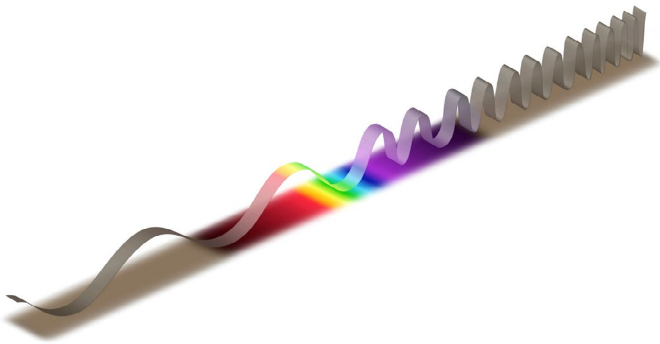
Cambridge Assessment International Education

Example Responses – Paper 4

Cambridge IGCSE™ / IGCSE (9–1) Physics 0625 / 0972

For examination from 2023



Cambridge Pathway

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Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE / IGCSE (9-1) Physics 0625 / 0972.

This booklet contains responses to all questions from June 2023 Paper 42, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub

0625 / 0972 June 2023 Question Paper 42

0625 / 0972 June 2023 Mark Scheme 42

Past exam resources and other teaching and learning resources are available from the School Support Hub

Question 1

1 (a) Fig. 1.1 shows a helicopter which is stationary at a height of 1500 m above the ground.

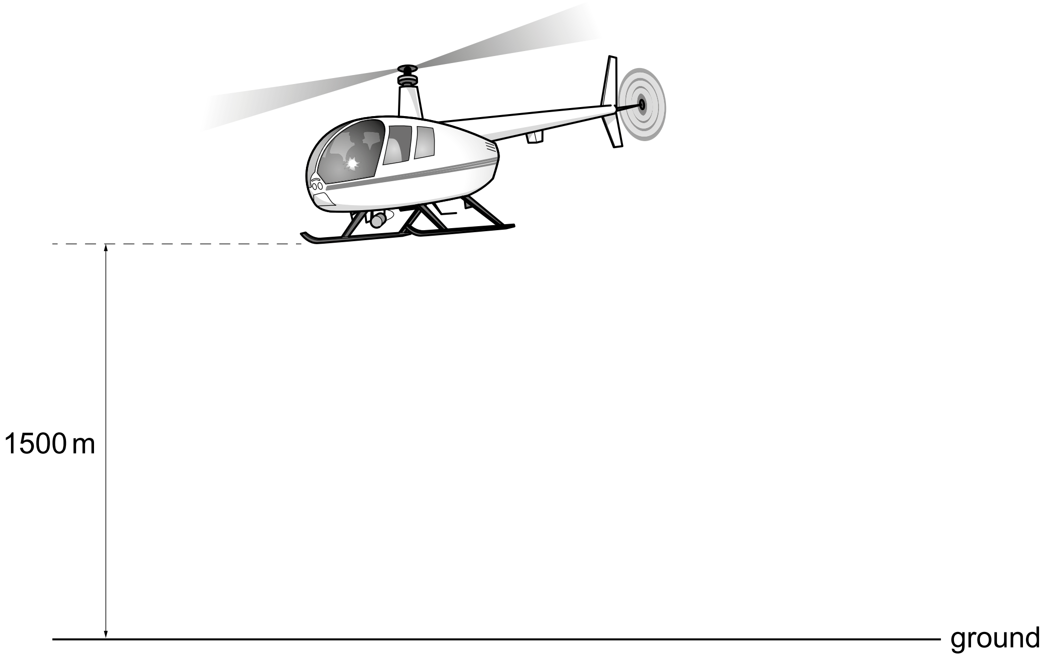

Fig. 1.1 (not to scale)

(i) State the **two** conditions necessary for the helicopter to remain in equilibrium.

condition 1 no resultant force ....

....

condition 2 no resultant moment ....

....

[2]

Examiner comment

Candidates frequently gave correct but incomplete answers, For example, a common error for condition 1 was to simply state 'the upward force = the downward force' and a common error for condition 2 was to 'state clockwise moments = anti clockwise moments'.

(ii) The mass of the helicopter is 3200 kg.

Calculate the change in the gravitational potential energy of the helicopter as it rises from the ground to 1500 m.

$\Delta Ep = mg(\Delta)h$

$\Delta Ep = 3200 \times 9.8 \times 1500$

change in gravitational potential energy = ...4.7×10^7 J.................... [2]

Examiner comment

The most common error was to omit the unit or to give a wrong unit.

(b) Fig. 1.2 shows a vertical speed–time graph for a parachutist who jumps from a stationary hot-air balloon.

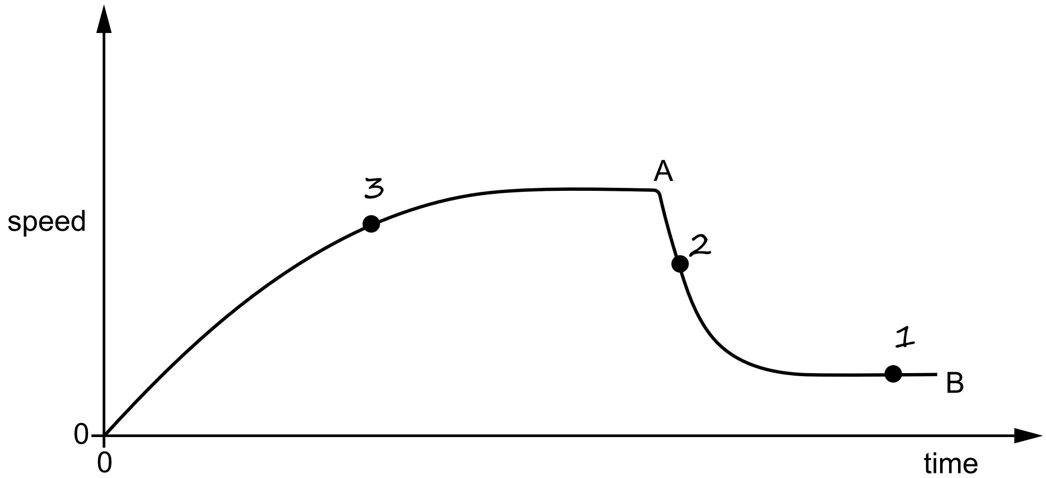

Fig. 1.2

The parachutist jumps from the balloon at time = 0 and reaches the ground at B. The point A indicates when the parachute opens.

(i) On Fig. 1.2, label a point on the graph where the acceleration is:

- zero with '1'
- negative with '2'
- decreasing with '3'. [3]

Examiner comment

The most common error was to confuse 'decreasing' acceleration with 'negative' acceleration and so the positions of points 2 and 3 were interchanged.

(ii) Explain, in terms of forces, the changes in motion which occur from when the parachutist leaves the hot-air balloon until point A.

Initially there is downward acceleration due to weight, then air resistance increases as velocity increases. As air resistance increases, resultant force downwards decreases. Then constant speed when air resistance = weight.

[4]

Examiner comment

- Some candidates ignored the instruction in the question to explain 'in terms of forces' and simply described how the speed of the parachutist varied during the fall.
- Other candidates described changes after the parachute opened at point A, rather than until point A.

Question 2

2 A student catches a cricket ball. The speed of the ball immediately before it is caught is 18 m/s. The mass of the cricket ball is 160 g.

(a) Calculate the kinetic energy stored in the cricket ball immediately before it is caught.

$Ek = ½mv^2$

$Ek = ½ \times 0.16 \times (18)^2$

kinetic energy = ... 26 J ...... [3]

Examiner comment

The most common errors made by candidates included not squaring the numerical value of the velocity when substituted in the equation, and not converting the mass in g into kg.

(b) It takes 0.12 s to catch the ball and bring it to rest.

Calculate the average force exerted on the ball.

$Ft = \Delta mv$

$F = \frac{(0.16 \times 18)}{0.12}$

average force = ... 24 N ...... [2]

Examiner comment

- Candidates who attempted to use $F = ma$ were often unable to calculate the acceleration correctly.
- There were many incorrect answers where candidates divided the kinetic energy they had calculated in **2(a)** by time, often stating $F = E / t$.

(c) As the student catches the ball, she moves her hands backwards.

Explain the effect of this action on the student's hands.

moving hands backwards as catching the ball gives a longer time of

impact and this gives a smaller force on the hands [1]

Examiner comment

Only a few candidates were able to explain that the reduction in force was due to an increase in time taken to catch the ball.

Question 3

3 (a) Fig. 3.1 shows a person moving across an ice-covered pond to reach a ball on the ice.

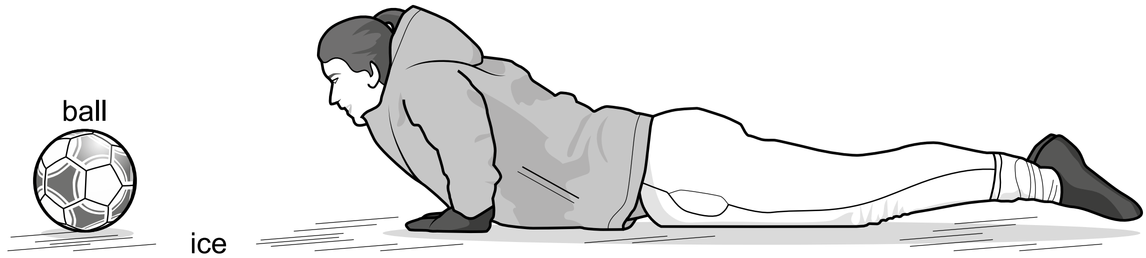

Fig. 3.1

Explain why this way of moving across the ice is safer than walking. Use your understanding of pressure in your answer.

When sliding on their front, the weight of the person is spread over a much greater area. p = F / A so pressure is inversely proportional to area. The force (weight) is the same, so the pressure is lower which means it is safer as the ice is less likely to crack. [3]

Examiner comment

Some candidates omitted the equation relating pressure and surface area or the statement about pressure being inversely proportional to area and some stated that the force changed. There was some confusion between the quantities of force and pressure.

(b) Fig. 3.2 shows a side view of the pond with a layer of ice floating freely on the water.

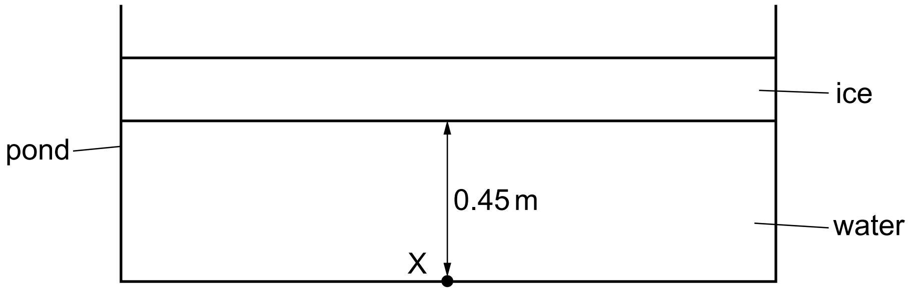

Fig. 3.2

The surface area of the pond is 5.0 m^2.
The mass of the ice is 690 kg.
The density of water is 1000 kg / m^3.
Point X is 0.45 m below the ice.

Calculate the pressure at point X due to the ice and the water.

p (due to water)= ρgh

p = 1000 x 9.8 x 0.45 so p(water) = 4410 Pa

W = mg so W = 690 x 9.8

p (due to ice) = 6762 ÷ 5 = 1352.4 Pa

total pressure = pressure due to water + pressure due to ice

total pressure = 4410 + 1352.4

pressure = *5.8 x 10^3 Pa* .... [4]

Examiner comment

Some candidates only calculated the pressure due to the water or subtracted the two pressures.

Some candidates calculated the pressure due to the ice incorrectly by using the mass and not the weight of the ice and others wrote the equation as *v*.

Question 4

4 **(a)** The temperature of a fixed mass of gas at constant volume is decreased.

State and explain, in terms of particles, how the pressure of the gas changes.

When the temperature is lower the particles have smaller kinetic energy and the pressure decreases. This is due to the slower particles colliding with a lower frequency with the walls and each collision is with a smaller force producing a smaller change in impulse. [3]

Examiner comment

- Some candidates only referred to fewer collisions instead of less frequent collisions.
- Some candidates did not refer either to the difference in force exerted or that a smaller momentum change occurred.
- Many candidates described the pressure change when the volume decreased, and others only described the pressure change when the temperature increased.

(b) **(i)** State the value of absolute zero in °C.

value of absolute zero = −273 °C [1]

Examiner comment

The value of absolute zero was not well known. There was a variety of incorrect answers with the most common being 0 and 273 (i.e. correct value but without the minus sign).

(ii) Explain what is meant by the term absolute zero. Refer to particles in your answer.

Absolute zero is the temperature at which particles have least kinetic energy. It is the lowest possible temperature.

[2]

Examiner comment

Common incorrect answers stated that water froze at this temperature – showing confusion between the Kelvin and Celsius scales of temperature.

(c) Cylinder 1 contains 350 cm^3 of gas at a pressure of 9.0×10^4 Pa. The gas is transferred to cylinder 2 and the pressure increases to 1.6×10^5 Pa. The temperature remains constant.

Calculate the volume of cylinder 2.

$$p_1V_1 = p_2V_2$$

$$9.0 \times 10^4 \times 350 = 1.6 \times 10^5 \times V_2$$

$$V_2 = \frac{[9.0 \times 10^4 \times 350]}{1.6 \times 10^5}$$

volume = ...200 cm^3.......... [3]

Examiner comment

- Some candidates attempted to convert cm^3 to m^3, with varying levels of success.
- Some were unable to correctly rearrange the equation.

Question 5

5 **(a)** Fig. 5.1 shows an electric heater used to heat a room.

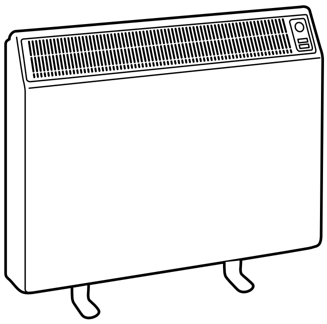

Fig. 5.1

The dimensions of the room are 4.5 m × 6.1 m × 2.4 m.
The density of air is 1.2 kg / m^3.

(i) Show that the mass of air in the room is 79 kg.

$$\rho = \frac{m}{V}$$

$$m = 1.2 \times 4.5 \times 6.1 \times 2.4 = 79.056 \text{ kg}$$

[2]

Examiner comment

Many candidates did not state the equation in symbols or words.

(ii) The power of the heater is 1100 W. The specific heat capacity of air is 1000 J / (kg °C).

Calculate the time taken to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

$\Delta E = mc\Delta\theta$

$\Delta E = 79 \times 1000 \times 4.0$ so $\Delta E = 316\,000$

$P = \frac{\Delta E}{t}$ so $\Delta E = 1100 \times t$

$t = \frac{mc\Delta\theta}{P}$ so $t = \frac{79 \times 1000 \times 4(.0)}{1100}$

$t = 290$ s

time = 290 s .... [4]

Examiner comment

Some candidates did not realise that the mass of the air was the value that they had been given in part **(i)** of the question.

(iii) Suggest **one** reason why the time calculated in **(a)(ii)** is the **minimum** time needed to increase the temperature of the air in the room from 16.0 °C to 20.0 °C.

this was the minimum time as some thermal energy is also

transferred to furniture / walls / objects in the room .... [1]

Examiner comment

- Successful answers to this question were those where candidates stated that thermal energy was transferred to other objects in the room or outside the room and not just to the air in the room.
- Answers of heat loss to the surroundings or that the power of the heater was less than 100 % were insufficient.

(b) Fig. 5.2 shows a cross-section of a double-glazed window in the room.

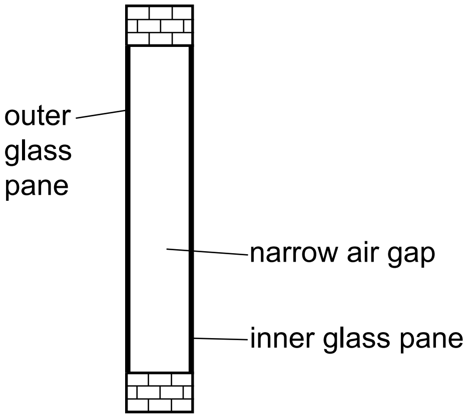

Fig. 5.2

State the main methods of thermal energy transfer from the room to outside which are reduced by this type of window.

thermal energy transfer by conduction and convection are reduced ..... [1]

by the double glazed window

Examiner comment

Some candidates gave explanations instead of naming the methods of heat transfer.

Question 6

6 Two types of seismic waves are P-waves and S-waves.

(a) State the types of wave that P-waves and S-waves can be modelled as.

P-waves longitudinal waves

S-waves transverse waves

[2]

Examiner comment

A common error was to interchange the types of wave.

(b) The velocity of a P-wave in the Earth's solid crust is 7.2 km/s and its frequency is 4.5 Hz.

Calculate the wavelength of this P-wave.

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{[7.2 \times 1000]}{4.5}$$

wavelength = 1600 m [3]

Examiner comment

Many candidates gave an incorrect rearrangement of the equation, i.e. to state $\lambda = fv$ or $\lambda = f \div v$ or they gave an incorrect unit.

Question 7

7 Fig. 7.1 shows a container of oil.

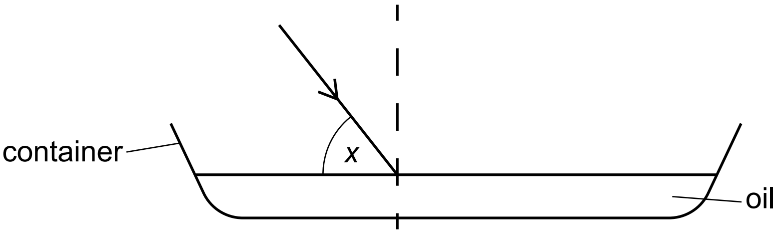

Fig. 7.1

A ray of light shines on the surface of the oil. The refractive index of the oil is 1.47.

(a) On Fig. 7.1, draw the normal at the point where the ray enters the oil. [1]

Examiner comment

- Candidates should use a ruler when asked to draw something that is a straight line.
- Some candidates drew the normal at right angles to the incident ray, or only drew a refracted ray in the oil.

(b) The angle *x* is 56°.

Calculate the value of the angle of refraction.

$i = 34°$

$\sin r = \sin \frac{34}{1.47}$

angle of refraction = 22° [3]

Examiner comment

- Some candidates used angle *x* from the question stem (i.e. using 56° as the angle of incidence) or subtracted 56° from 180° to give the angle of incidence.
- Some candidates just multiplied or divided 56° by 1.47 or were unable to find the inverse sine.

(c) State the approximate speed of light in air.

the approximate speed of light is 3.0×10^8 m / s [1]

Examiner comment

Less successful candidates did not know the correct value for the speed of light in air and often gave the value of the speed of sound in air. Sometimes the unit was missing or incorrect.

(d) Calculate the speed of light in the oil.

Give your answer to three significant figures.

$$n = \frac{\text{speed of light in air}}{\text{speed of light in oil}}$$

$$\text{speed of light in oil} = \frac{\text{speed of light in air}}{n}$$

$$\text{speed of light in oil} = \frac{3.0 \times 10^8}{1.47}$$

speed = 2.04×10^8 m / s [2]

Examiner comment

- Some candidates rearranged the equation incorrectly.
- Some candidates gave the answer to 3 significant figures as required by the question. Many gave the answer to 1 or 2 significant figures and a few to 4 or more significant figures.
- Sometimes candidates omitted the unit from their answer.

Question 8

8 (a) (i) State what is meant by a magnetic field.

a magnetic field is a region in which a magnetic pole experiences a force [1]

Examiner comment

- Some candidates stated that the magnetic field was the area around a magnet, that a region where an object (unqualified by the word magnetic) experiences a force.
- Some candidates were confused between electric and magnetic fields.

(ii) Define the direction of a magnetic field.

the direction of a magnetic field is in the direction of the force on a N pole [1]

Examiner comment

The most common error was confusion between an electric and a magnetic field so candidates referred to the direction of the force on a positive charge, or from positive to negative.

(b) Fig. 8.1 shows a negatively charged metal sphere.

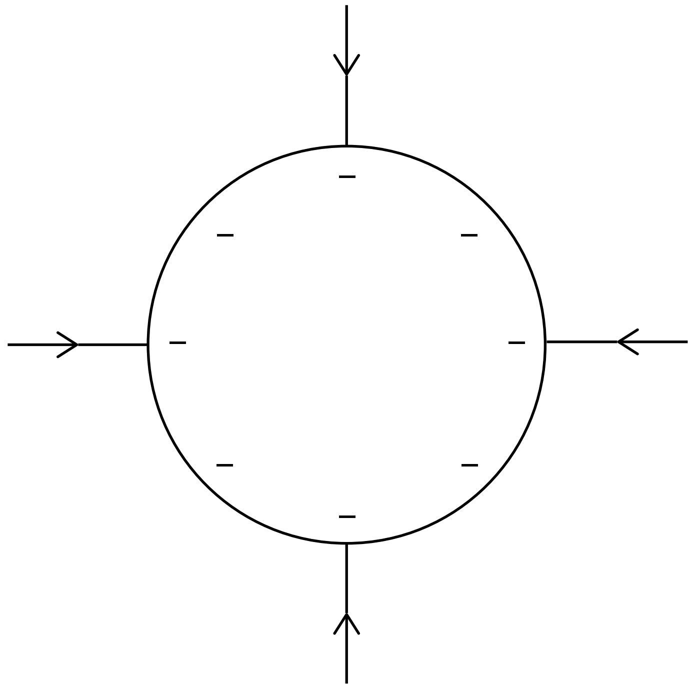

Fig. 8.1

On Fig. 8.1, draw **four** lines to show the electric field and its direction. [2]

Examiner comment

- Candidates should use a ruler and a sharp pencil to draw straight lines and be precise with the end points of the lines.
- Some candidates had the wrong direction for the arrows and others tried drawing the shape of the magnetic field around the Earth.

(c) Fig. 8.2 shows a circuit.

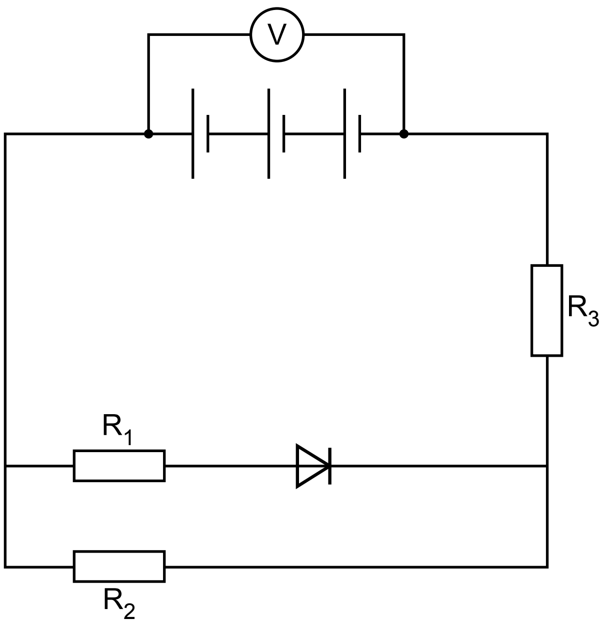

Fig. 8.2

The three cells are identical and have zero resistance.
The resistors R_1, R_2 and R_3 are identical.
The reading on the voltmeter is 6.0 V.
When the diode is conducting, it has zero resistance and zero potential difference (p.d.) across it.

(i) Determine the e.m.f. of one cell.

the e.m.f. of one cell = voltmeter reading ÷ number of cells

e.m.f. of one cell = 6.0 ÷ 3

e.m.f. = *2.0 V* .... [1]

Examiner comment

Some candidates confused a cell with a battery and gave the answer of 6.0 V, or they omitted the unit.

(ii) Determine the ratio of the p.d. across R_2 to the p.d. across R_3.

the ratio of the p.d. across R_2 to the p.d. across R_3 = 1:2 .... [1]

Examiner comment

There were few correct answers to this question. The most common incorrect answers were 2:1 and 1:1.

(iii) All the cells are reversed.

1. State and explain the change in current in R_1.

the current is zero in R_1 as the diode is in wrong direction to allow current in that branch of the parallel circuit [1]

Examiner comment

- Some candidates just stated that the current would be 0 without any adequate explanation.
- Common wrong answers were that the current increased or decreased or changed direction.

2. Determine the new value of the ratio of the p.d. across R_2 to the p.d. across R_3.

the ratio of the p.d. across R_2 to the p.d. across R_3 is now 1:1 [1]

Examiner comment

- The most common incorrect answers were 1:2 and 2:1.
- The answers 1 or $R_1 = R_2$ were insufficient.
- Candidates should be encouraged to use the format x : y when expressing ratios.

Question 9

9 **(a)** Table 9.1 shows some properties and values for α-particles, β-particles and γ-radiation.

Complete Table 9.1.

Table 9.1

type of radiation	number of protons	number of neutrons	charge / C	stopped by
α	2	2	$+ 3.2 \times 10^{-19}$	thin sheet of paper
β	0	0	-1.6×10^{-19}	thin sheet of aluminium
γ	0	0	0	thick lead block

[3]

Examiner comment

- There were not many completely correct answers for this question.
- Most candidates knew that the number of neutrons in an alpha particle was 2 but a significant number stated 4 neutrons.
- The charge on the beta particle was often given as -1 thus ignoring the unit in the heading and the prompt of the value of the charge on an alpha particle being given.
- Many candidates indicated that lead was needed to stop gamma radiation, but 'lead' on its own was insufficient. There needed to be an indication that it should be thick lead (i.e. at least 10 cm or many cm of lead).

(b) State how β-decay changes the nucleus of an atom.

the nucleus has one less neutron and one more proton after β-decay [1]

Examiner comment

Very few candidates gave a fully correct answer to this item. Some candidates stated that the neutron number would increase or that the proton number would be unchanged or decrease.

(c) A radiation detector used in a laboratory detects a background count rate of 30 counts / min. A radioactive source is placed in front of the radiation detector. The initial reading on the detector is 550 counts / min. The half-life of the source is 25 minutes.

Calculate the expected reading on the detector after 75 minutes.

initial count rate due to source = total count rate – background count rate

=550 – 30 counts / min

75 min = 3 half-lives so final count rate = 520 x ½ x ½ x ½ or 520 x ⅛

final count rate due to source = $\left(\frac{520}{8} = \right) 65$

final reading on detector = count rate due to source + background count rate

final reading on detector = 65 + 30 = 90

reading = 90 counts / min [4]

Examiner comment

- Some candidates forgot to subtract and / or add on the background count rate.
- Some candidates made arithmetical errors and some candidates multiplied the initial count rate by 3 or divided it by 25.
- Candidates should be encouraged to write down all the steps, including the number of half-lives, clearly in their working so that compensatory marks can be awarded.

(d) State **two** safety precautions taken when moving, using or storing radioactive sources in a laboratory.

1 limit the time of exposure to the radioactive source

2 store the radioactive sources in lead boxes

[2]

Examiner comment

Answers such as wear 'protective clothing ' or 'goggles' were too vague.

Question 10

10 **(a)** State the equation that defines the average orbital speed *v* of a planet. State the meaning of any symbols you use.

$v = \frac{2\pi r}{T}$

where: r = (average) radius of the orbit and T = (orbital) period [2]

Examiner comment

- Some candidates wrote down only the right-hand side of the equation, but this was insufficient for the equation.
- Answers defining *r* as radius and *T* as time were insufficient and those defining *r* as the radius of the planet were incorrect.
- Some candidates gave the general equation for *v* i.e. $v = s / t$, but this was insufficient.

(b) Suggest why countries that are a significant distance from the Equator experience significant temperature variation throughout the year.

the countries experience significant temperature variation throughout the year because the rays from Sun strike the country at different angles through the year and the rays from Sun strike the country for different number of hours per day through the year [1]

Examiner comment

Candidates who were awarded the mark for this question were usually given it because they referred to the tilt of the Earth's axis. Few were able to express that the rays from the Sun strike the country at different angles during the year or that the country received rays from the Sun for a different number of hours per day.

(c) Fill in the gaps in the paragraph about a star much more massive than the Sun.

The stage that follows the stable state in the life cycle of the star is the

red supergiant stage.

It then explodes as a supernova to form a nebula, this leaves behind a

neutron star or a black hole.

[4]

Examiner comment

- Few candidates could correctly identify all the stages in the life cycle of a star more massive than the Sun.
- Some candidates omitted the 'super' from 'red supergiant', referred to the nebula as a planetary nebula or omitted the 'star' from 'neutron star'.

(d) A galaxy is moving away from the Earth with a speed of 33 000 km / s.
The value of the Hubble constant is 2.2×10^{-18} per second.

Calculate the distance from the galaxy to the Earth. Give your answer in light-years.

$$H_0 = \frac{v}{d} \quad \text{or} \quad d = \frac{v}{H_0}$$

d = [33 000 x 103] / [2.2 x 10^{-18} x 9.5 x 10^{15}]

distance = ...1.6 x 10^9...... light-years [2]

Examiner comment

Some candidates did not know the equation $H_0 = v / d$ or were unable to rearrange it correctly and few correctly converted km into light-years.

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org   www.cambridgeinternational.org