BOON LAY SECONDARY SCHOOL

PRELIMINARY EXAMINATION

2024

Name	**( )**
Class	

Subject	:	**PHYSICS**
Paper No	:	**2**
Subject Code	:	**6091/02**
Level	:	**SECONDARY FOUR EXPRESS**
Date/Day	:	**23 AUGUST 2023 (FRIDAY)**
Time	:	**1030 – 1215**
Duration	:	**1 HOUR 45 MINUTES**

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A

Answer **all** questions.

1 Fig. 1.1 shows a container ship dragging its anchor in the sea while sailing forward.

The anchor has a mass of 3000 kg and is made of cast-iron (density = 6900 kg m^{-3}).

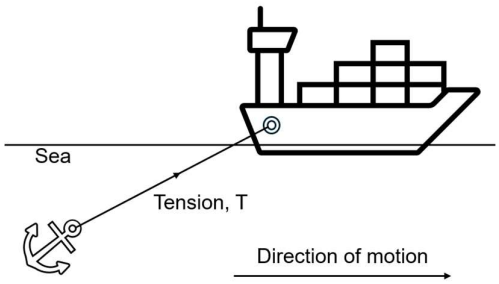

Fig. 1.1

(a) The density of sea water is 1020 kg m^{-3}. Calculate the mass of sea water displaced by the anchor when it is in the sea.

mass of sea water displaced by the anchor = ... [2]

(b) The anchor experiences a horizontal drag force of 40 kN while sailing.
By means of a scaled vector drawing, determine the tension, T, on the chain pulling the anchor.
scale: .....

tension, T = ... [3]

[Total: 5]

2 The autonomous robot shown in Fig. 2.1 is travelling in a straight line.

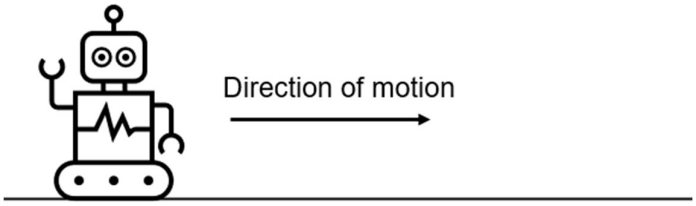

Fig. 2.1

Fig. 2.2 shows the velocity-time graph of the robot over a 10 s period.

(a) Complete the displacement-time graph for the same robot on Fig. 2.2.
Include labels for appropriate points.

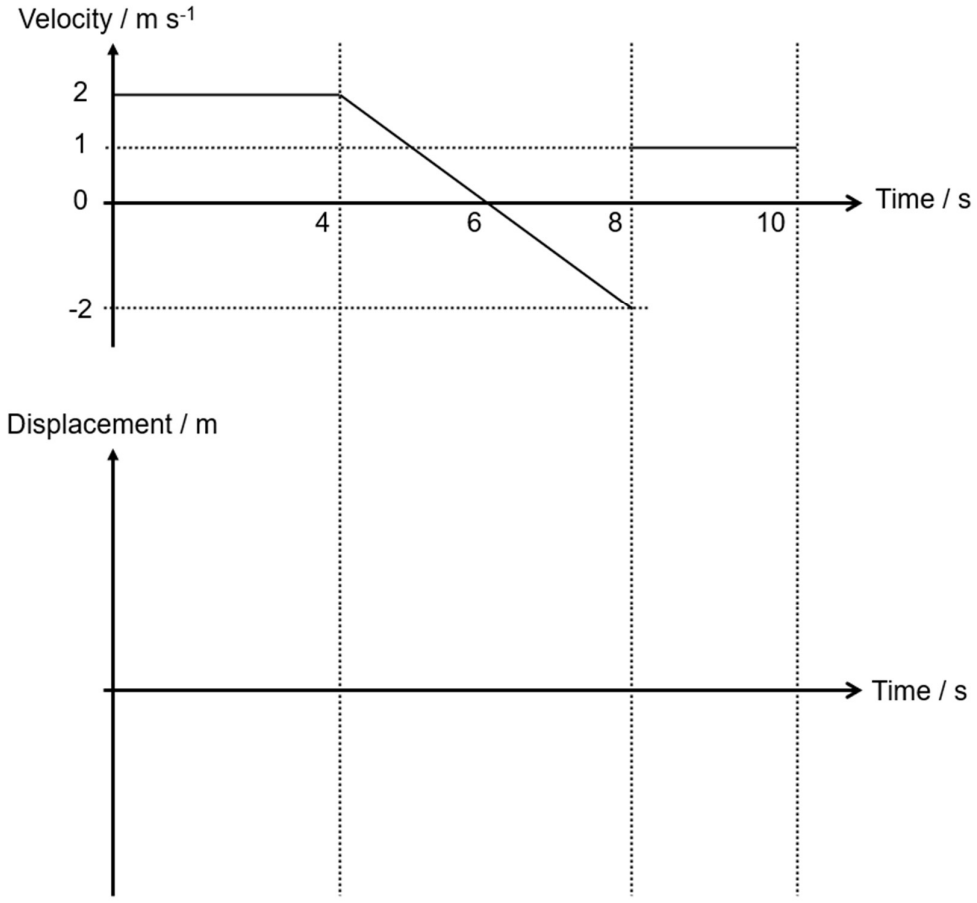

Fig. 2.2

[3]

(b) Calculate the acceleration of the robot between 4 s to 8 s.

acceleration = ... [1]

(c) Fig. 2.3 shows the path of the robot as it navigates a right turn.

The robot moves at a constant speed of 2 m s^{-1} while navigating the turn.

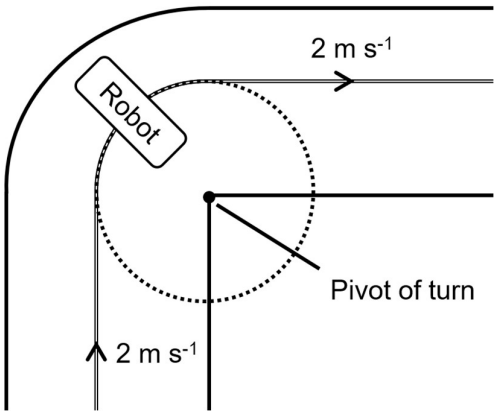

Fig. 2.3

Using information provided in Fig. 2.3, explain if the robot is accelerating while making the right turn.

……

……

……

…… [2]

[Total: 6]

3 Fig. 3.1 shows a set of caliper brakes used on bicycles.

To engage the brakes, a pulling force is applied on a cable (Part 1).

This action pulls the arms upwards (Part 2), which in turn closes the brake pads on the wheel (Part 3).

Fig. 3.2. provides additional information on the dimensions and lines of action of forces on the caliper brakes.

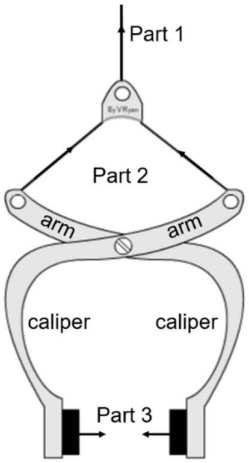

Fig. 3.1

(a) F_2 needs to be at least 400 N to stop the bicycle safely.
The contact area of a brake pad with the wheel is 0.0003 m^2.

Using information given in Fig. 3.2, calculate the pressure applied on the wheel by F_2.
Give your answer in pascals.

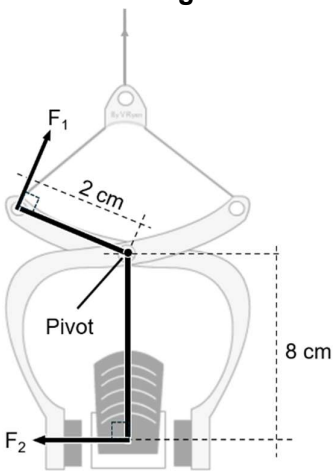

Fig. 3.2

pressure = ... [1]

(b) State the principle of moments for a body in equilibrium.

.....

.....

..... [2]

(c) Calculate the value of F_1.

F_1 = ... [2]

(d) With reference to the spinning wheel on a bicycle that is in motion, explain the changes in energy stores when the brakes are engaged to slow the bicycle.

……

……

……

…… [1]

[Total: 6]

4 Recreational scuba diving certifications allow divers to descend to depths of 18 m or deeper with the use of specialised equipment and training.

The densities of seawater and mercury are 1030 kg m^{-3} and 13600 kg m^{-3} respectively.
Standard atmospheric pressure (1 atm) is defined as 101.3 kPa.

(a) A mercury manometer is commonly used to measure atmospheric pressure.
Calculate the height of the mercury column at the surface of the sea.

height of mercury column = …….. [1]

(b) Calculate the total pressure a diver experiences at 18 m underwater.

total pressure = …….. [2]

(c) A diver exhales and releases a bubble at 18 m underwater. Assuming the temperature of the seawater at 18 m underwater is the same as the surface, predict what can be observed of the bubble as it rises towards the surface.

……

……

…… [1]

(d) While resurfacing from a dive, divers need to make decompression (deco) stops to allow air bubbles to escape from the body or risk injuries like severe pain, paralysis or even death. Explain why decompression stops are necessary.

……

……

……

…… [2]

[Total: 6]

5 In the day, energy from the Sun causes 1000 kg of sand at a beach to heat up by 3 °C. The specific heat capacities of sand and water are 4000 J kg^{-1} $°C^{-1}$ and 800 J kg^{-1} $°C^{-1}$ respectively.

(a) With reference to sand, define the term “specific heat capacity”.

……

……

…… [2]

(b) The same amount of energy that raised the temperature of the sand by 3 °C is absorbed by 10000 kg of water. Calculate the change in temperature of the 10000 kg of water.

change in temperature = …… [2]

(c) Using Fig. 5.1 below, explain how a breeze is formed in the day.

You may sketch on Fig. 5.1.

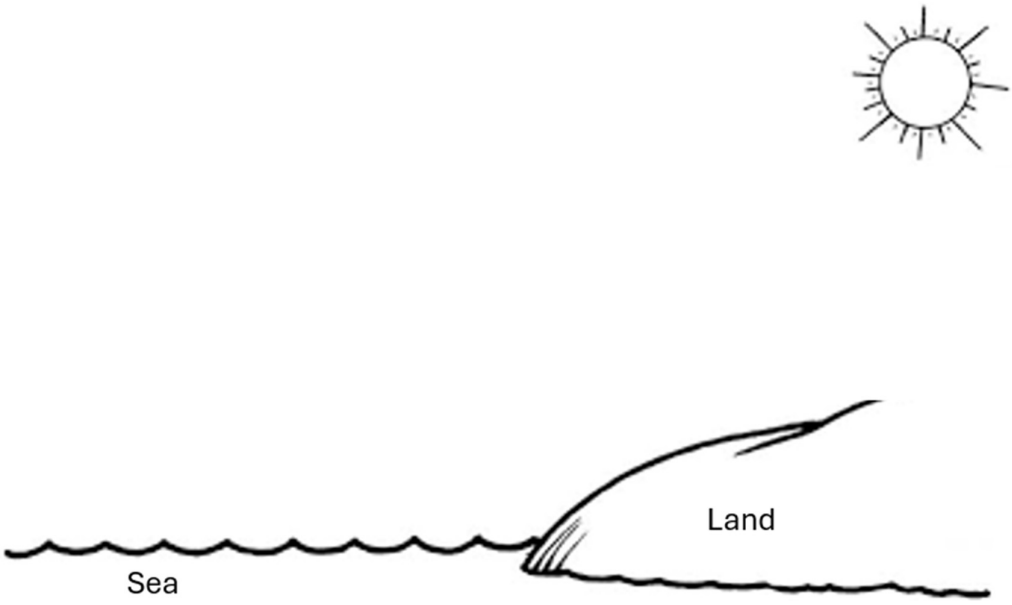

Fig. 5.1

……

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……

……

…… [3]

[Total: 7]

6 The Sun in our galaxy is a star that produces both heat and light energy by means of nuclear fusion.

(a) What is “nuclear fusion”?

……

……

…… [2]

(b) Electromagnetic (EM) waves produced by the Sun takes 8.5 minutes to reach Earth. Calculate the distance between the Sun and Earth. Give your answer in giga-meters.

distance between the Sun and Earth = …… [2]

(c) EM waves like X-rays are ionising waves. Explain what “ionising waves” are and give another example of an ionising wave, and its usage in a beneficial setting.

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……

…… [3]

(d) Explain why the constant explosions on the Sun cannot be heard on Earth.

……

……

……

…… [2]

[Total: 9]

7 Converging lenses are used to make magnifying glasses that magnify images of objects.

(a) What are converging lenses?

……

……

…… [1]

(b) Other than being larger, list one other property of images produced by magnifying glasses.

……

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…… [1]

(c) Complete the ray diagram in Fig. 7.1 to locate the image of the object through a thin converging lens. Label your diagram clearly.

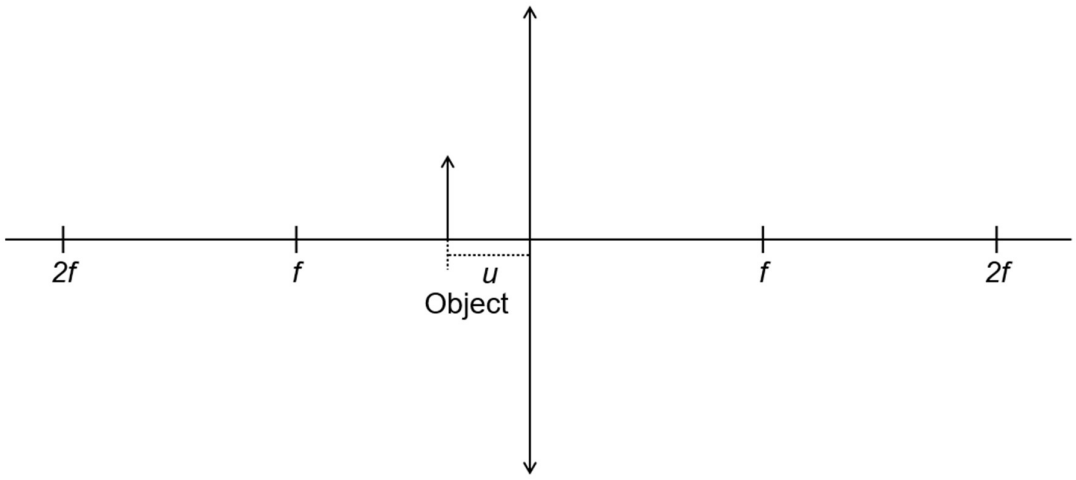

Fig. 7.1

[3]

(d) What will happen to the image of the object if the magnifying glass is brought closer to the object?

…… [1]

[Total: 6]

8 **(a)** A silk cloth is rubbed against a glass rod several times. The glass rod is then observed to repel a positively charged gold foil.

Explain how the glass rod could have become charged.

……

……

……

…… [2]

(b) **(i)** Describe an example where electrostatic charging is a potential hazard.

……..

……..

……..

…….. [2]

(ii) Suggest a solution to mitigate the hazard mentioned in **(b)(i)**.

……..

……..

…….. [1]

[Total: 5]

9 An experiment is conducted to determine the electrical properties of a filament lamp, a resistor, and a thermistor.

In each experiment, one of the three components is placed in position P and readings on the ammeter and voltmeter are recorded.

Fig. 9.1 shows the circuit used to obtain the readings, and Fig. 9.2 is a graph of the readings obtained.

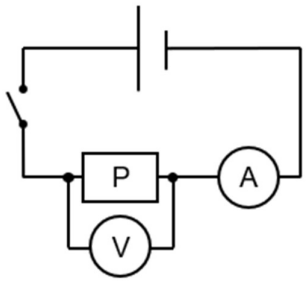

Fig. 9.1

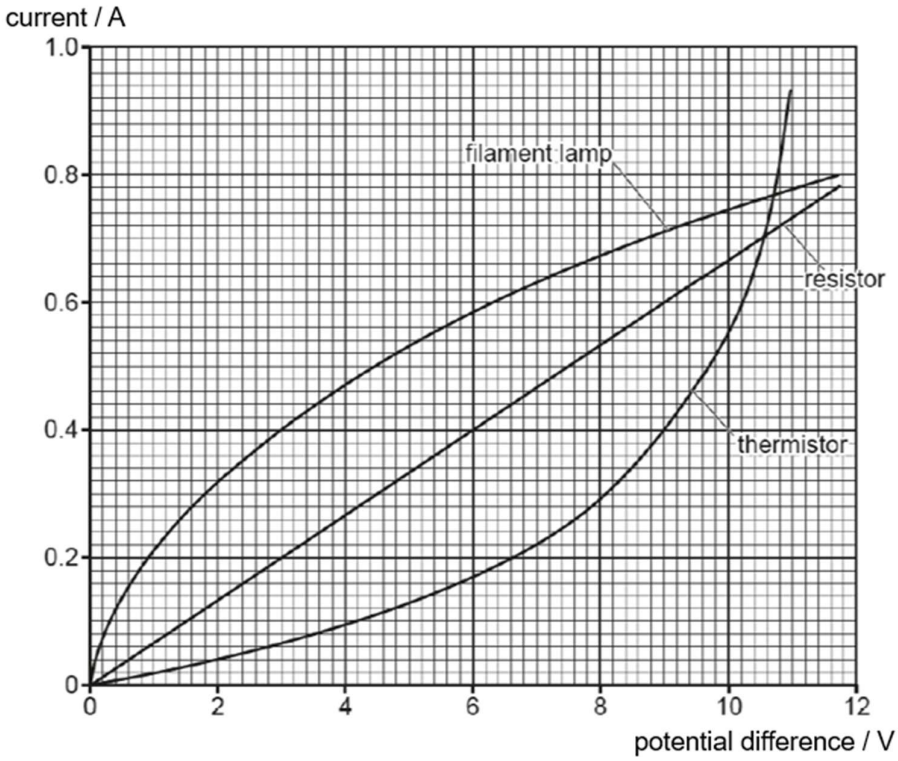

Fig. 9.2

(a) Based on information from Fig. 9.2, describe how the resistance of the filament lamp and the thermistor changes as potential difference (p.d.) changes.

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……

…… [2]

(b) A student claims that the thermistor and filament lamp have the same resistance when a p.d. of 10.7 V is applied across them as their graphs intersect.
Comment on the accuracy of the student's claims.

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……
……
……
…… [2]

(c) The resistor, the thermistor and the filament lamp are all connected in series and connected with a direct current (d.c.). power supply.
Using the graph in Fig. 9.2, determine

(i) the electromotive force of the power supply when the p.d. across the resistor is 8.0 V.

electromotive force = …… [3]

(ii) the total resistance in the circuit.

total resistance = …… [2]

(d) Using suitable example(s) from Fig. 9.2, explain what is an ohmic conductor.

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…… [2]

[Total: 11]

10 Fig. 10.1 shows two circuits used in an electrical motor.

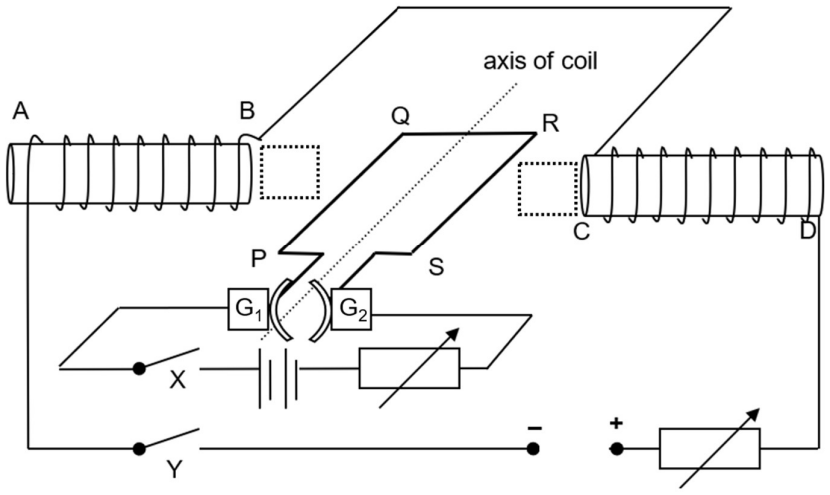

Fig. 10.1

(a) On Fig. 10.1, label

(i) the poles at B and C when switch Y is closed. [1]

(ii) the direction of current at QP and RS when switch X is closed. [1]

(b) State the direction that PQRS will rotate in. Explain the reason for its motion and the direction of the motion.

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…… [4]

(c) Identify and explain the function of G_1 and G_2.

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…… [2]

(d) Suggest one modification to increase the speed of rotation of PQRS.

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…… [1]

[Total: 9]

Section B

Answer **one** question from this section.

11 Information about several radioactive isotopes is given in Table 11.1.

Table 11.1

	Nuclide	Half-life / years	Decay mode
P	$^{14}_{6}C$	5715	β^-
Q	$^{239}_{94}Pu$	24110	α
R	$^{40}_{19}K$	1.248 x 10^9	β^-

(a) Identify nuclide P and why it is considered an isotope.

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……
……
…… [2]

(b) Write a balanced equation in nuclide notation for nuclide Q as it undergoes nuclear decay.

……
…… [2]

(c) Using nuclide R as an example, explain the term “half-life”.

……
……
……
…… [2]

(d) A Geiger counter is a device used to measure ionising nuclear radiation.

(i) State the SI unit of radioactivity and what one unit represents.

……..
……..
……..
…….. [2]

(ii) With reference to how signals are received, explain how Geiger counters differ from a microphone used by a singer.

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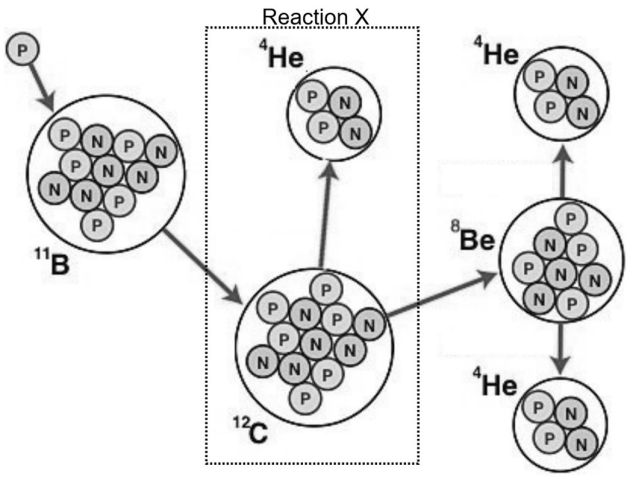
…… [2]

[Total: 10]

12 Fig. 12.1 shows a reaction chain reaction commonly used in rocket fuel for spacecrafts.



Adapted from: https://ntrs.nasa.gov/api/citations/20110014263/downloads/20110014263.pdf

Fig. 12.1

(a) Boron-11 is considered stable whereas Boron-12 has a half-life of 20.20 milliseconds. Explain the term "half-life" in this context.

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……

……

…… [2]

(b) Explain if this reaction chain is a fusion or fission reaction.

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……

……

…… [2]

(c) Explain if reaction X classifies as an alpha, beta or gamma decay.

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…… [2]

(d) The living quarters of a spacecraft is heavily shielded from most forms of radiation.

(iii) List two types of radiation that a spacecraft might be exposed to in space.

……..

……..

……..

…….. [2]

(iv) Explain why there is a need to shield the living quarters from radiation.

……..

……..

……..

…….. [2]

[Total: 10]