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GCSE (9–1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/04 Summer 2022 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 4 series overview

J259/04 Depth in Physics is one of the two examination components aimed at Higher Tier candidates studying GCSE (9-1) 21st Century Science Suite which assesses content across the teaching chapters P1 to P7 including assessment of P8 Practical Skills. Questions 1 to 3 are overlap questions with the Foundation paper. The examination assesses the three Assessment Objectives; AO1 demonstrating knowledge and understanding of scientific ideas, techniques and procedures, AO2 applying that knowledge to solve problems and AO3 analysing information, drawing conclusions and improving experimental procedures. The majority of the paper assesses candidate's demonstration and application of their knowledge with 20% of the paper assessing their ability to analyse, interpret and evaluate information. With all J259 examinations there is a requirement to assess mathematical skills which comprise of approximately 30% of the paper which include calculations and graphical interpretation. This paper includes two LOR Questions; 2 and 7 and synoptic Questions 5a, b and c and 9ai where candidates are required to demonstrate and apply knowledge from the different teaching chapters in the specification.

Only a very small number of candidates achieved marks that indicated that the Foundation Tier examination would have been a more appropriate paper for them. There was a broad spread of marks given which indicates the accessibility of the paper and that candidates have been entered for the correct tier of entry. This may be due to the Advanced Information issued to Centres to mitigate the disruption caused by the pandemic centres to help support all teachers and students with revision for the Summer 2022 exams and the data sheet of all specification equations given to candidates in the examination.

The information in the advance information for J259/04:

J259/04 Depth in Physics, Higher Tier Up to approximately 80% of the total paper content will be assessed from:

- Section 1.4 What happens when light and sound meet different materials?
- Section 3.2 What determines the current in an electric circuit?
- Section 3.4 What determines the rate of energy transfer in a circuit?
- Section 3.7 What is the process inside an electric generator?
- Section 4.4 How can we describe motion in terms of energy transfers?
- Section 5.2 How can radioactive materials be used safely?
- Section 6.4 How does the particle model relate to pressure in fluids?
- Section 6.5 How can scientific models help us understand the Big Bang?

Required practical skills that will be assessed:

- Practical Activity Group 6: Investigating the I-V characteristics of a diode

Topics not assessed in this paper:

- Section 1.1 What are the risks and benefits of using radiations?
- Section 1.2 What is climate change and what is the evidence for it?
- Section 2.2 How can electricity be generated?
- Section 3.1 What is electric charge?
- Section 3.6 How do electric motors work?

- Section 4.2 How can we describe motion?
- Section 5.3 How can radioactive materials be used to provide energy?
- Section 6.1 How does energy transform matter?
- Section 6.3 How does the particle model relate to material under stress?

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
The positive attributes of the candidates in this component were: • Selecting, rearranging, and substituting numbers into equations with their working shown clearly • Describing a relationship between two quantities presented in a table or chart • Developed their reasoning or justifications with correct and suitable scientific terminology • Generally, good comprehension of command terms such as describe, explain, evaluate, etc.	There were some missed opportunities in this component. Candidates are reminded that they can maximise marks in future examinations by following some of the procedures below: • Converting units e.g. mA to A • If a question specifically asks to refer to information/data/graph in a figure it must be used/manipulated to support a relationship described in their response • If a question specifically asks to refer to a scientific model/quantity it must be used to explain their response e.g. particle model, wave speed and wavelength • Recognising that when drawing a line of best fit for plotted points that a curved line is required and to avoid the misconception that a line of best fit is always a straight line

Question 1 (a)

1 Layla is investigating how the pressure of a given mass of gas changes when the volume of the gas is increased.

She uses the apparatus shown in **Fig. 1.1**, and keeps the experiment at a constant temperature.

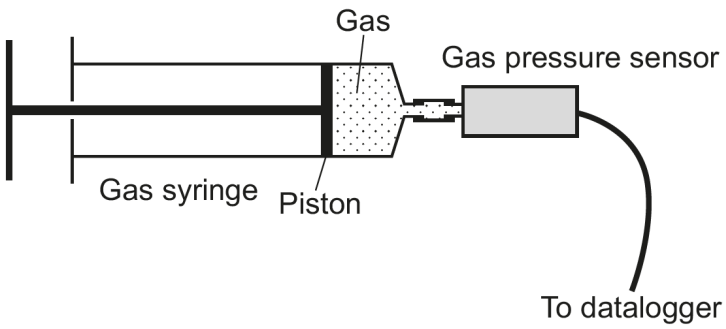

Fig. 1.1

(a) Explain why Layla needs to keep the temperature constant.

Use ideas from the particle model in your answer.

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..... **[2]**

Candidates did well on this question as most were given 1 or 2 marks for explaining the relationship between temperature and energy of the gas particles and with fewer of candidates linking this relationship to the particle model in terms of a change in the frequency of collisions but some did not score as they would confuse ideas of particle model of the pressure of a gas with changes of state.

Question 1 (b)

(b) **Fig. 1.2** shows a close-up image of the gas syringe and the path of a gas particle hitting the piston.

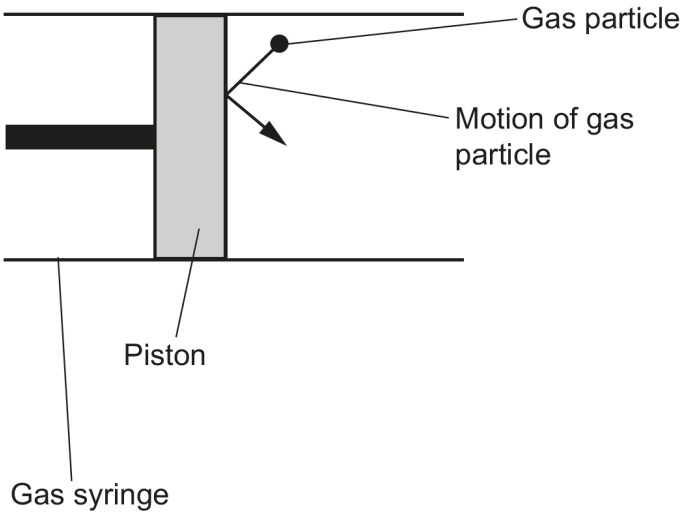

Fig. 1.2

Draw an arrow on **Fig. 1.2** to show the direction of the net force applied to the piston by the gas particle. **[1]**

Over half of candidates were given 1 mark for correctly drawing the net force applied by the gas particle perpendicular to the surface of the piston.

Question 1 (c) (i)

(c) Layla moves the piston to increase the volume of the gas and records her results in the table.

Volume (cm^3)	Pressure (N/cm^2)
4.0	8.40
8.0	4.20
12.0	2.80
16.0	2.10
20.0	1.68

(i) Calculate the total force acting on the area of the piston when the volume of the gas is 8.0 cm^3.

The cross sectional area of the piston is 4 cm^2.

Use information from the table and the Data Sheet.

Force = ... N **[3]**

Candidates performed well on this question as the majority correctly calculated the Force by selecting the equation Pressure = Force/Area from the data sheet and the correct value of pressure from the table.

Question 1 (c) (ii)

(ii) Calculate the constant for this given mass of gas.

Use the equation: pressure × volume = constant

Give your answer to **2** significant figures.

Constant = ... Ncm **[3]**

Candidates performed well on this question as over half of candidates were given 3 marks but some candidates were given 2 marks as they did not give their answer to 2 significant figures as stated in the question.

Question 1 (c) (iii)

(iii) Explain what conclusions Layla can make from the results in her table.

Use data from the table to support your answer.

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..... **[3]**

Candidates performed well on this question as almost all candidate responses were given 1 mark for describing the relationship between pressure and volume for the results given in the table. The most successful responses given by less than half of candidates used supporting data from the table to explain the relationship between pressure and volume but very few candidates qualified this relationship as being inversely proportional.

Question 2*

2* The table shows the half-life and penetration power of some isotopes, A to E.

Isotope	Half-life	Penetration power
A	5 years	Reduced by thick lead
B	5 hours	Stopped by thin aluminium
C	2 minutes	Stopped by skin
D	6 hours	Reduced by thick lead
E	47 days	Stopped by thin aluminium

A medical tracer is injected into the body, for medical imaging purposes. A medical tracer contains a radioactive isotope that emits radiation. This radiation is detected from outside the body to produce an image.

Evaluate which isotope would be best suited to be used as a medical tracer.

Use your knowledge of the risks and benefits of using radioactive isotopes for medical imaging in your answer.

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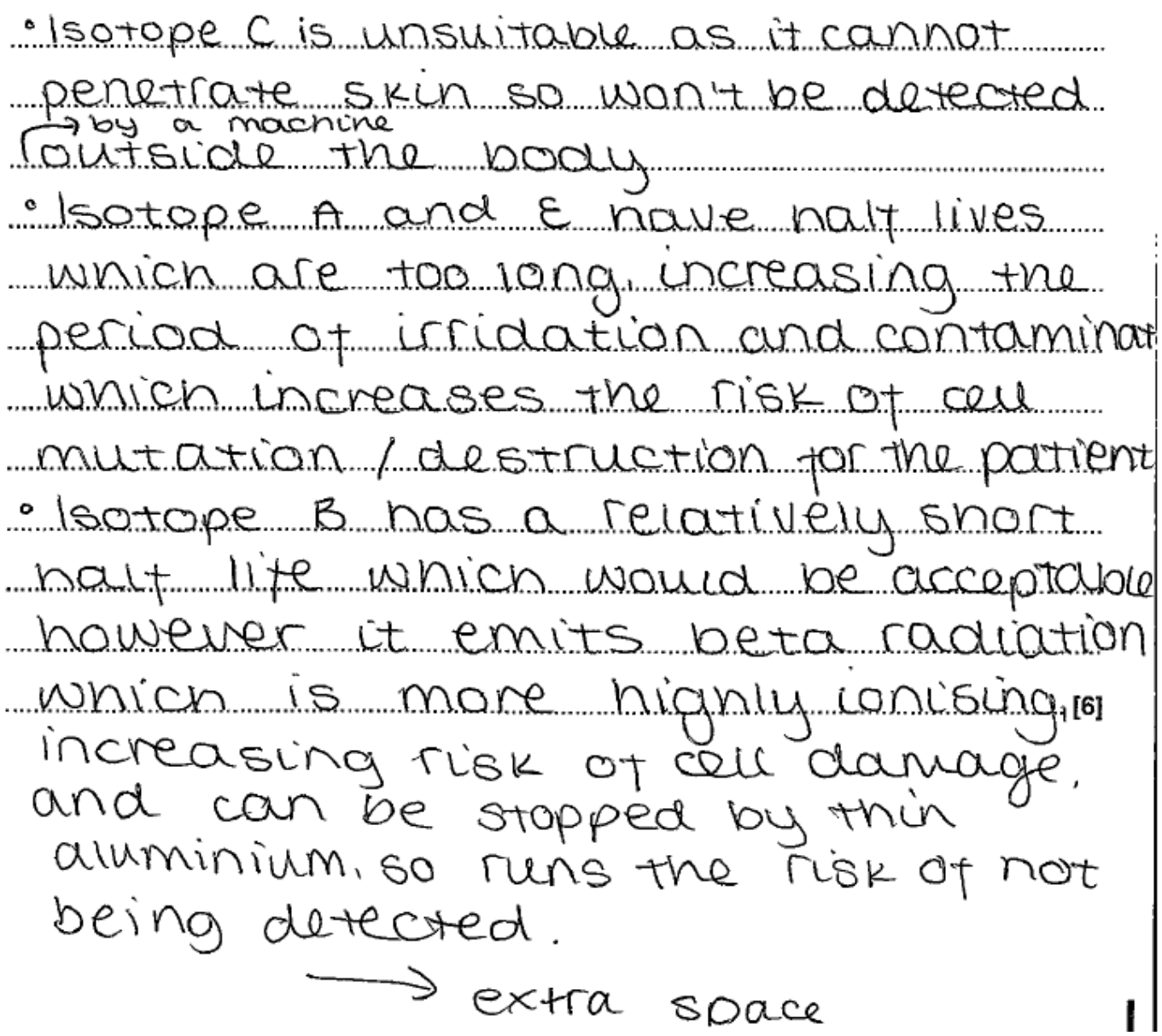
..... **[6]**

This question was the overlap LOR question so higher tier candidates are expected to do well on this question which was demonstrated by about half of candidates being given L3 5/6 marks. Some candidates gave an excellent evaluation of a single radioactive isotope but did not compare to another isotope, so this limited them from gaining L3 marks. Most candidates demonstrated a good understanding of the risks of radioactive isotopes in terms of ionising power with some candidates making the link between the penetration power and the type of radiation emitted. There were less successful descriptions of the risks and minimisation of risk in terms of contamination and irradiation but there was a good understanding of half-life and how this impacted on safety when minimising the risk to patients. Some candidates confused a radioactive tracer with radiotherapy as they described the penetration of the different isotopes into the body rather than exiting the body and some discussed issues with handling and storage of the isotopes which did not answer the questions in terms of the suitability as a medical tracer for medical imaging.

Assessment for learning

When asked to evaluate the most suitable quantity, in this case radioactive isotopes, candidates are expected to judge the most appropriate quantity by comparing the desirable properties of a minimum of 2 isotopes to conclude which would be the best suited when addressing the question and the given information.

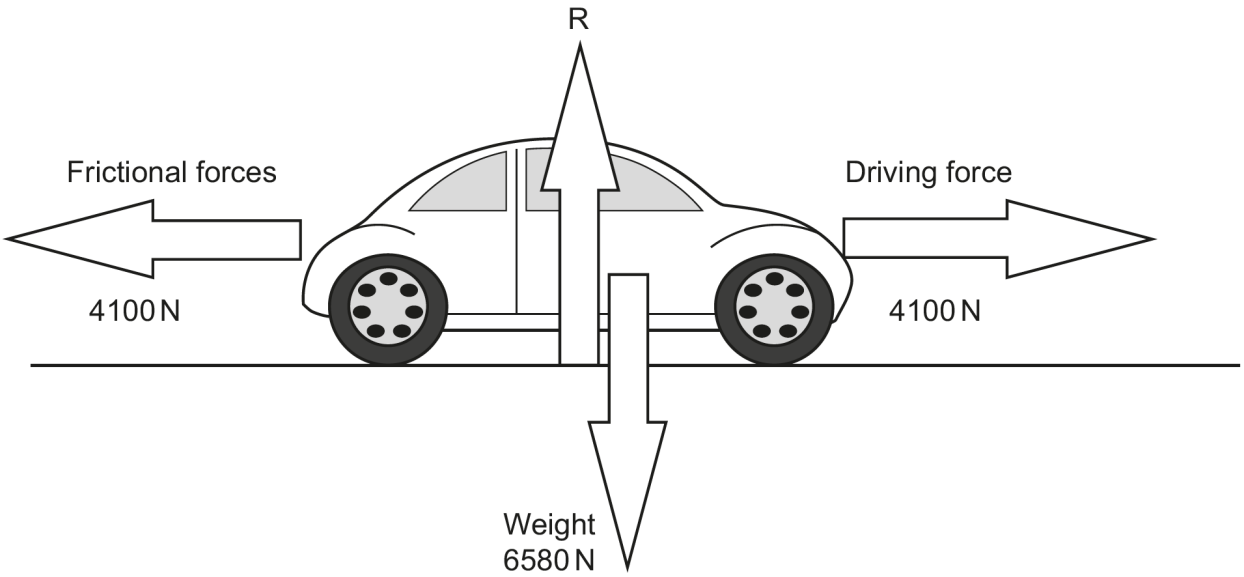
Exemplar 1



This response shows a Level 3 response where several isotopes have been compared to evaluate the most suitable radioactive isotope used for medical imaging.

Question 3 (a) (i)

3 The diagram shows the forces acting on a car travelling at a constant speed in a straight line.



(a) (i) Calculate the mass of the car.
Use the Data Sheet.

Gravitational field strength = 10 N / kg

Mass = ... kg **[3]**

All candidates performed well on this questions and correctly selected w=mg to calculate the mass of the car.

Question 3 (a) (ii)

(ii) What is the magnitude of the total reaction force, R?

..... **[1]**

Only a few candidates were not given a mark for stating that the magnitude of the reaction force was equal to the weight of the car.

Question 3 (a) (iii)

(iii) The driving force is increased to 4500 N and the car accelerates.

State the resultant force acting on the car as the car accelerates.

..... **[1]**

About half of candidates stated that the resultant force was 400N as they applied that the resultant force was the driving force – frictional forces acting when the car was accelerating. For candidates not given the mark it was because the responses given just stated a force acting on the car i.e., driving force or frictional force rather than recognising that the resultant force is the overall force.

Question 3 (b)

(b) Explain how the magnitude of the resultant force changes as the car accelerates to its maximum speed.

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..... **[3]**

Candidates did not perform as well on this question as only a little more than a quarter of candidates were given at least 1 mark as they only discussed the magnitude of the resultant force at the instant that the car started to accelerate when the driving force had increased to 4500N rather than that the car was accelerating to its maximum speed. The most common response from candidates was that the driving force had increased and hence the resultant force had increased as the car was accelerating. Candidates did not recognise that when reaching a maximum speed that the acceleration is decreasing and hence the resultant force was reducing. Some candidates attempted to describe that the forces were balanced when the car reached its maximum speed but confused driving force and resultant force when equating it to the frictional forces acting.

Misconception

? The resultant force decreases when an object is accelerating to a maximum speed as the frictional forces acting are increasing until they are balanced with the driving force and the acceleration is zero.

Question 4 (a)

4 Li investigates the I-V characteristics of a diode using the circuit shown in **Fig. 4.1**.

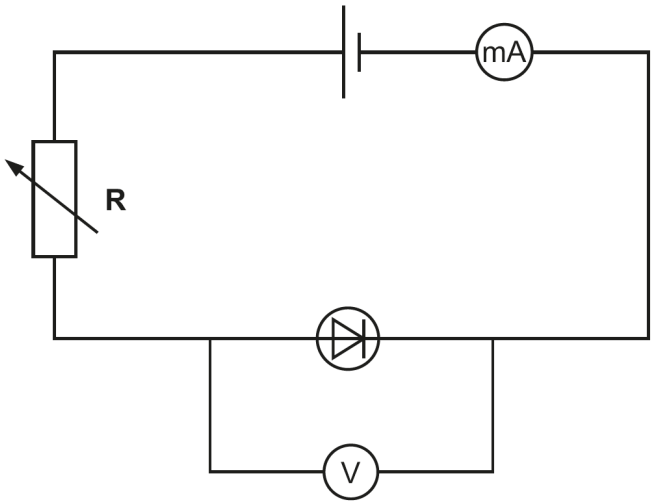


Fig. 4.1

(a) Li's results are shown **in Fig. 4.2**.

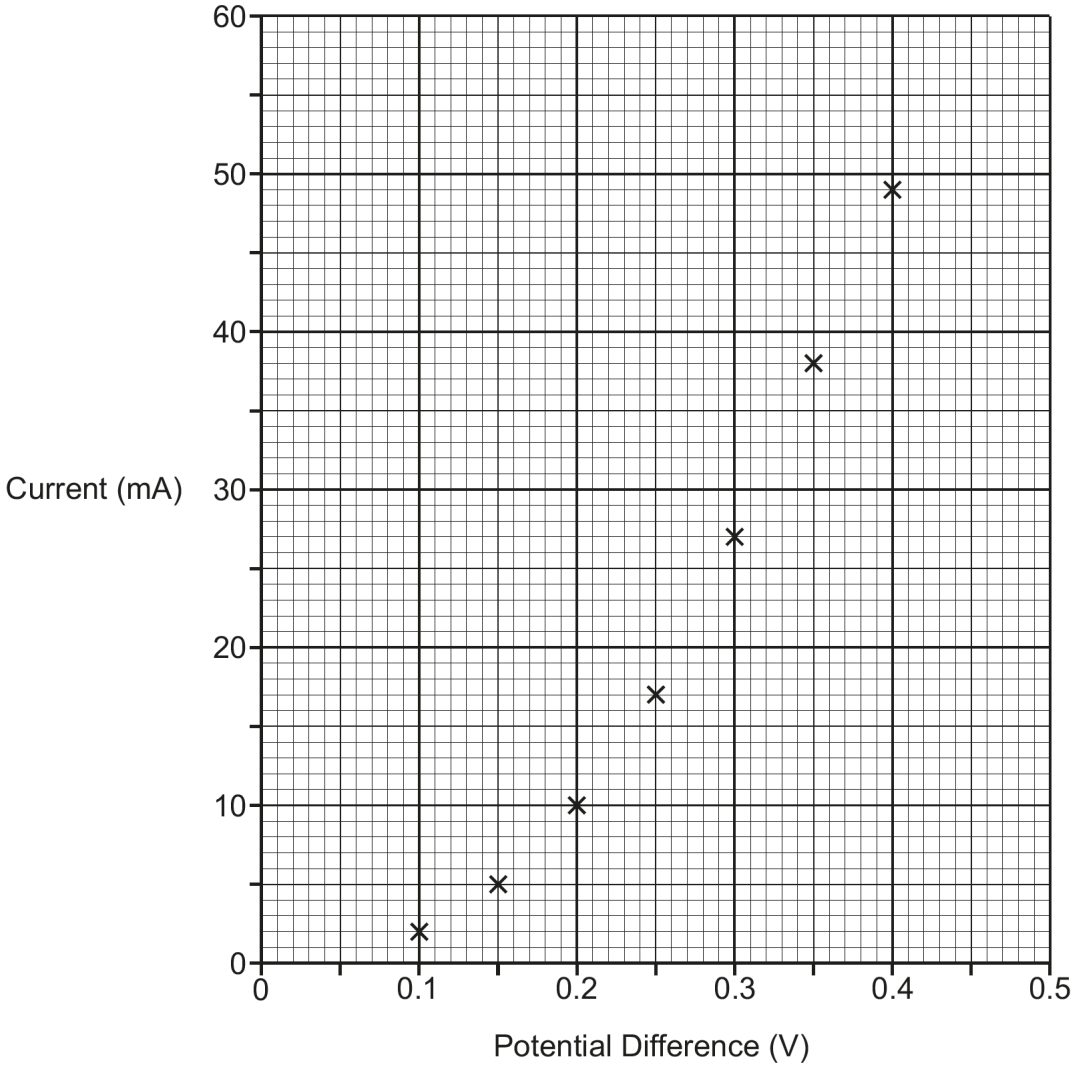
Draw a line of best fit for Li's results. **[1]**

Only half of candidates drew a correct curved line of best fit and this was consistent across all abilities of candidates.

Misconception

This is a common misconception that a line of best fit is a straight line that goes through the middle of all the scatter points irrespective on the scatter of the plotted points.

Question 4 (b) (i)



(b) (i) Name the component, **R**, in **Fig. 4.1** and explain how it is used to produce the graph in **Fig. 4.2**.

Component **R** is .....

Explanation .....

.....

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..... **[3]**

Candidates did not perform as well on this question as it was mostly candidates in the highest quartiles that were given a mark for correctly identifying the component R as a variable resistor. Typical responses identified the component as a resistor, diode or thermistor and attempts to use the graph to explain the named component were less successful.

Question 4 (b) (ii)

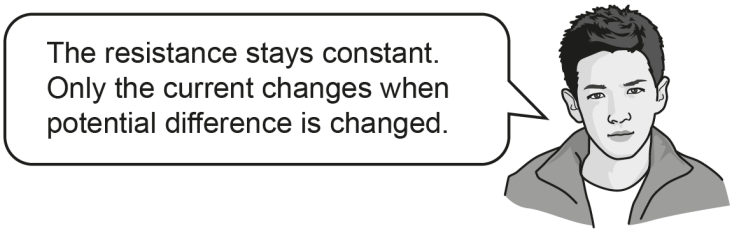
(ii) Calculate the resistance of the diode when the potential difference across it is 0.3 V, using **Fig. 4.2**.
Use the Data Sheet.

Resistance = ... Ω **[4]**

Candidates performed well on this question as about half of candidates were given 3 marks for calculating a value of resistance with the value of 27mA taken from the graph. It was mostly candidates in the upper quartile that were given 4 marks for carrying out a correct conversion of mA to A.

Question 4 (c)

(c) Li makes this conclusion:



Explain why Li is wrong.

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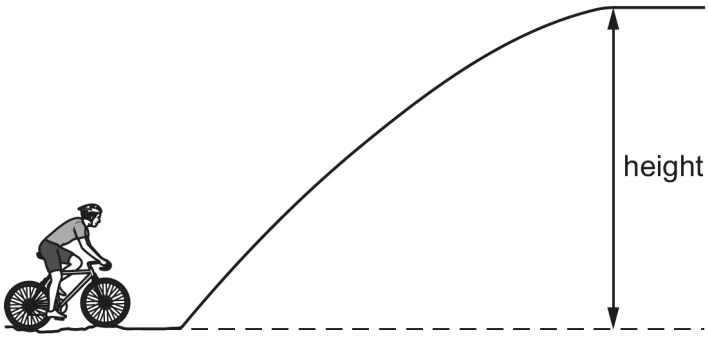
..... **[2]**

Candidates at all abilities did not perform well on this question as very few candidates referred to the graph recognising that the gradient represented the resistance and that it was not constant.

Question 5 (a) (i)

5 Alex is cycling up a hill as shown in the diagram.

The mass of Alex and the bicycle is 95 kg.



(a) (i) At the top of the hill, the gravitational potential energy store of Alex and the bicycle has increased by 7600 J.

Calculate the height at the top of the hill.

Use the equation:
gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N / kg

Height = ... m **[2]**

Nearly all candidates were given 2 marks for correctly calculating the height of the hill with the given equation for gravitational potential energy.

Question 5 (a) (ii)

(ii) Alex transfers 9000 J of energy to reach the top of the hill.

Explain why the amount of energy transferred by Alex is different to the increase in the gravitational potential energy store.

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..... **[3]**

Over half of candidates were not given a mark for explaining that the difference in the increase of the gravitational potential energy store was due to having to do work against resistive forces resulting in an increase to the thermal energy store of the surroundings. Typical responses described the energy transfer between the kinetic energy store to the gravitational potential energy store with occasional references of energy losses to 'heat' but did not qualify this response by describing that the thermal store of the surroundings was increasing. Some candidates had the idea that friction was acting against Alex as he cycled up the hill, but this was not developed in terms of doing work and therefore, responses given were vague and superficial.

Question 5 (a) (iii)

(iii) Calculate the efficiency of Alex to get to the top of the hill.

Use the equation: efficiency = useful energy transferred ÷ total energy transferred

Efficiency = ... **[2]**

Most candidates were given 2 marks for calculating the correct efficiency of Alex. Candidates that were not given a mark tended to be in the lowest quartile.

Question 5 (b)

(b) Alex goes back down the hill without pedalling.

Calculate the maximum speed that Alex can reach.

Assume that no energy is lost going back down the hill.

Use the equation: kinetic energy = 0.5 × mass × $(\text{speed})^2$

Give your answer to **1** decimal place.

Speed = ...m/s **[3]**

Few candidates were not given a mark usually for not giving an incorrect answer to 1dp. Over a third of candidates were given 3 marks for using the correct value of KE to be 7600J assuming no energy losses but fewer used the value 9000J as the KE which did not equate to the GPE but correctly calculated the speed given to 1dp to be given 2 marks.

Question 5 (c)

(c) Alex buys an electric bike which assists pedalling by supplying 11 A of current from a 24 V battery. It takes Alex 30 seconds to reach the top of the hill.

A total of 9000 J of energy needs to be transferred by Alex and the battery to reach the top of the hill.

Calculate the energy supplied by the battery, and use this to calculate the energy that Alex needs to supply by pedalling.

Use the equations: power = current × potential difference **and** power = energy ÷ time

Energy supplied by Alex = ... J **[4]**

This question discriminated between the highest and lowest quartiles of candidates as candidates in the highest quartiles were given 3 or 4 marks in contrast with candidates in the lowest quartile who did not perform as well. Candidates had to use the two equations to firstly calculate the energy of the battery and then subtract this from 9000J or calculate the difference in power of the battery and Alex to then calculate the energy Alex needed to supply by pedalling. Candidates in the lower quartiles made attempts at calculating a power either of the battery or Alex but did not continue this further to find the difference and hence the energy needed to be supplied by pedalling.

Question 5 (d)

(d) Alex says 'If I cycle more slowly, I will use less power to reach the top of the hill'.

Explain why Alex is correct.

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..... **[3]**

Candidates did not perform as well on this question as about half of candidates were not given a mark. About half of candidates linked the increase in time to cycle to his slower speed but some candidates just repeated the stem of the question that the power would be less without explaining this with reference to power = energy/time. A lot of responses described that the energy transferred would be less and this was the reason for the decrease in power.

Misconception

For this question Alex is cycling up the same hill so the energy transfers are the same, but many candidates linked the reduction in power to less energy rather than an increase in time for the same energy transfer.

Question 6 (a)

6 (a) Which ray diagram in **Fig. 6.1** shows how rays of light are refracted by a **concave** lens?

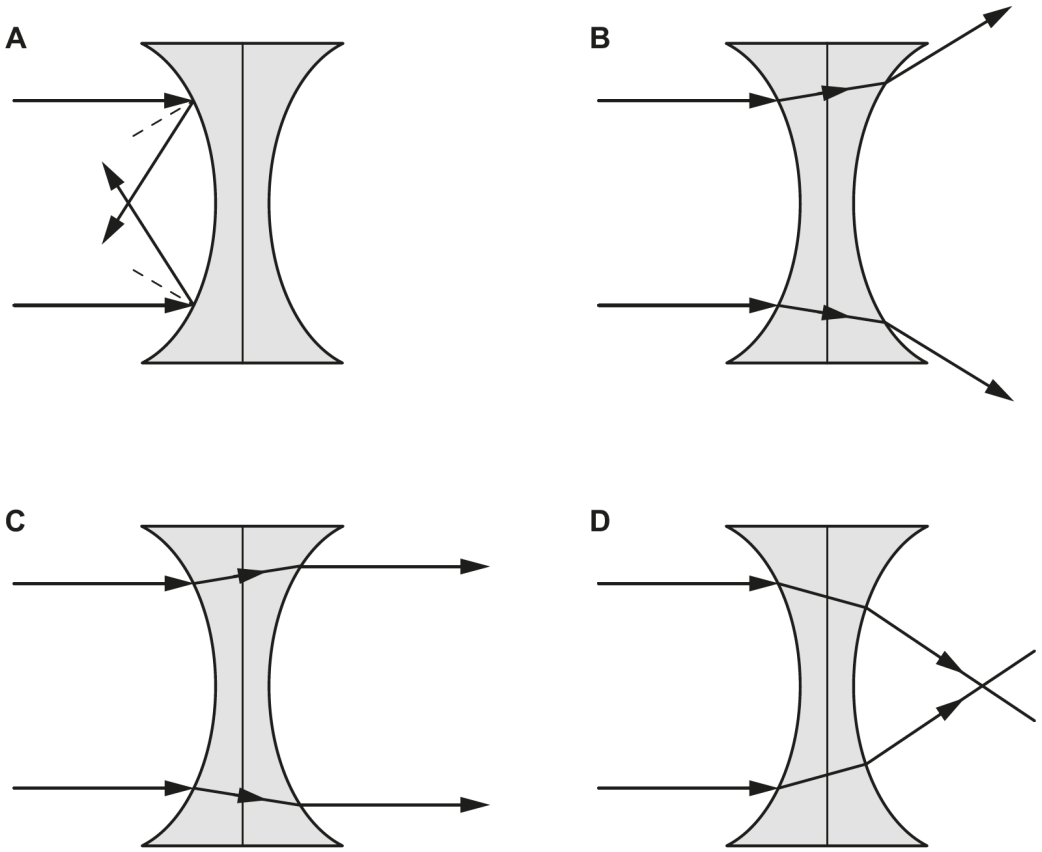

Fig. 6.1

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

Candidates performed well on this question with most candidates were given 1 mark.

Question 6 (b) (i)

(b) Blue light is shone on to a **convex** lens.

Fig. 6.2 shows two parallel rays **A** and **B**. The path of ray **A** is drawn. Ray **B** is only partially drawn.

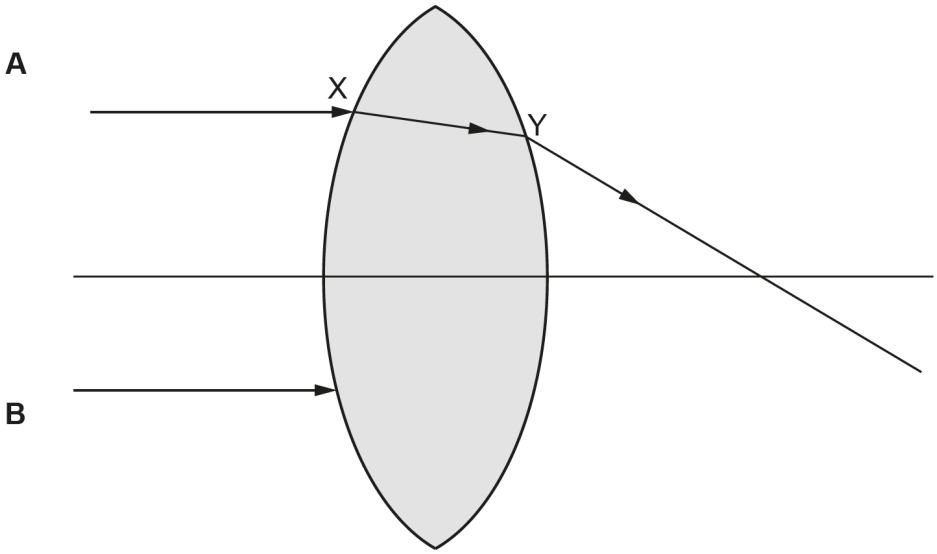

Fig. 6.2

(i) Complete the path of ray **B**. **[2]**

Candidates performed well on this question as most candidates were give 2 marks for correctly drawing the path of ray B in the convex lens. Candidates who were given either 0 or 1 mark were for either not intersecting rays A and B on the principal axis or incorrectly drawing the refraction of ray B entering or leaving the lens.

Question 6 (b) (ii)

(ii) Ray **A** enters the lens at point X and leaves the lens at point Y.

Explain why ray **A** changes direction at the points X and Y.

Use ideas about wave speed and wavelength in your answer.

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..... **[3]**

About a third of candidates were not given a mark for this question and also a third were only given 1 mark for correctly describing that the wave speed decreased at X (or increased at Y) due to the difference in density of medium. Only about a quarter of candidates then explained this change in wave speed to the wavelength as directed by the question or explained the corresponding change in direction at point X or Y to be given 2 or 3 marks.

Misconception

Candidates would sometimes confuse the refraction of light with sound describing that the wave speed would increase when it entered at point X. Also, candidates did not apply the proportional relationship between wave speed and wavelength as frequency is constant ($v=f\lambda$) when light passes through a difference medium.

Question 6 (c)

(c) Red light has a longer wavelength than blue light.

Explain how the path of ray **A** in **Fig. 6.2** would be different if red light was used.

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..... **[2]**

Candidates did not perform well on this question as more than half of candidates were not given a mark. Candidates described how the wavelength of red light was greater than blue light but did not explain how this difference in wavelength affected the refraction of the path of the ray as it passed through and out of the lens. Some candidates tried to qualify their response when the ray left the lens, but these were vague and not well developed, e.g. red light comes out straighter so were not given a mark.

Question 7*

7* Edwin Hubble studied the visible light spectrum of distant galaxies and compared them to the spectrum of our Sun.

Fig. 7.1 shows the visible light spectrum of our Sun, and the visible light spectrum of two galaxies, Galaxy X and Galaxy Y.

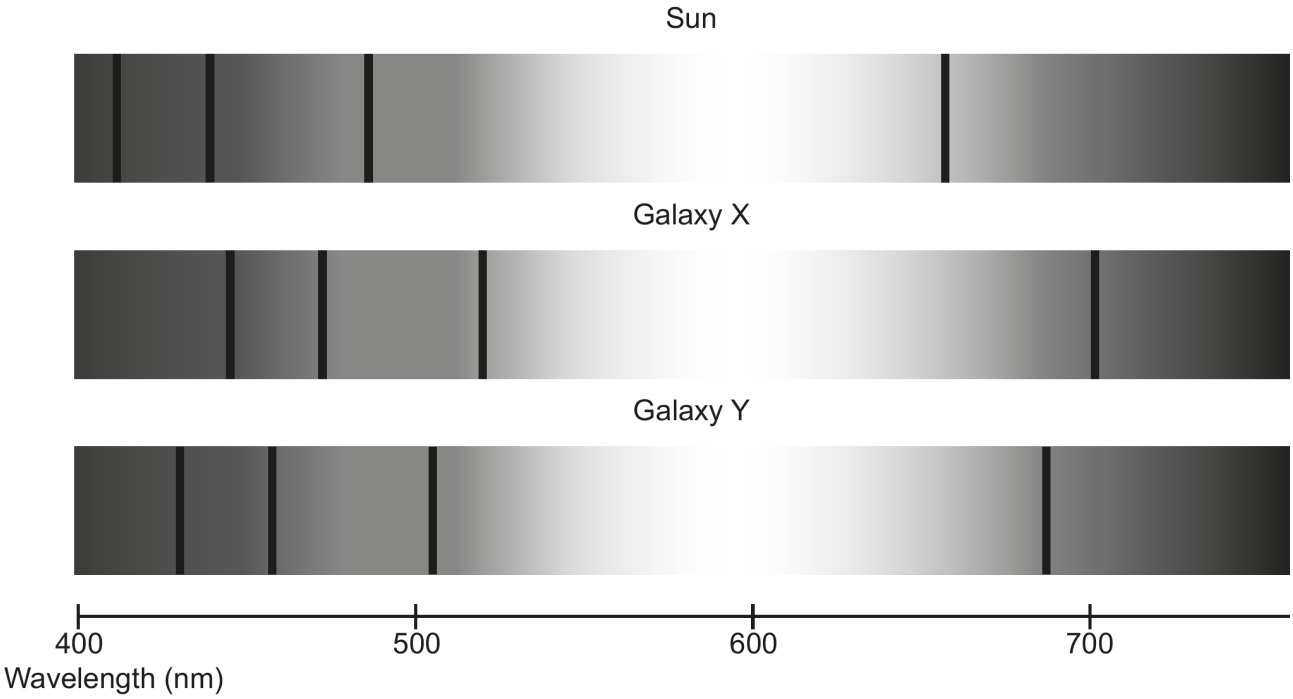

Fig. 7.1

Hubble used his observations to produce the graph shown in **Fig. 7.2**. The graph includes the two galaxies, Galaxy X and Galaxy Y.

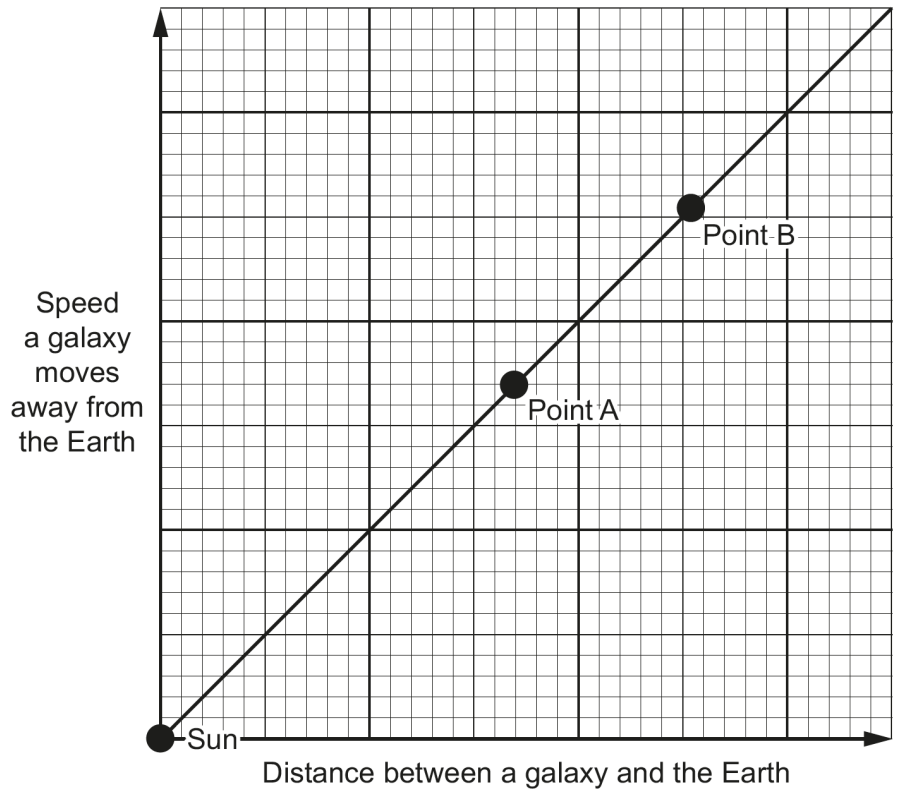

Fig. 7.2

Explain how the evidence in **Fig. 7.1** and **Fig. 7.2** leads to the 'Big Bang' model of the universe.

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..... **[6]**

This LOR question discriminated between the different abilities of candidates as candidates in the higher quartiles were given higher marks > 3 marks for higher L2 and L3 responses. These candidates used correct scientific language to explain red shift when interpreting Figure 7.1 and would support this with reference to Figure 7.2 and the relationship between the recessional speed of a galaxy and its distance from Earth and then use this to explain the expansion of the Universe.

Responses from candidates in the lower quartiles were less developed as candidates made simple descriptions of one figure without interpretation and explanation of how it leads to the Big Bang.

Exemplar 2

As an object travels away from you, the light it gives off becomes streatched therefore the wave length increases. Red light has the longest wavelength, so the light given off by galaxys or suns moving away from us looks red. This can be seen in Fig. 7.1 because galaxy X and Y's visable light is closer to the right than the suns and therefore is moving away from us. All galaxys in the universe apear to be moving away from us which shows everything is moving out from a singular point (The sigut of the big bang) if galaxys were just traveling in any direction same galaxies would be traveling towards us. [6]

The further away a galaxy is from us the faster it is traveling so the redder it will apear because all galaxies have travelled from the same point and started traveling at the same time so therefore it must be traveling faster.

This response shows a Level 3 response where the evidence in both figures 7.1 and 7.2 has been interpreted and explained how it supports the idea of the Big Bang and the Universe is expanding.

Question 8 (a)

8 **Fig. 8.1** shows an alternating current (a.c.) generator.

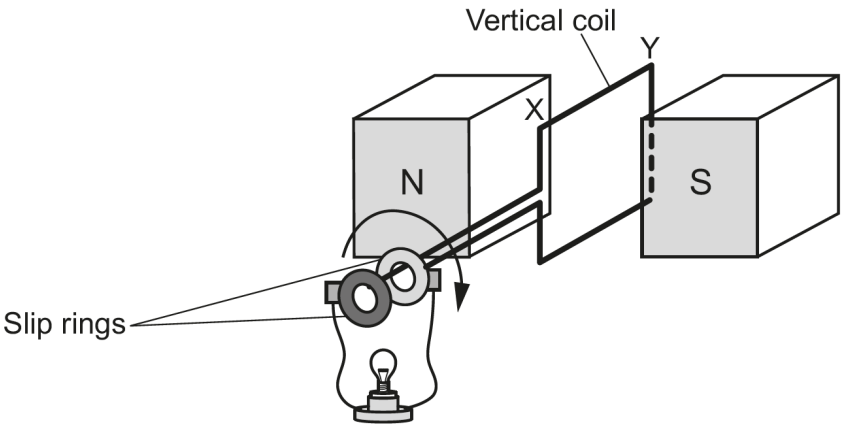

Fig. 8.1

Fig. 8.2 shows the potential difference generated across the bulb as the coil rotates.

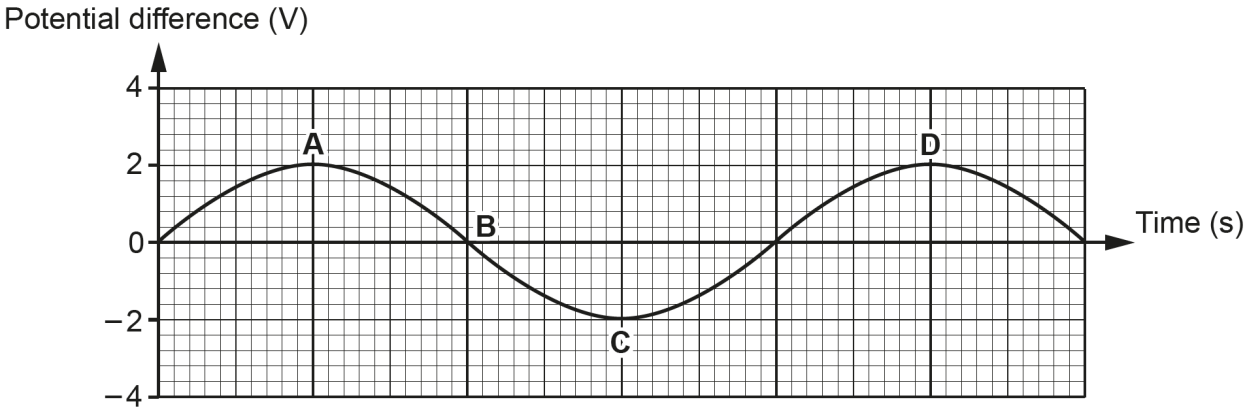

Fig. 8.2

(a) Which letter in **Fig. 8.2**, **A**, **B**, **C**, or **D**, shows the potential difference when the coil is in the vertical position shown in **Fig. 8.1**?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

Candidates performed well on this question as most correctly identified that the position of the coil corresponded to B on the potential difference/time graph.

Question 8 (b)

(b) Explain the change in potential difference during one complete revolution of the coil, using **Fig. 8.2**.

Include the side of the coil labelled XY **in Fig. 8.1** in your answer.

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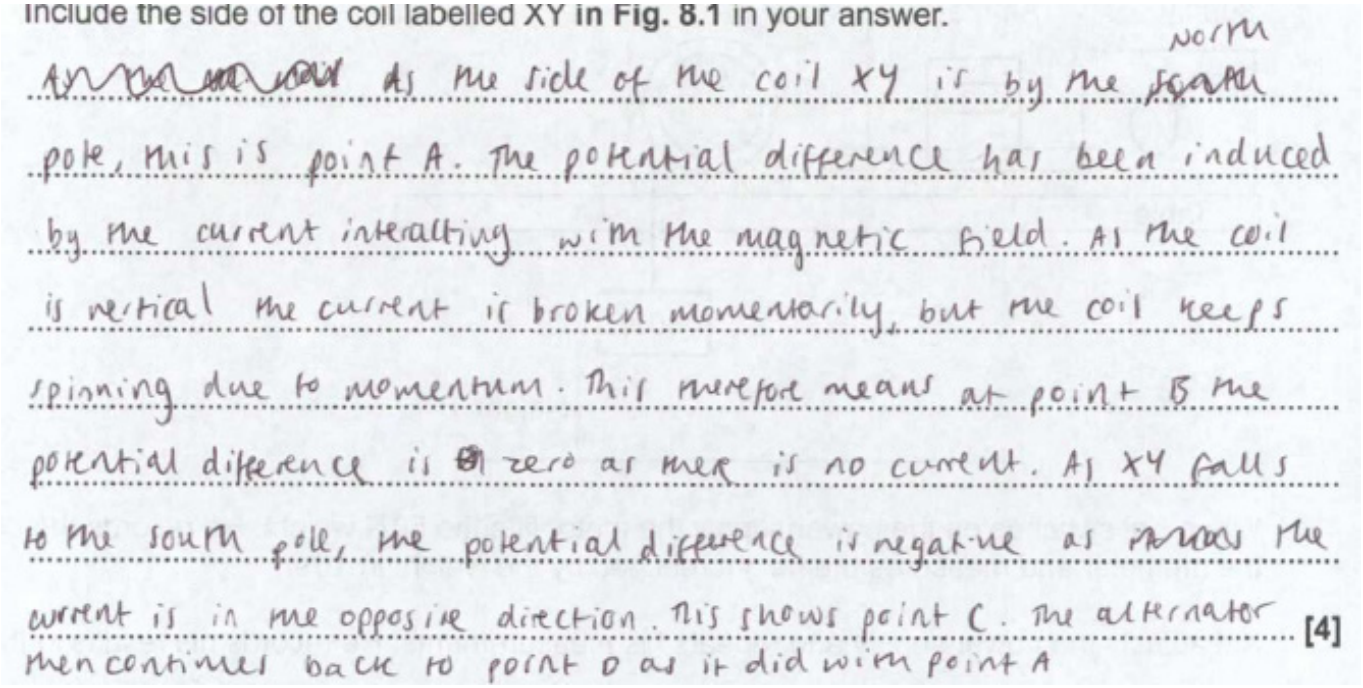
..... **[4]**

Candidates did not perform well on this question as over half of candidates were not given a mark as explanations were vague and not developed as they described the movement of the coil and did not link the position of XY with the values of potential difference at A, B and C on the graph Fig. 8.2. Some candidates confused the ac generator with the motor effect. When marks were given, it was generally candidates in the highest quartle as they used correct scientific terminology understanding that potential difference was induced when the coil rotated in the magnetic field, and some were able to explain how the change in potential difference on the graph linked to a position of XY.

Exemplar 3


Include the side of the coil labelled XY in Fig. 8.1 in your answer.

At the start as the side of the coil XY is by the north pole, this is point A. The potential difference has been induced by the current interacting with the magnetic field. As the coil is vertical the current is broken momentarily, but the coil keeps spinning due to momentum. This therefore means at point B the potential difference is zero as there is no current. As XY falls to the south pole, the potential difference is negative as across the current is in the opposite direction. This shows point C. The alternator then continues back to point D as it did with point A [4]

Exemplar 3 shows a response of a candidate performing at the highest quartile. They have explained that potential difference is induced and the change in potential difference at B when the coil is vertical. The candidate has explained sufficiently the change in potential difference at C and linked this to the position of the coil to be given the mark.

Question 8 (c) (i)

(c) (i) What change could be made to the generator in **Fig. 8.1** to change it into a direct current (d.c) generator?

.....

..... **[2]**

Candidates did not perform well on this question as more than half of candidates were not given a mark. Candidates who did suggest that a split ring commutator was needed to change the generator to a direct current generator were in the highest quartile with only a few fully qualifying their response by suggesting that this needed to replace the slip rings labelled in Fig. 8.1.

Question 8 (c) (ii)

(ii) Draw the potential difference output for a **direct** current generator rotated at the same speed, on **Fig. 8.3**.

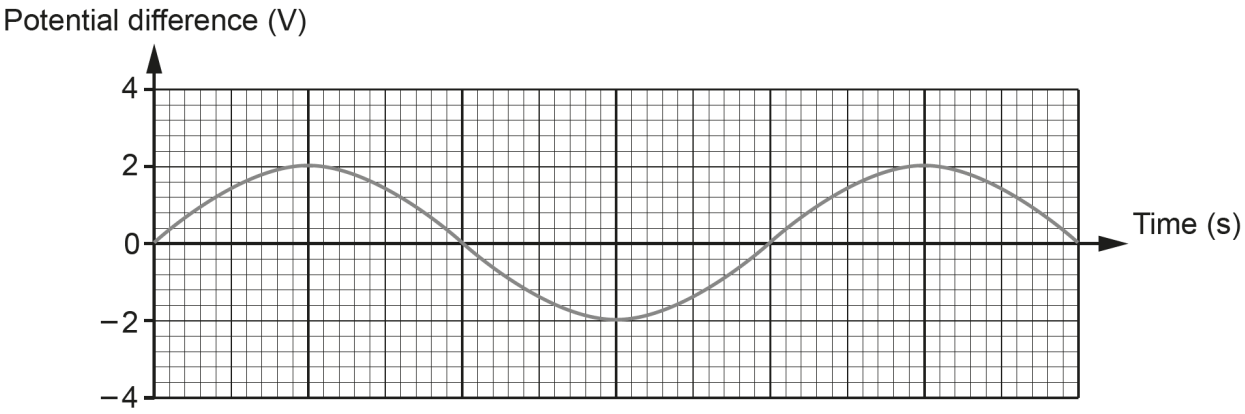


Fig. 8.3

[2]

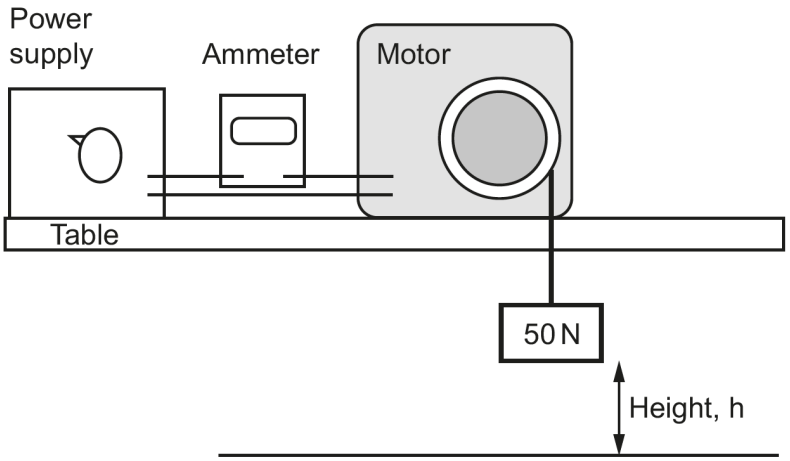
Candidates did not perform well on this question as more than half of candidates were not given a mark. There was also a high omittance rate on this question and candidates who were given a mark were in the highest quartile.

Misconception

? A common response from candidates was a dc voltage graph at a constant potential difference graph drawn at 2V as they did not apply for a dc generator that the graph is a sine curve that is in positive (or negative) all the time.

Question 9 (a) (i)

9 Kai uses the apparatus shown in the diagram to investigate the efficiency of an electric motor.



When Kai switches on the power supply the motor lifts the 50 N weight. He records the current on the ammeter and measures the height reached by the weight in 10 s.

Kai adjusts the power supply and repeats his measurements. He records his results in the table.

Current (A)	Height reached by 50 N weight (m)	Power output (W)
0.0	0.0	0.0
0.5	1.24	6.2
1.0	1.90	9.5
1.5	2.24	11.2
2.0	2.30	

(a) (i) Calculate the power output when the current is 2.0 A.

Use the equation: power = work done ÷ time

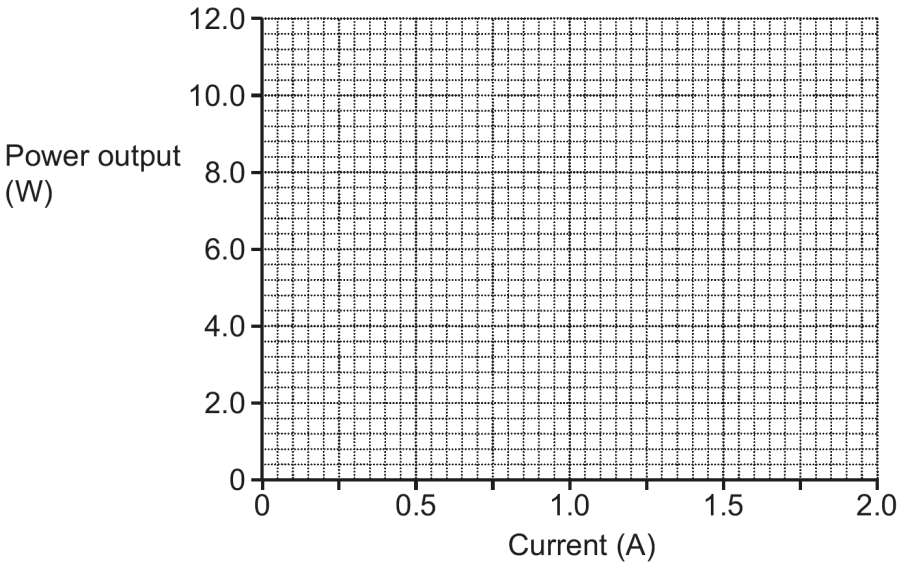
Use the Data Sheet.

Power output = ... W **[3]**

Candidates performed well on this question as most candidates were given 3 marks for correctly selecting the equation work done=force x distance and substituting into the given equation for power to calculate the power output of the motor consistent with the values given in the table.

Question 9 (a) (ii)

(ii) Plot the power output against the current on the graph.

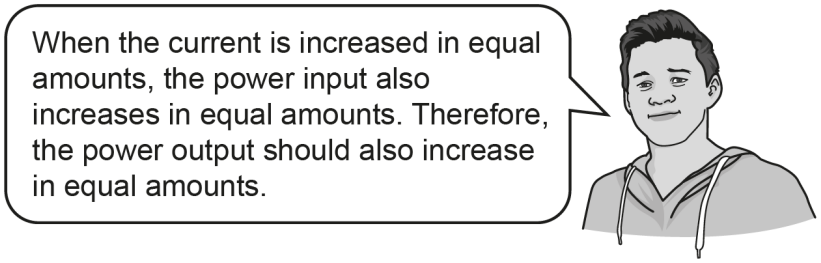


[2]

Over three quarters of candidates were given at least 1 mark with less than half of candidates scoring 2 marks for correctly plotting the points and drawing a line of best fit. For candidates who were not given a mark, it was for not plotting all the points given in the table, generally omitting to plot the point (0, 0). For the candidates who were given 1 mark it was for either plotting all the points correctly or drawing a line of best fit for the points plotted.

Question 9 (b)

(b) Kai made a hypothesis before recording his results.



What other quantity would need to be measured to confirm this hypothesis?

Explain your answer.

Quantity .....

Explanation .....

.....

.....

[2]

Candidates did not perform well on this question as most candidates were not given a mark. This question discriminated between the higher and lower quartiles as it was mostly candidates' responses from the highest quartile that were given a mark for identifying that the potential difference was the quantity to be measured to confirm the hypothesis as power input would need to be calculated from potential difference x current.

Question 9 (c)

(c) Write a conclusion that Kai can make about the electric motor.

Use data from the graph to support your answer.

.....

.....

.....

..... **[2]**

Candidates across all abilities did not perform well on this question as most candidates were not given a mark. Most typical candidate responses described a proportional relationship between the power output and current from the graph sometimes supporting this with data to show that as the current increased so did the power output. Only a few candidates demonstrated an understanding of the relationship shown in the graph by developing a conclusion describing a non-linear relationship and/or the gradient was decreasing. Very few candidates correctly supported this relationship with data from the graph to show that the gradient was decreasing and hence the efficiency of the motor decreased with increasing current.

Assessment for learning

In these types of questions candidates must use data from the graph whether a gradient calculation or comparison of a pair of values. Describing a relationship between two quantities on a graph without supporting this with numerical values or a calculation to make a comparison limits candidates accessing all possible marks attributed to the question.

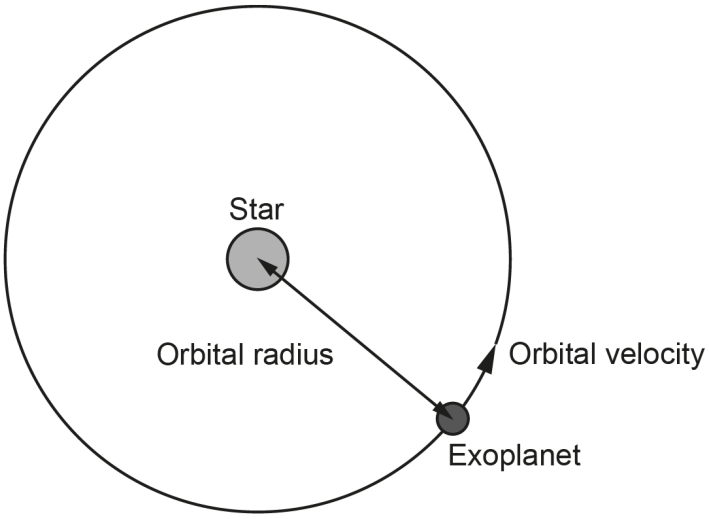
Question 10 (a)

10 Exoplanets are planets that orbit stars outside our Solar System. The table shows details on some exoplanets that could sustain life.

Exoplanet	Star	Mass of star compared to the Sun	Orbital period (days)	Orbital radius ($\times 10^9$ m)	Orbital velocity (m/s)
Gilese 667 c	Gilese 667	3.8	28	225	5.8×10^5
Kepler 452 b	Kepler 452	1.2	384	225	4.2×10^4
Earth	Sun	1	365	150	3×10^4

(a) The force needed to keep an object moving in a circle depends on the speed of the object and the radius of the circle. The greater the speed and/or the smaller the radius, the greater the force needed.

The diagram shows an exoplanet orbiting a star.



Explain why Gilese 667 c has a higher orbital velocity than Kepler 452 b.
Use the idea that the weight of an object is proportional to its mass.

.....

.....

.....

..... **[2]**

Candidates did not perform well on this question as most candidates were not given a mark. Candidates were directed to use the idea that weight and mass are proportional in terms of gravitational field strength, but candidates confused this instruction as typical responses described how the weight of Gilese 667 is greater due to a greater mass rather than understanding that the gravitational field strength was increased and hence there would be a greater gravitational force acting on Gilese 667 resulting in a higher orbital velocity. Candidate responses that were given a mark were from candidates in the higher quartile and very few candidates stated that a higher orbital velocity is required for a stable orbit.

Question 10 (b)

(b) Another exoplanet is discovered in orbit around a star.

The star has the same mass as Kepler 452. The orbital velocity of the planet is approximately the same as the Earth's orbital velocity.

What is the possible range of values for the orbital radius of this exoplanet?

Explain your answer.

Orbital radius is **between** ..... $\times 10^9$ m **and** ..... $\times 10^9$ m

Explanation.....

.....

.....

.....

[3]

Most candidates were given 1 mark for correctly stating a possible range for the orbital radius but very few were given marks for an explanation in terms of the gravitational force acting on the exoplanet and the decreased orbital velocity. Typical responses just stated that the orbital velocity was the same as the Earth's without making a comparison that the orbital velocity was less hence the reason for the increase in orbital radius so very few candidates were given more than 1 mark.

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