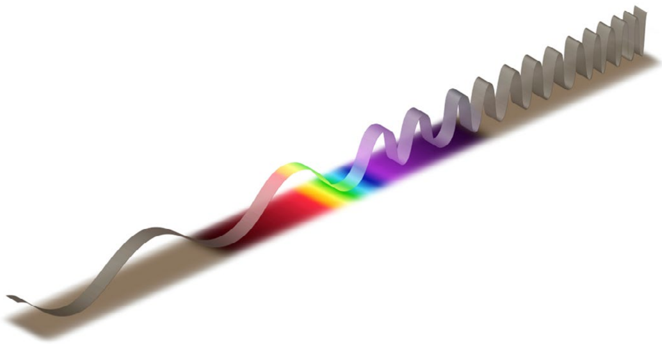
Cambridge Assessment International Education

Example Responses – Paper 2

Cambridge O Level Physics 5054

For examination from 2023



Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge O Level Physics 5054.

This booklet contains responses to all questions from June 2023 Paper 22, 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

5054 June 2023 Question Paper 22

5054 June 2023 Mark Scheme 22

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

Question 1

1 Fig. 1.1 shows the speed–time graph for a car travelling on a straight horizontal road.

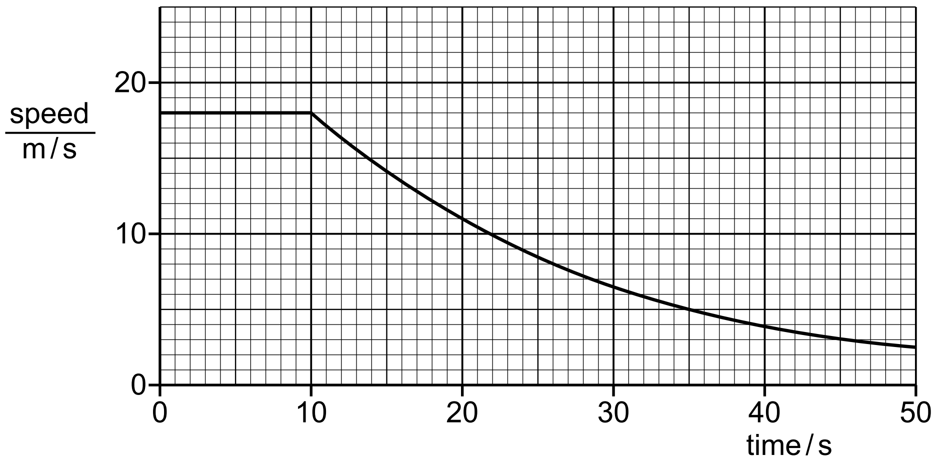


Fig. 1.1

(a) Describe the motion of the car shown in Fig. 1.1.

The speed is constant at 18 m / s for the first 10 s. The car then decelerates non-uniformly for another 40 s.

[2]

Examiner comment

The description needed some detail, either that the deceleration is non-uniform or giving the values of time for the different stages of the motion. Some candidates misread the vertical axis, taking the graph as a distance–time graph rather than a speed−time graph and suggesting that the car is stationary for the first 10 seconds. Since the question asked for a description of the graph, there was no need for any explanation of the physical principles involved or a calculation, for example a calculation of the average acceleration.

(b) At time t = 10 s the engine of the car is switched off. The brakes are not applied.

(i) Name **two** forces that act on the car to cause the change in motion after t = 10 s.

1 friction

2 air resistance

[1]

Examiner comment

The question asks for two forces that act to change the motion. Forces such as the weight and the contact force are present and were mentioned in some answers, but are not involved in the change in the motion.

(ii) Suggest why Fig. 1.1 is a curve after t = 10 s.

there is a non-uniform deceleration caused by decrease in the air resistance as the car slows down

[1]

Examiner comment

Rather than just stating that the car slows down, as in many answers, more detail was required about why this decrease in speed produces a curve. The simplest statement was to say that the deceleration is non-uniform but a better suggestion is to explain why the deceleration is non-uniform by stating what happens to the air resistance.

(c) Between t = 10 s and t = 20 s the speed of the car changes from 18 m/s to 11 m/s.

The mass of the car is 1200 kg.

(i) Calculate the change in momentum of the car in this time.

Give the unit of your answer

momentum change = m(v−u) = 1200 × (18 − 11) = 8400 kg m / s

momentum change = 8400 unit kg m / s [2]

Examiner comment

Candidates should start by writing down the formula for momentum or they should show that they knew that momentum is mass × velocity. They then needed to insert numerical values and calculate the numerical result. In this case, the unit of the answer was required. This was the only place on the paper where a unit was needed on the answer line because elsewhere the unit was provided on the question paper. Some candidates were unable to give the unit correctly, for example writing it as kg / m / s, or kg m / s^2.

(ii) Calculate the average resultant force exerted on the car during this time.

F = change in momentum / time = 8400 / 10 = 840 (N)

average resultant force = ...840.......... N [2]

Examiner comment

- Many candidates successfully used the equation $F = ma$, rather than using the rate of change of momentum. This was accepted.
- The answer could be given as 840 N or −840 N.

Question 2

2 Fig. 2.2 shows a rider on an electric scooter.

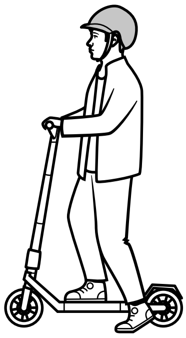


Fig. 2.2

The scooter contains a battery and a motor to drive the back wheel.

(a) **(i)** State the name of the energy store in the battery.

chemical energy [1]

Examiner comment

Some candidates suggested that the energy stored in a battery is electrical energy. This is not an 'energy store' that is mentioned in the syllabus; the syllabus terms for energy stores are 'kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal)'.

(ii) Describe, in terms of work done, the stages of energy transfer from the energy store in the battery to the kinetic energy of the scooter.

An electrical current transfers energy from the battery to the motor when work is done on the electrons in the wire that connects the battery and the motor. The kinetic energy increases when mechanical work is done by the motor in turning the back wheel [2] to provide a driving force on the scooter.

Examiner comment

The question asked for a description of the energy transfer in terms of the work done. Many candidates produced long lists of energy transfer which did not often involve any idea of work being done and sometimes involved energy transfers other than to the kinetic energy of the scooter, for example that thermal energy (heat) was produced. These transfers were often incorrect when the energy was shown as, for example, chemical to heat to kinetic energy. Candidates needed to explain the role of work being done as energy is transferred from one store to another, rather than just giving the energy stores involved.

(b) The total mass of the scooter and the rider is 70 kg.

Calculate the total kinetic energy of the rider and scooter when the scooter has a speed of 4.0 m/s.

$KE = \frac{1}{2} mv^2 = \frac{1}{2} \times 70 \times 4^2 = 560 (J)$

kinetic energy = ...560.......... J [2]

Examiner comment

Candidates needed to square the value of the velocity when using a calculator as some answers were given as 140 J.

(c) The battery is marked 'energy capacity 0.35 kilowatt-hour (kW h)'.

(i) Define what is meant by a kilowatt-hour.

a kilowatt-hour is the energy produced in 1 hour when the power output is 1 kW [1]

Examiner comment

Many candidates did not recognise that the kilowatt-hour is a value of energy and, instead, suggested it is a unit of power.

(ii) The scooter stops working because the battery is totally discharged (flat). This means that there is no more energy stored in the battery.

The battery is then recharged using a 70 W power supply.

Calculate the time taken to fully recharge the battery.

$$T = \frac{E}{P} = \frac{0.35}{0.07} = 5$$

time = ...5.......... hours [2]

Examiner comment

Candidates needed to recognise that if the power was used as 70 W, then the energy capacity of 0.35 kW h needed to be changed to 350 W h. Similarly, that 70 W needed to be changed to 0.07 kW if the energy capacity of 0.35 kW h was used. Candidates needed to be conscious of the units used in an equation so that they remained consistent.

Question 3

3 A fixed mass of gas in a glass tube is trapped by a seal at one end of the tube and by a column of mercury. The mercury is free to move within the tube.

The tube is rotated slowly from the vertical as shown in Fig. 3.1 to the horizontal as shown in Fig. 3.2. The volume of the gas increases and its temperature remains constant.

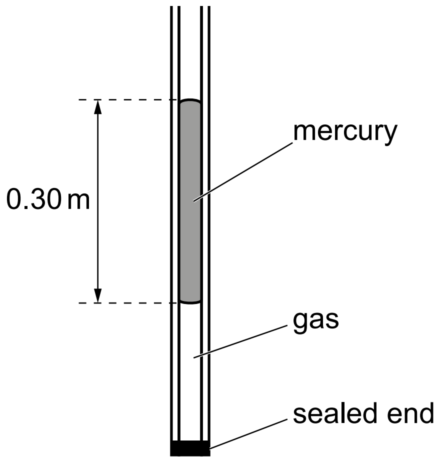


Fig. 3.1 (not to scale)

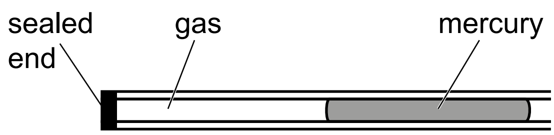


Fig. 3.2 (not to scale)

(a) **(i)** Describe why rotating the tube changes the pressure of the gas in the sealed end.

when the tube is vertical the mercury exerts a pressure on the gas

[1]

Examiner comment

- Candidates gave some alternative answers, for example that when the tube is rotated the mercury does not exert a pressure and only atmospheric pressure acts on the gas.
- Many candidates attempted to answer the question by explaining that pressure decreases because volume increases, without explaining the cause of these changes or realising that the volume changes because the pressure decreases.
- Some candidates gave a kinetic theory pressure to explain why the pressure decreases, effectively giving answers to the next section, **(a)(ii)**. Candidates needed to read through every part of the question before starting their answer to avoid repetition.

(ii) Explain, using ideas about particles, why the pressure of the gas decreases when its volume increases.

When the volume increases particles hit the walls of the container less frequently. This reduces the force acting on the container (or on the mercury) and thus reduces the pressure.

.... [3]

Examiner comment

- Many candidates gave vague answers which suggested that there is more space for the particles to move around or that they are freer to move around, rather than focussing on how the particles create a pressure by a series of forces as particles hit the walls. It is only the rate at which the particles hit the walls and their change in momentum during an individual collision that changes the pressure.
- Acceptable alternative answers stated that the change in momentum of a single collision was constant, but that the number of collisions per second increased.

(b) In Fig. 3.1 the length of the mercury column is 0.30 m.

The density of mercury is 14 000 kg / m^3.

Atmospheric pressure is 1.0×10^5 Pa.

Calculate the pressure of the gas in the tube.

P = dgh = 14000 × 9.8 × 0.3 = 41160

pressure in tube = 41160 + 1.0 × 10^5 = 140 000

pressure = ...*140 000*.......... Pa [3]

Examiner comment

- The final value in a calculation was accepted to any number of significant figures greater than or equal to 2. This was the value shown, but candidates could give their answers to more but not less significant figures.
- The value of *g* is given on the front page of the examination paper and was best taken as 9.8. In this case, it did not make any difference to the final result when written to 2 significant figures if a value of 10 was used in the calculation. The actual question did not give the value of *g* and this seemed to prompt a number of candidates to take atmospheric pressure as the value of *g* in the equation for pressure.
- Many candidates calculated the change in pressure, but did not add on atmospheric pressure. Many subtracted the change (41160 Pa) from atmospheric, rather than adding it on.

(c) The pressure of a different sample of gas changes at constant temperature.

Fig. 3.3 shows one point, marked X, on a graph of pressure against volume for the gas sample.

At X the pressure of the gas is P_0 and its volume is V_0.

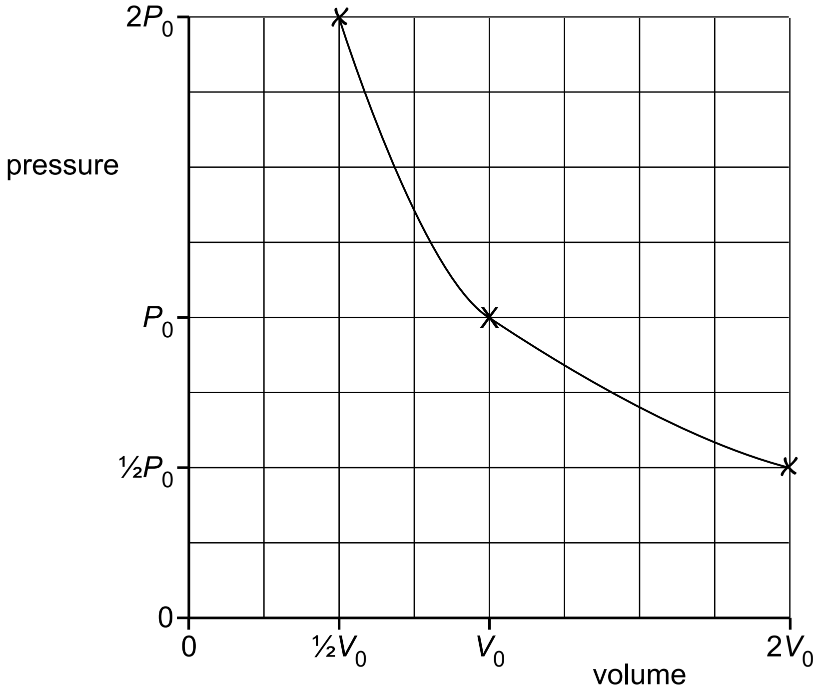


Fig. 3.3

On Fig. 3.3, sketch the graph as the pressure of the gas decreases from $2P_0$ to $\frac{1}{2}P_0$. [2]

Examiner comment

- Many candidates drew a curved line with the correct shape, but their graphs did not go through the point at (V_0,P_0) or through ($2V_0$,$\frac{1}{2}P_0$) and ($\frac{1}{2}V_0$, $2P_0$).
- Some candidates made sure that their graph was correct at $\frac{1}{2}V_0$, V_0 and $2V_0$, but merely joined these points with straight lines rather than thinking about how the graph would change.

Question 4

4 Fig. 4.1 shows the particles (atoms) at one instant in a sample of iron at a temperature below its melting point.

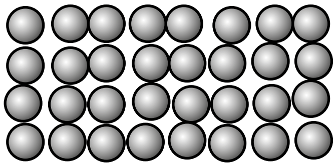


Fig. 4.1

(a) **(i)** State the lowest possible temperature on the Celsius scale and on the Kelvin scale.

Celsius scale ......−273............ °C Kelvin scale ....0............ K [1]

Examiner comment

Many candidates gave the values as −273 K and 0 °C, or gave the lowest possible temperature as 273 °C.

(ii) The temperature of the solid increases. The sample remains a solid.

Describe how the motion of the particles changes.

the particles gain kinetic energy and vibrate faster, with a greater

amplitude .... [2]

Examiner comment

- An increase in the speed or kinetic energy of the particles, as well as a description of how the vibration is affected, was required.
- Many candidates suggested that an increase in temperature merely causes the particles to 'start to vibrate' or to 'vibrate more'. They often did not specify what was meant by 'more' which might mean vibrate 'for a longer time'. Stating that extra energy 'starts' the particles to move or 'starts' them vibrating suggests that they were not vibrating or moving initially.

(iii) The solid melts.

State what happens to the internal energy and the temperature of the solid as it melts.

internal energy .increases..

temperature .remains constant..

[2]

Examiner comment

All possible combinations of 'increase', 'decrease' and 'stays constant' were seen. Many candidates suggested that the temperature increases as a solid melts, rather than stays constant.

(b) A student:

- places a 300 g piece of iron in boiling water until the iron is at a temperature of 100 °C
- removes the iron from the water and places it immediately into 100 g of water at 25 °C.

The iron cools and the water warms until both reach the same temperature, 44 °C.

The specific heat capacity of water is 4.2 J / (g °C). No energy is lost to the surroundings.

(i) Calculate the change in energy (internal energy) of the water as it warms up.

$E = mc\Delta T = 100 \times 4.2 \times (44-25) = 7980$

change in energy = ...7980.......... J [2]

Examiner comment

Some candidates gave the formula as C = *mcT*. This was not advisable as it often led to confusion as to which 'c' is the specific heat capacity. Other candidates made mistakes in the temperature rise of the water.

(ii) Calculate the specific heat capacity of iron.

$c = E / mc\Delta T = 7980 / (300 \times 56) = 0.48$

specific heat capacity = ...0.48.......... J / (g °C) [2]

Examiner comment

- Many candidates were not able to distinguish between the amount of energy and the specific heat capacity in the equation. Some did not realise that the energy in **(i)** should be used in **(ii)**, since the energy transfer from the iron as it cools is used to warm the water.
- Some candidates made errors in rearranging the formula to make the specific heat capacity the subject of the equation, or used wrong values in the calculation. Candidates needed to read and understand the question thoroughly to make sure they used the correct values for the iron and the water.

Question 5

5 Water waves are transverse waves.

(a) Underline **two** other examples of transverse waves.

seismic P-waves **seismic S-waves** **sound** **X-rays** [1]

Examiner comment

Although many correctly correctly suggested X-rays are transverse, the other example of transverse waves was often stated wrongly as seismic P-waves or sound.

(b) Fig. 5.1 shows a wooden bar and a glass block in a ripple tank. The depth of water in the tank is less than the height of the glass block.

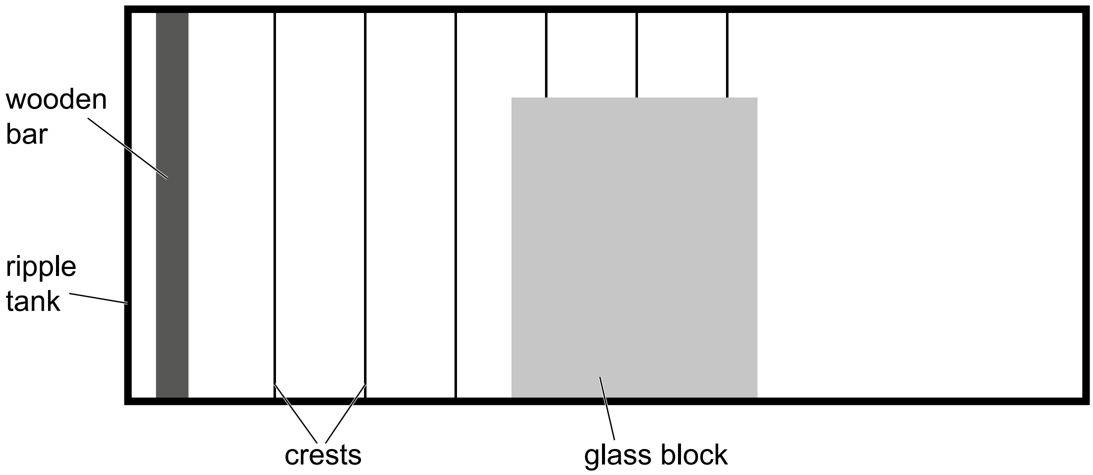


Fig. 5.1 (not to scale)

The wooden bar moves up and down once every 0.15 s to create the crests.

(i) The speed of the water wave is 27 cm / s.

Calculate the frequency and the wavelength of the wave.

$$f = \frac{1}{T} = \frac{1}{0.15} = 6.7 \text{ (Hz)}$$

$$\lambda = \frac{v}{f} = \frac{27}{6.7} = 4.1 \text{ (cm)}$$

frequency = ...6.7.......... Hz

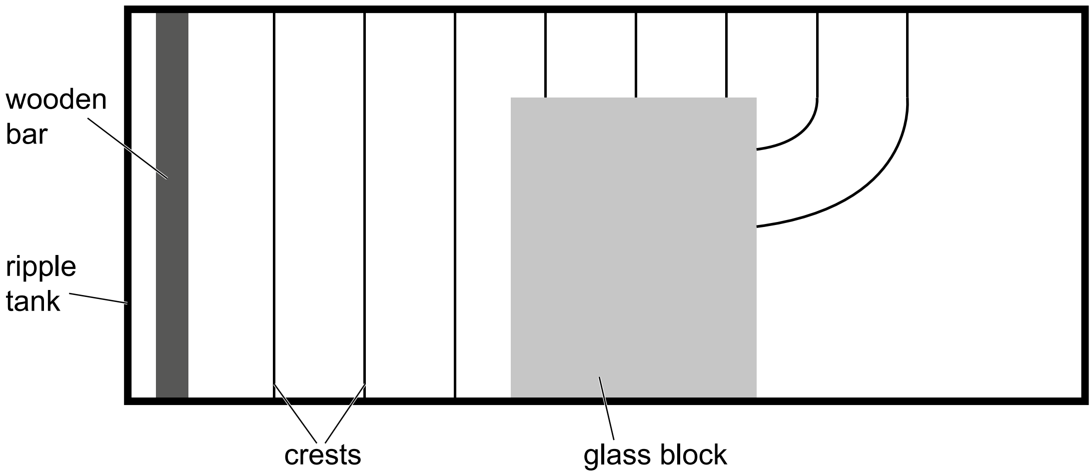
wavelength = ...4.1.......... cm [3]

Examiner comment

- Candidates were usually able to start the calculation either by calculating the frequency from the period or by calculating the wavelength as the distance a crest moves in 0.15 s at a speed of 27 cm / s.
- Some candidates struggled to use the equation $v = f\lambda$ because they had neither the wavelength nor the frequency. Those candidates who just wanted to use the equation were often in difficulty as they needed to devise a method of calculating at least one of the two quantities before they could use the equation.
- Rearrangement of the formula to make *f* or *v* the subject of the formula caused difficulty for some candidates the time taken for one wave was incorrect.

(ii) The wave diffracts at the right-hand edge of the glass block.

On Fig. 5.1 draw **two** crests after they pass the glass block to show the diffraction. [2]



Examiner comment

- Candidates needed to draw the crests the same distance apart throughout the diagram, but many did not.
- Candidates needed to draw the diagram with a ruler, both to measure the distance between crests and to make sure they were constant, rather than the attempting to draw them entirely freehand.
- In the shadow region where the wave is diffracted the crests should appear curved, ideally approximately a quarter circle. This was rarely shown well.

(iii) Describe how a wave with a smaller wavelength is made with the wooden bar.

increase the frequency of movement of the bar

[1]

Examiner comment

Although many candidates suggested the movement of the wooden bar needed to be different, the change was often not clear, for example candidates stated 'move it more'. Just suggesting that the speed of the wave should be increased or changed in some way was not usually sufficient.

(iv) Describe how a decrease in wavelength affects the diffraction.

less diffraction is seen ....

.... [1]

Examiner comment

- A regular misconception was that decreasing the wavelength increases the amount of diffraction.
- Some answers suggested that the frequency increases as the wavelength decreases. Although this was true, it did not suggest how the diffraction is affected by the decrease in wavelength.

Question 6

6 Fig. 6.1 shows an electric circuit containing a filament lamp, a resistor R, a 12 V battery and five meters.

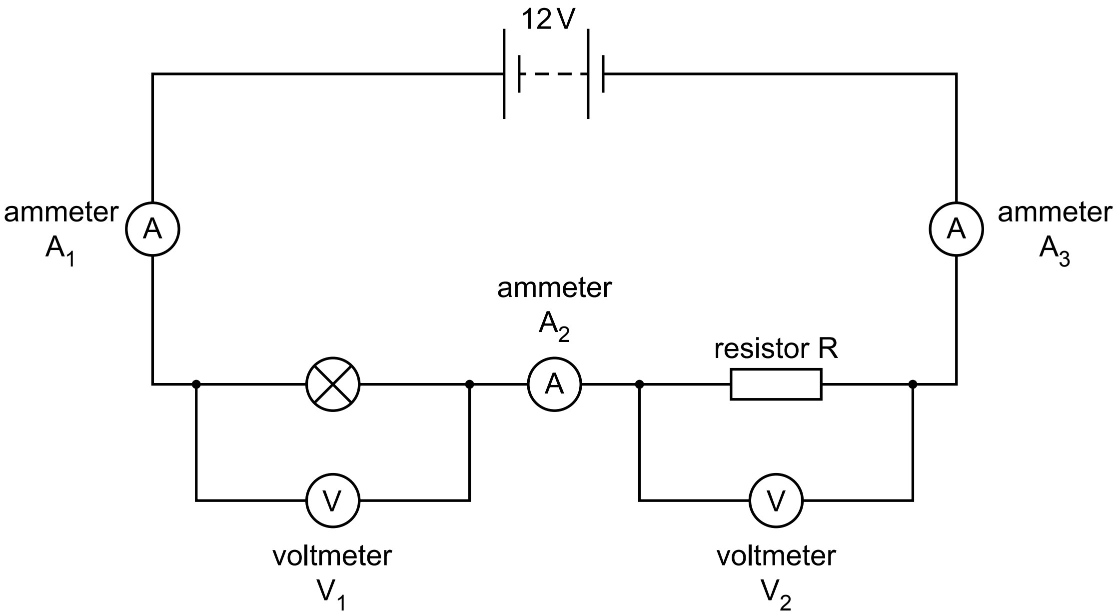


Fig. 6.1

(a) (i) The reading on ammeter A_1 is 0.25 A.

The reading on voltmeter V_1 is 3.0 V.

Determine the readings on the other meters.

reading on ammeter A_2 = ...0.25.......... A

reading on ammeter A_3 = ...0.25.......... A

reading on voltmeter V_2 = ...9.......... V

[2]

Examiner comment

- Most candidates suggested that at least one of the ammeters measures 0.25 A, but not always that both were 0.25 A.
- Some candidates incorrectly gave the reading on the voltmeter as 3.0 V, e.g. equal to the reading on voltmeter 1.

(ii) Calculate the resistance of resistor R.

$$R = \frac{V}{I} = 36$$

resistance of resistor R = ...36........................ Ω [2]

Examiner comment

- Some candidates gave the formula relating voltage, current and resistance at the start of their calculation, which was helpful.
- Although many candidates knew the formula $R = \frac{V}{I}$ they did not always use the values for the reading of voltmeter 2 or the reading in ammeter 2 to obtain their answer.

(iii) The resistor obeys Ohm's law.

State Ohm's law.

the current in a metal wire is directly proportional to the potential difference across the wire, provided the temperature is constant

.... [2]

Examiner comment

- Many answers suggested that resistance is proportional to voltage or inversely proportional to current. Ohm's law merely relates the relationship between voltage and current and does not specifically mention resistance.
- Many candidates correctly stated that the basic proportionality was correctly stated by many candidates, but the provision that temperature is constant was not as well known.

(b) Fig. 6.2 shows the current–voltage graph for the filament lamp.

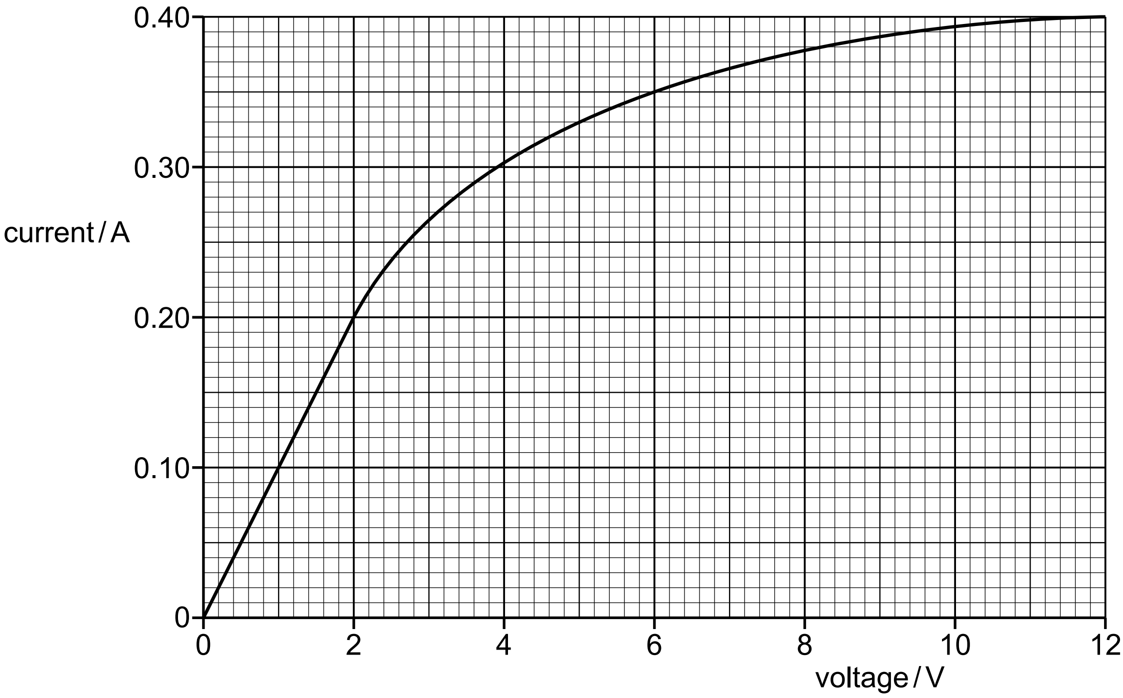


Fig. 6.2

The battery in Fig. 6.1 is replaced with a different battery which has a different e.m.f. (electromotive force).

The voltage across the lamp increases to 6.0 V.

Use data from the graph to determine the e.m.f. of the second battery.

Show your working.

$I = 0.35$ A

p.d. across resistor = $IR = 0.35 \times 36 = 12.6$ (V)

e.m.f. of battery = $12.6 + 6 = 18.6$ (V)

e.m.f. = ...19.......... V [3]

Examiner comment

- Many candidates did not realise that the diagram in this section was a new situation. For this section of the question, the resistance of the lamp was not found from values given in **(a)(i)**, only the resistance of resistor R is the same as the value found in **(a)(ii)**.
- Those candidates who used the total resistance of the circuit often incorrectly used the initial resistance of the lamp in finding the total resistance.
- Those candidates who attempted to set out their work logically could be awarded marks for using the correct current or calculating the voltage across resistor R.

Question 7

7 (a) Ultraviolet radiation is one component of the electromagnetic spectrum.

(i) State the name of **two** components of the electromagnetic spectrum that have a smaller wavelength than ultraviolet radiation.

1 *x-rays*

2 *gamma radiation*

[1]

Examiner comment

The two components of the electromagnetic spectrum that were chosen were more often correct than not, but components with a higher wavelength than ultraviolet, e.g. radio waves and infra-red were sometimes chosen.

(ii) State **one** useful application of ultraviolet radiation.

detecting counterfeit bank notes [1]

Examiner comment

Candidates gave many useful applications of ultraviolet, and 'providing a suntan' was very popular. A few applications were clearly not suitable, for example cleaning jewellery or providing a scan for an unborn baby, where candidates confused ultrasound or with another component of the electromagnetic spectrum.

(iii) Exposure to ultraviolet radiation from the Sun damages the eyes.

State **one** type of damage to the eye caused by ultraviolet radiation.

formation of cataracts in the lens of the eye [1]

Examiner comment

- The question asked for a statement of one type of damage to the eye caused by ultraviolet radiation. There were a number of possible answers, apart from the formation of cataracts, e.g. burning the cells in the retina or causing cancer. Many answers just mentioned damage to a particular part of the eye, without specifying what type of damage.
- Blindness might have been the outcome of many possible causes and candidates needed to give more detail about what had caused the blindness.

(b) Fig. 7.1 shows a ray of light. The ray passes into a semi-circular block of glass at A and leaves the glass at B, travelling along the surface to C.

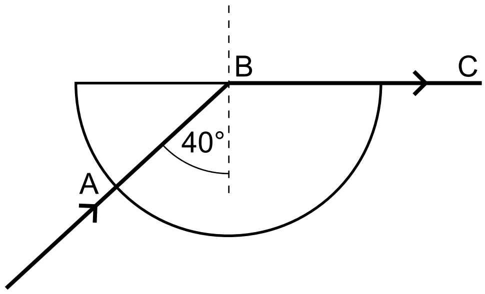


Fig. 7.1

(i) State the name given to the angle of incidence marked as 40°.

critical angle .... [1]

Examiner comment

Although most candidates gave correct answers, others gave 'the normal', 'refractive index' or just 'angle of incidence'.

(ii) Calculate the refractive index of the glass.

$$n = \frac{1}{6\sin c} = \frac{1}{\sin 40} = 1.56$$

refractive index = ...1.6.......... [2]

Examiner comment

Many candidates applied the equation for refractive index as $\frac{\sin i}{\sin r} = \frac{\sin 40}{\sin 90}$ and obtained an answer less than 1. When using this version of the formula to calculate the refractive index, the ray should be moving from air into glass and not from glass to air as in the diagram. Since light is reversible, the angle of incidence should be taken as the air angle, in this case 90°.

Question 8

8 Fig. 8.1 shows a step-down transformer used to operate an electric bell.

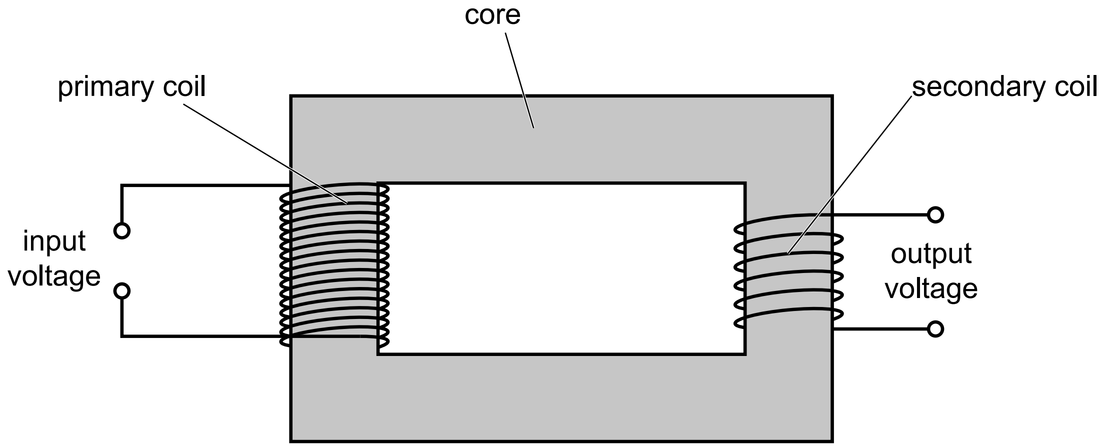


Fig. 8.1

(a) State the material used for the core of the transformer.

iron [1]

Examiner comment

Although most candidates knew that the core of a transformer is made from iron, some just suggested that it is made from 'a metal' or incorrectly stated the metal to be copper.

(b) A current in the primary coil produces a magnetic field in the core.

Explain how an alternating voltage is produced in the secondary coil.

An alternating current in the primary coil causes a changing magnetic field in the core. The changing magnetic field passes through the core to the secondary coil where it cuts the secondary coil and induces an alternating voltage in the secondary. [3]

Examiner comment

- Many candidates wrote at length about the construction of a step-down transformer, rather than answering the question which asked how an alternating voltage is produced.
- Many candidates incorrectly suggested that a current flows through the core from the primary to the secondary coil.
- Even where the idea of the cutting of the magnetic field by the secondary coil was mentioned, candidates did not always include that the current in the primary coil is the cause of the changing magnetic field.

(c) The transformer has 4600 turns on the primary coil which is connected to a mains supply of 230 V.

An output of 5.0 V is used to operate the bell.

Calculate the number of turns needed on the secondary coil.

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

$$N_s = 4600 \times \frac{5}{230} = 100$$

number of turns = ...100.......................... [2]

Examiner comment

Although most candidates knew the formula relating the turns on the coils to the voltages across the coils, some found it difficult to establish that the 5 V, used to operate the bell, was the voltage across the secondary coil.

(d) State one change that can be made to the transformer shown in Fig. 8.1 so that it can be used as a step-up transformer.

increase the number of turns on the secondary coil so that it is larger

than the number of turns on the primary coil .... [1]

Examiner comment

Most candidates recognised that to increase the output voltage then the number of turns on the secondary should be increased, but fewer mentioned that it should be greater than the number of turns on the primary coil. Some candidates suggested that the two coils should be swapped.

Question 9

9 A radioactive source emits α-particles, β-particles and γ-radiation.

(a) **(i)** State which type of radiation produces the strongest ionising effect.

alpha .... [1]

Examiner comment

Although candidates also gave beta radiation, some incorrectly considered that gamma radiation has the strongest ionisation effect.

(ii) State which type of radiation is deflected most by a magnetic field.

beta .... [1]

Examiner comment

Both gamma and alpha radiation were mentioned by those candidates who were incorrect, even though gamma is neutral and not deflected at all by a magnetic field and alpha radiation is deflected only a little because of its large mass.

(b) Fig. 9.1 shows a Geiger-Müller (G.M.) tube and counter. A radioactive source is placed 10 cm from the G.M. tube.

In Fig. 9.2 a piece of metal 5 mm thick is placed between the source and the G.M. tube. The readings on the counter have been corrected for background radiation and show the count rate due to the source.

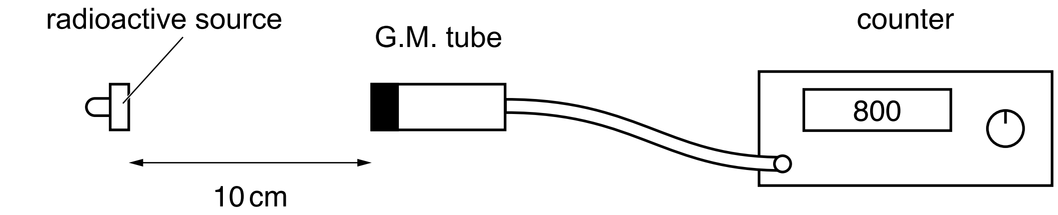


Fig. 9.1

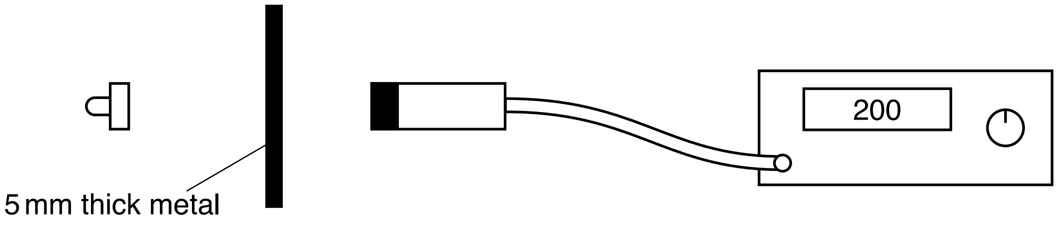


Fig. 9.2

(i) Explain how the readings show that the source emits β-particles and γ-radiation.

The fall in count rate, from 800 to 200, shows that beta particles are emitted by the source.

This fall is because beta radiation is stopped by the metal sheet.

The emission of gamma radiation is shown by the count rate of 200, since gamma radiation passes through the metal. [3]

Examiner comment

- Many candidates spent too much time describing how alpha radiation cannot be detected and so answered the next section **(b)(ii)**, without answering the question of how the emission of beta particles and gamma radiation is shown.
- Statements of fact, such as 'beta radiation is stopped by metal but gamma radiation is not stopped', needed to be applied to the question by using the information given in the question, in this case by mentioning the count rates given.
- Several candidates stated that both beta and gamma radiation are stopped by the metal.

(ii) State why the readings **cannot** be used to show that the source emits α-particles.

alpha radiation is stopped by a few cm of air and will not reach the detector, 10 cm from the source [1]

Examiner comment

Many candidates mentioned that alpha particles are stopped by paper, or just stated that alpha particles are easily stopped or do not travel far. They did not mention the range in air or the distance given in the question.

(c) Describe **one** way that a radioactive source is moved safely in a school laboratory.

use tongs to handle the radioactive source

[1]

Examiner comment

Of a number of possible safety precautions that could be mentioned, the storage of the source in a lead box was the most common. Some candidates merely stated that the source should be placed in a box, without specifying that the box be made of lead or a thick metal.

Question 10

10 (a) Astronomical distances are measured in light-years.

(i) State what is meant by 'a light-year'.

a light-year is the distance travelled in a vacuum by light in one year [1]

Examiner comment

- Many candidates did not recognise that a light-year is a distance. Instead, they stated that it was a time or that it was a distance, but did not mention either light or 'in a time of 1 year'.
- Some candidates gave details about the light-year, e.g. that it is used to measure distances to stars, but these were not sufficient unless detailed enough, e.g. that 1 light-year is 9.5×10^{15} m.

(ii) The Sun is one star in the Milky Way galaxy.

State the approximate diameter of the Milky Way galaxy.

diameter of Milky Way = 100 000 light-years [1]

Examiner comment

Only a few candidates knew this figure, even though it is stated in the syllabus.

(b) There are several stages in the life cycle of a star.

(i) Complete Fig. 10.1 to show the stages that a **massive** star goes through after it has used up most of the hydrogen at the centre of the star.

Use words from the following list:

nebula **neutron star** **protostar** **red giant** **supernova** **white dwarf**

massive star (much larger than our Sun)

↓

red supergiant

↓

.............supernova.............

↓

.............nebula............. and black hole or ....neutron star.........

Fig. 10.1

[2]

Examiner comment

Almost all the possible combinations of the words provided in the question were seen in the spaces provided in the two boxes. 'Protostar' was a common error.

(ii) State the stage in the life cycle of a star where heavy elements are formed.

..supernova.. [1]

Examiner comment

Only a few candidates mentioned the supernova as the stage in the life cycle of a star where heavy elements are formed, despite this being stated in the syllabus. Many candidates gave 'red giant' or 'red supergiant' instead. Although these giant stars form when most of the hydrogen in the centre of the star has been converted to helium, the heavy elements heavier than iron are formed in a supernova.

(c) Current scientific understanding is that the universe began 14 billion years ago in an event known as the Big Bang.

Explain **one** observation that supports the Big Bang Theory.

observation *the red shift shows the universe is expanding*

explanation *The red shift from distant stars and galaxies shows that they are moving away from the Earth; the amount of red shift is used to measure their speed. It is found that the further a galaxy from the Earth the greater the red shift and the faster it is moving away. Moving backwards in time, all stars and galaxies were closer together, initially in a very dense state.*

[4]

Examiner comment

- Explanations were usually in terms of red shift, but candidates also mentioned cosmic microwave background radiation. This was usually in terms of this radiation being left over radiation from the early universe, red shifted to microwave wavelengths. Its uniform intensity from all directions suggests that the universe was initially very compact and dense.
- Many candidates did not mention that the further the star or galaxy is from the Earth, the faster it is moving away from Earth. This was part of the narrative needed to show that matter in the universe was initially dense. Many candidates suggested that initially the universe was a 'point'. Ideally an answer would not state that the universe was originally a point, but that the universe was initially very dense. A statement that the universe started from a point was accepted, however.

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