Name ______________________________ (   )   Class ______________

PRELIMINARY EXAMINATION
GENERAL CERTIFICATE OF EDUCATION ORDINARY LEVEL

PHYSICS 6091/02

Paper 2 Theory

21 August 2024

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use highlighters, correction fluid or correction tape.

Section A
Answer **all** questions.

Section B
Section B consist of two questions. Answer **only one** out of these two questions.

Students are reminded that **all** quantitative answers should include appropriate units.
The use of 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.

For Examiner's Use	
Section A (70 Marks)	
Section B (10 Marks)	
Total (80 Marks)	

This document consists of **24** printed pages.

圣尼各拉女校
CHIJ ST NICHOLAS GIRLS' SCHOOL
Girls of Grace · Women of Strength · Leaders with Heart

[Turn over]

Section A (70 marks)
Answer **all** the questions in this section.

1 A firework leaves the ground with an intial velocity of 45 m/s, travelling vertically upwards. When it reaches a height of 100 m, it fails to explode and falls back down the same vertical path to the ground.

At any point on its path, the firework has both a speed and a velocity.

(a) Explain the difference between speed and velocity.

…………………………………………………………………………………

………………………………………………………………………………… [1]

(b) Fig. 1.1 shows the displacement-time graph for the first 5.0 s of the motion.

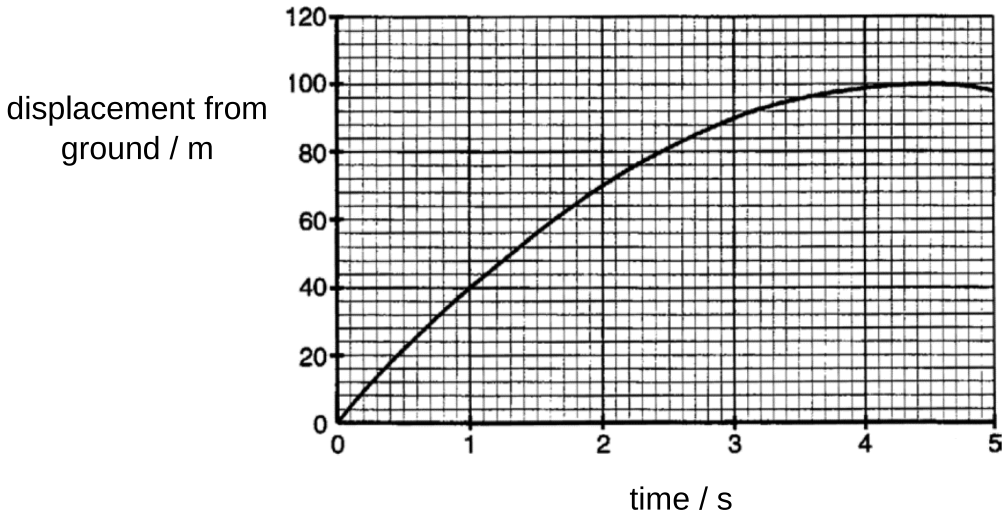


Fig. 1.1

(i) Determine the time taken for the firework to reach the maximum height.

time taken = ……………………… [1]

(ii) Describe the motion of the firework for the first 5.0 s of its journey.

…………………………………………………………………….....

…………………………………………………………………….....

…………………………………………………………………….....

.... [2]

(c) The air resistance acting on the firework is negligble.

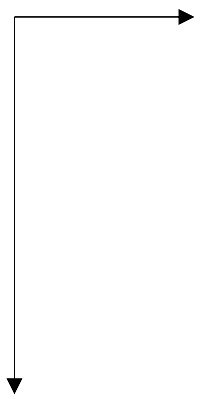
The table below is for the magnitude and direction of the acceleration of the firework. Complete the table. Give the unit for the magnitude of any acceleration that you write down.

	magnitude	direction
as the firework moves upwards		
at maximum height		

[2]

(d) In another situation, the firework falls vertically in a horizontal wind. Fig. 1.2 shows the horizontal and vertical velocity of the firework, drawn to a scale where a length of 1.0 cm represents a speed of 10 m/s.

On Fig 1.2, draw the resultant velocity of the firework. Label it with the letter R and its magnitude. Give your answer to a suitable number of significant figures.



[2]

Fig. 1.2 (to scale)

[total: 8]

2 Fig. 2.1 shows a farmer lifting a barrel of fruit from the ground to a platform.

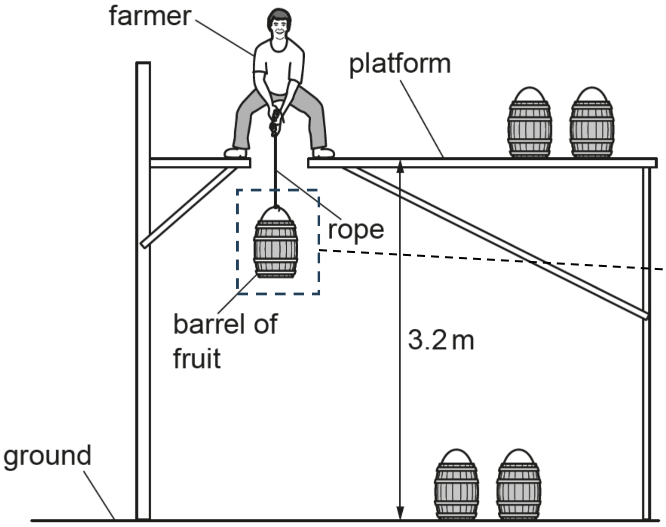


Fig. 2.1

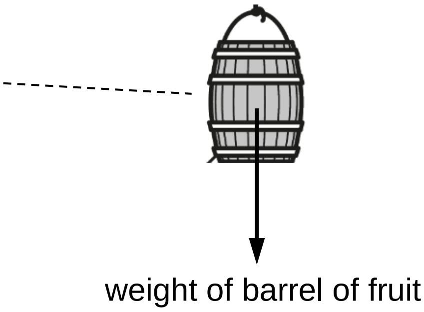


Fig. 2.2

(a) Fig. 2.2 shows an enlarged diagram of the barrel of fruit lifted by the farmer and one of the two forces acting on the barrel.

Describe the force that forms an action-reaction pair with the force drawn in Fig. 2.2.

.... [1]

(b) The farmer lifts the barrel of fruit at a constant speed. The mass of the barrel of fruit is 14 kg.

(i) Calculate the work done on the barrel of fruit in lifting it from the ground to the platform. The gravitational field strength is 10 N/kg.

work done = ... [1]

(ii) Describe the energy transfer as the farmer lifts the barrel of fruit.

…………………………………………………………………………

………………………………………………………………………… [1]

(c) The farmer wants to make the process faster. He buys a machine to lift the barrels of fruit.

(i) The output power of the machine is 75 W.

Calculate the time taken for the machine to lift a barrel of fruit onto the platform.

time taken = ………………. [2]

(ii) When the barrel of fruit is near to the platform, the farmer adjusts the output power and decreases the upward force produced. The barrel decelerates with a value of 0.50 m/s^2.

Calculate the upward force produced by the machine.

upward force = ………………. [2]

[total: 7]

3 Fig. 3.1 shows a pot on a hotplate. The hotplate heats up the pot and water.

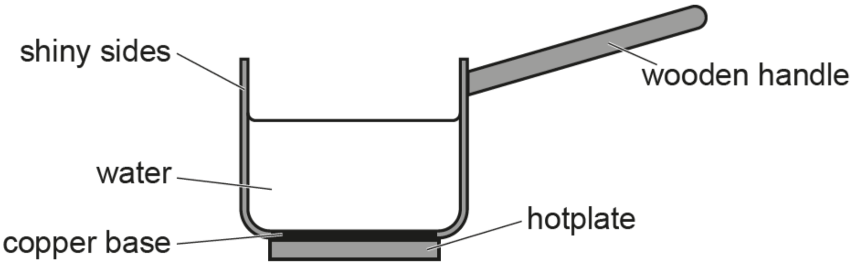


Fig. 3.1

(a) Describe how water is heated by convection.

………………………………………………………………………………

……………………………………………………………………………… [2]

(b) Suggest why

(i) the handle of the pot is made of wood,

………………………………………………………………………………

……………………………………………………………………………… [1]

(ii) the side of the pot is made of a shiny material,

………………………………………………………………………………

……………………………………………………………………………… [1]

(iii) the base of the pot is made of copper.

………………………………………………………………………………

……………………………………………………………………………… [1]

[total: 5]

4 Fig. 4.1 shows a ray of light passing into a right-angled prism at D.
After reaching E, the light travels along two paths, with one ray travelling along the surface of the prism and one ray along EF.

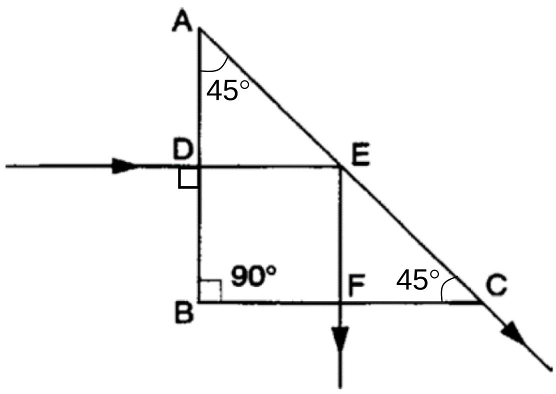


Fig. 4.1

(a) State one property of light that changes at D and whether it increases or decreases.

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(b) **(i)** On Fig.4.1, identify the critical angle and label with letter X. [1]

(ii) Hence, determine the refractive index of this glass.

refractive index = ……………… [2]

(iii) The prism is replaced with another one with a greater refractive index. Describe what happens to the path of light.

…………………………………………………………………………

………………………………………………………………………… [1]

(c) Visible light is a type of electromagnetic wave. All electromagnetic waves transfer energy and travel through vacuum at a speed of 3.0×10^8 m/s.

(i) State one other property common to all components of the electromagnetic spectrum.

.... [1]

(ii) The wavelength of red light is 690 nm.
Calculate the frequency of this wave in vacuum.

frequency = ... [2]

[total: 9]

5 Fig. 5.1 shows the I/V characteristic graph for a filament lamp and a resistor.

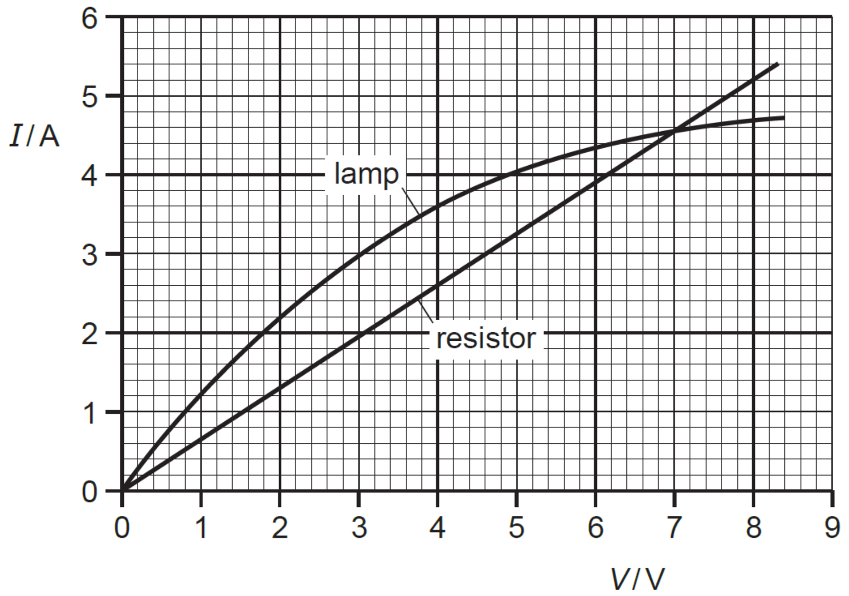


Fig. 5.1

(a) Describe how Fig. 5.1 shows that the resistor obeys Ohm's Law.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(b) State the value of the potential difference where the lamp and the resistor have the same resistance.

potential difference = ………………….. [1]

(c) Another resistor X is made of the same material as the original resistor but is twice as long and has a diameter three times larger.

Calculate the resistance of resistor X.

resistance = ……………………… [2]

(d) Another lamp labelled 6 V, 12 W is connected to a 6 V fully charged battery and it shines at normal brightness for 12 hours.

Calculate the charge that passes through the lamp during this time.

charge = ……………………. [2]

[total: 6]

s

6 Fig. 6.1 shows a circuit with a light-dependent resistor (LDR) and a resistor with fixed resistance of 8.0 kΩ.

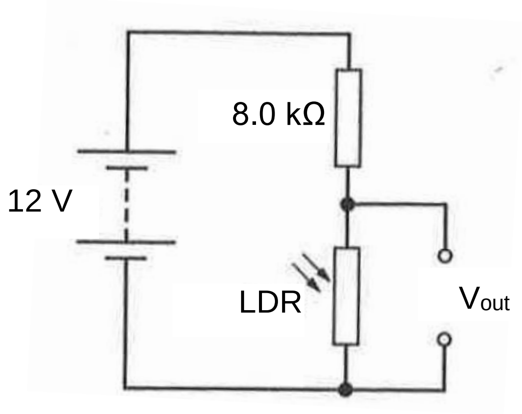


Fig. 6.1

The LDR has a resistance of 600 Ω in bright light.

(a) Calculate the output voltage V_{out} when the LDR is in bright light.

V_{out}= ……………….. [2]

(b) In dim light, V_{out} is 8.0 V. For this level of brightness, determine

(i) the voltage across the fixed resistor,

V = …………………. [1]

(ii) the resistance of the LDR.

resistance = ……………………… [1]

(c) The output is now connected across the resistor. A lamp is connected across the output, and this lamp only switches on when V_{out} is larger than 8.0 V.

Describe and explain the operation of this new device as the level of light changes.

……………………………………………………………………………………......

……………………………………………………………………………………

……………………………………………………………………………………..

…………………………………………………………………………………….. [2]

[total: 6]

7 **(a)** Fig. 7.1 shows the Fleming's left-hand rule, which helps to deduce the direction of force on a current carrying conductor in a magnetic field.

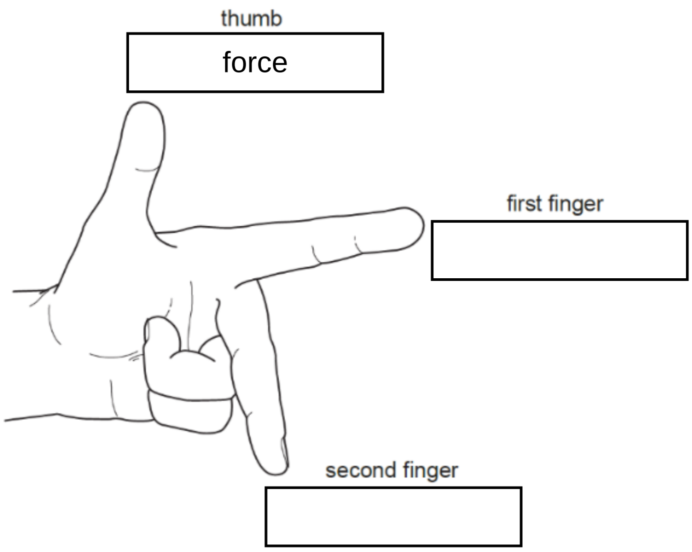


Fig. 7.1

One direction has been labelled. In each of the other two boxes, write the name of the quantity that direction represents. [1]

(b) Fig. 7.2 shows a single-coil d.c. motor connected to a battery and a switch. X is the axle of the motor.

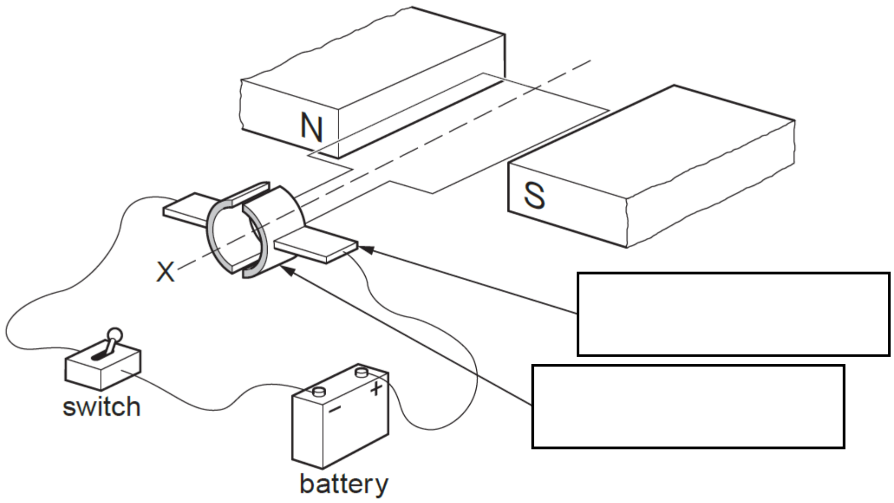


Fig. 7.2

(i) On Fig. 7.2, write in each of the boxes the name of the part of the motor that the arrow is pointing to. [1]

(ii) Explain what happens to the single-coil between the poles of the magnets when the switch is closed.

....

....

....

....

.... [2]

[total: 4]

8 Fig. 8.1 shows a copper rod rolling at steady speed down two sloping parallel copper rails. The rails are in the region of a strong magnetic field pointing vertically downwards.

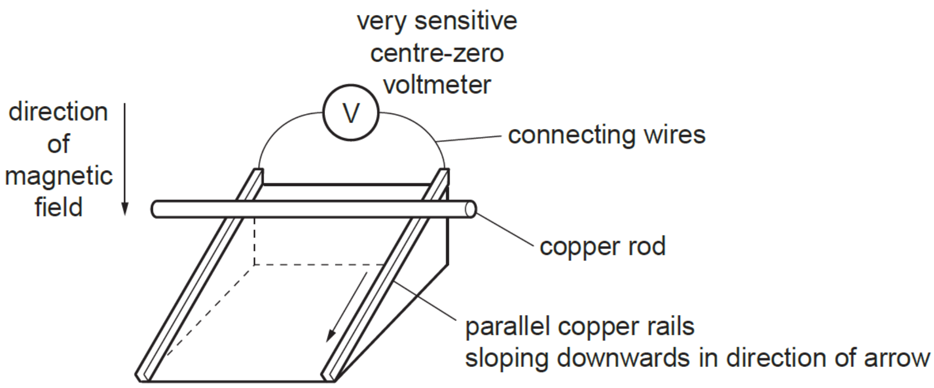


Fig. 8.1

(a) Explain why the voltmeter shows a deflection.

....

....

.... [2]

(b) State, with reasons, the effect of slightly increasing the slope of the copper rails on the voltmeter deflection.

....

.... [1]

(c) The voltmeter is removed. The experiment is repeated using a large rectangular copper coil of the same mass as the copper rod.

Explain why the coil initially falls slower down the sloping rails than the copper rod.

....

....

.... [2]

[total: 5]

9 Fig. 9.1 shows how the temperature of wax varies with time as it is heated in a container, without a lid.

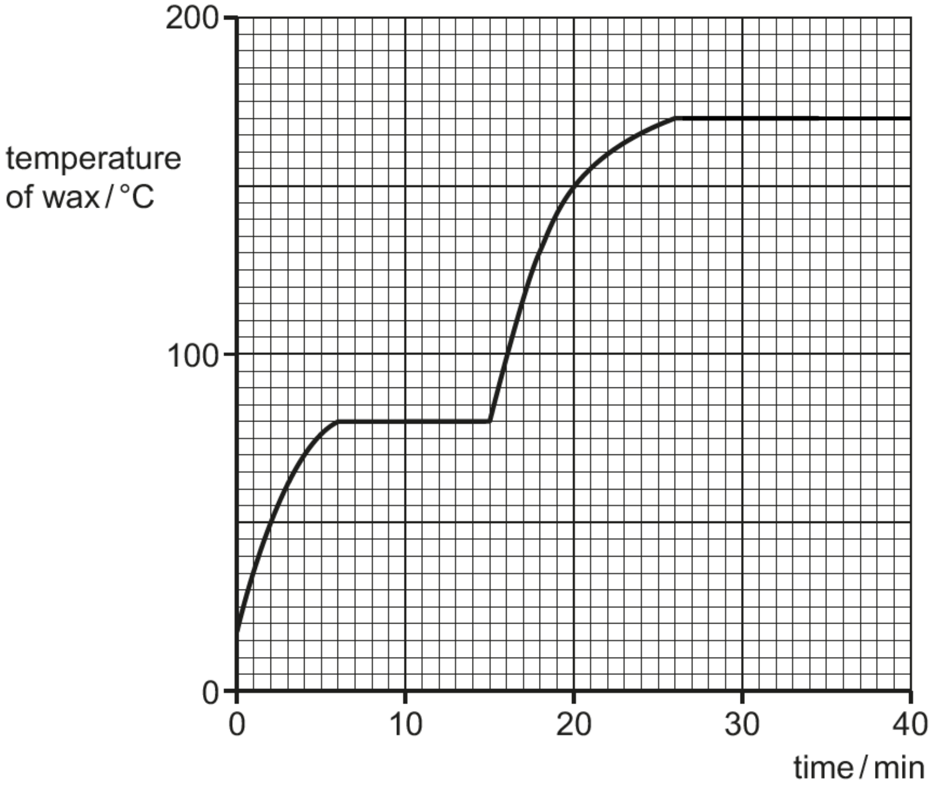


Fig. 9.1

(a) Using the graph in Fig. 9.1, determine

(i) the melting point of wax,

.... [1]

(ii) and the time at which the wax starts to boil.

....

.... [1]

(b) Thermal energy is supplied to the wax using an electric heater. The mass of the wax is 200 g.

(i) If the ammeter and voltmeter connected to the heater reads 2.5 A and 50.0 V respectively, determine the power supplied by the heater.

power supplied = ……………………… [1]

(ii) Assume that the heating process has an efficiency of 80%, determine the specific latent heat of fusion of wax.

specific latent heat of fusion = ……………………… [3]

(c) Using Fig. 9.1, state and explain how the specific latent heat of fusion of the substance compares with its specific latent heat of vaporisation.

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

(d) The experiment is repeated using the same amount of wax in the same container but with a lid.

On Fig. 9.1, sketch a line to show the new variation of temperature with time after the heater is switched on.

[2]

(e) At the end of the process, the *internal energy* (energy in the internal store) of the wax in the container increases.

Define *internal energy*.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [1]

[total: 11]

10 Fig. 10.1 shows a radioactive source used in a smoke detector.

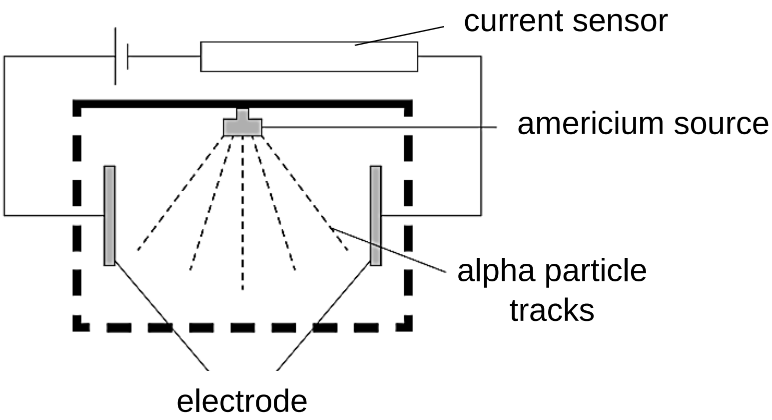


Fig. 10.1

(a) Some radioactive sources emit alpha particles, some beta particles and some gamma radiation. These different radiations have different penetrating abilities.

Place one tick (√) in each row of Table 10.1 to compare alpha, beta, gamma radiation.

Table 10.1

	alpha (α)	beta (β)	gamma (γ)
Least penetrating			
Most penetrating			

[1]

(b) Americium-241 nuclide is used in the radioactive source in Fig. 10.1. A nucleus of americium-241 emits an alpha particle as it decays.

(i) The radioactive decay of a nucleus is a random and spontaneous process.

1. Explain what is meant by a random decay.

……………………………………………………………………… [1]

2. Explain what is meant by a spontaneous decay.

……………………………………………………………………….. [1]
.

(ii) In nuclide notation, americium-241 has 146 neutrons. This nuclide decays to neptunium through alpha emission.

Complete the nuclear equation for this decay.

$$^{241}_{\square}Am \rightarrow {}^{\square}_{93}Np + {}^{\square}_{\square}He$$ [2]

(c) Explain why this radioactive source is suitable for use in a household smoke detector.

....

.... [1]

(d) Table 10.2 shows the decay of Americium-241.

Table 10.2

No. of years elapsed	Fraction of Am-241 Remaining
0	1.000
100	0.841
200	0.708
300	0.595
400	0.500
500	0.420

With reference to the values in Table 10.2,

(i) deduce, with a reason, the half-life of Americium-241.

....

....

.... [2]

(ii) suggest whether the radioactive source will need to be replaced during the typical lifespan of the detector of 10 years.

....

.... [1]

[Total: 9]

Section B (10 marks)

Answer **only one** of the two questions in this section.

11 **(a)** Fig. 11.1 shows the magnetic field pattern around two permanent bar magnets. The magnets are repelling each other.

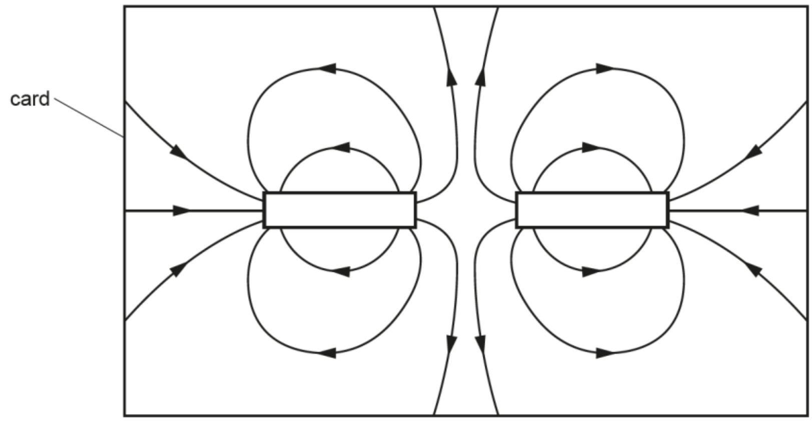


Fig 11.1

(i) On Fig 11.1, label both the poles on each bar magnet. [1]

(ii) Describe how to plot the shape and direction of the magnetic field pattern shown in Fig. 11.1.

....

....

....

....

....

....

....

.... [3]

(b) A student demonstrates in the laboratory how different types of materials can be separated from each other during the recycling process. Fig. 11.2 shows the simple set-up comprising of a plastic tray with small pieces of aluminium foil and iron.

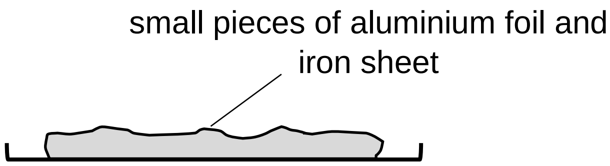


Fig. 11.2

(i) A bar magnet is placed just above the materials. Explain why the small pieces of iron are attracted to the magnet.

....

.... [2]

(ii) A plastic rod is uncharged. When the rod is rubbed with a woollen cloth, the rod becomes negatively charged.

1. Describe and explain how the rod becomes negatively charged.

....

.... [1]

2. The negatively charged rod is placed just above the materials in the tray. Explain why the small pieces of aluminium foil are attracted to the rod.

....

....

....

....

....

....

.... [3]

[total: 10]

12 A platform rests on a pivot as shown in Fig. 12.1. The centre of gravity of the platform is 0.40 m from the pivot.

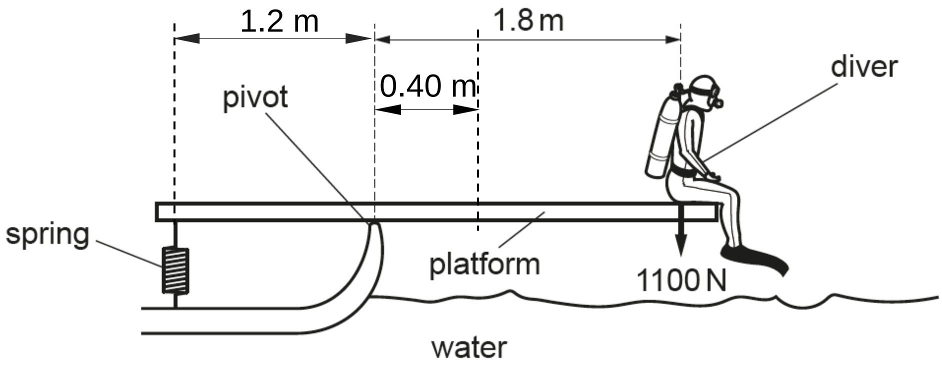


Fig. 12.1 (not to scale)

(a) State the *principle of moments*.

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [1]

(b) The platform remains horizontal as the diver sits on one end. The weight of the platform is 185 N and the weight of the diver is 1100 N.

(i) Calculate the downward force exerted by the spring.

downward force = ……………….. [2]

(ii) Calculate the upward force that the pivot exerts on the platform.

upward force that the pivot = ………………… [1]

(c) Fig. 12.2 shows a manometer used to measure the pressure of the scuba cylinder used by the diver before each dive.

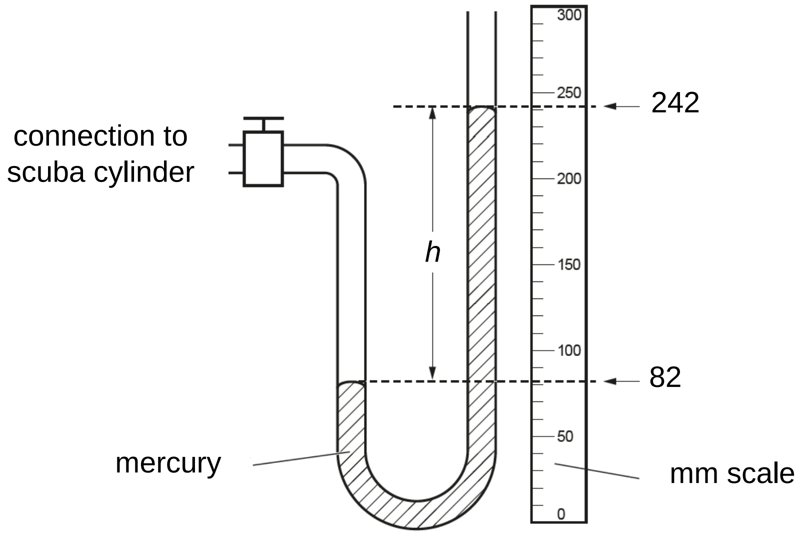


Fig. 12.2

The density of mercury is 13600 kg/m^3. The gravitational field strength g is 10 N/kg.

(i) Determine the pressure difference between scuba cylinder and the atmosphere. Give your answer in Pa.

pressure difference = …………………. Pa [2]

(ii) State what happens to the distance h in Fig. 12.2 if

1. the manometer tube is narrower

……………………………………………………………….. [1]

2. water is used in the manometer.

……………………………………………………………….. [1]

(d) The scuba cylinder is a non-flexible, constant volume container. The pressure of the gas in the cylinder increases as temperature increases. Hence, for safety reasons, the full cylinders are stored in a cool place.

Using ideas about particles, explain why the pressure of the gas increases as temperature increases.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

[total: 10]

END OF PAPER