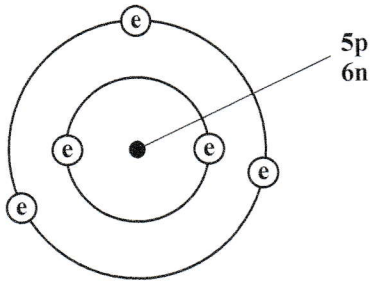

Figure 11. Structure of atom of Element Y

(i) State the mass number and atomic number of this atom.

Mass number .....

Atomic number .....

(2 marks)

(ii) Write the symbol for another possible isotope of Element Y.

.....

(1 mark)

(d) (i) A polonium-210 nucleus decays by α-particle emission to a lead (Pb) nucleus. Complete the equation for the decay of polonium-210.

$$^{210}_{84}\text{Po} \rightarrow$$

(3 marks)

(ii) Polonium-210 has a half-life of 138 days. At a certain time, a sample contains 6.4×10^6 polonium nuclei. Calculate the number of polonium nuclei remaining after 552 days.

(3 marks)

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.