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Centre Number

Student Number



CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2003

TRIAL HIGHER SCHOOL CERTIFICATE
EXAMINATION

Physics

Afternoon Session

Thursday, 14 August 2003

Total marks – 100

Section I Pages 2–19

75 marks

This section has two parts, Part A and Part B

Part A

15 marks

- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B

60 marks

- Attempt Questions 16–28
- Allow about 1 hour and 45 minutes for this part

Section II Pages 20–27

25 marks

- Attempt ONE question from Questions 29–33
- Allow about 45 minutes for this section

Disclaimer

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Section I
Total marks – 75

Part A

15 marks

Attempt Questions 1-15

Allow about 30 minutes for this part

Use the Multiple Choice Answer Sheet provided

- 1 Using the data in the table below answer the following question.

Planet	Acceleration of Gravity
Earth	9.8 m/s ²
Mars	3.7 m/s ²

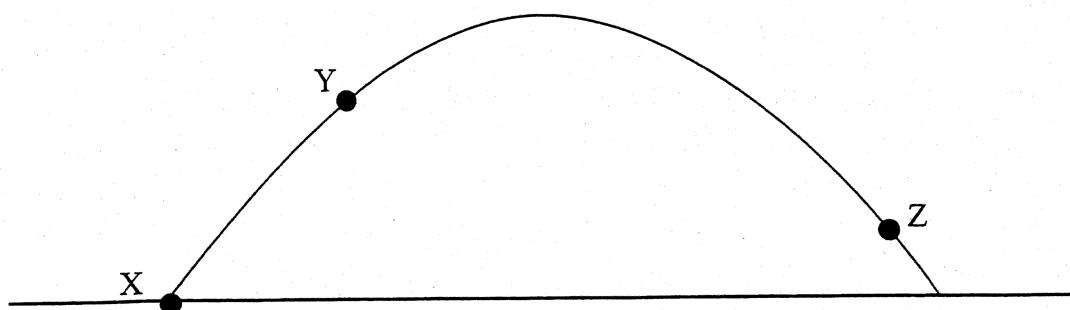
A person stood on scales that were designed for the Earth whilst on Mars. The scale gave a reading of 50 Kg. What is the actual mass of the person?

- (A) 132.4 Kg
- (B) 50 Kg
- (C) 18.9 Kg
- (D) 490 N

- 2 A projectile is fired horizontally at 10 ms^{-1} from the top of a cliff, 55m high, into the water. What is the magnitude of its velocity as it impacts with the water?

- (A) 32.8 ms^{-1}
- (B) 1078 ms^{-1}
- (C) 1175.8 ms^{-1}
- (D) 34.3 ms^{-1}

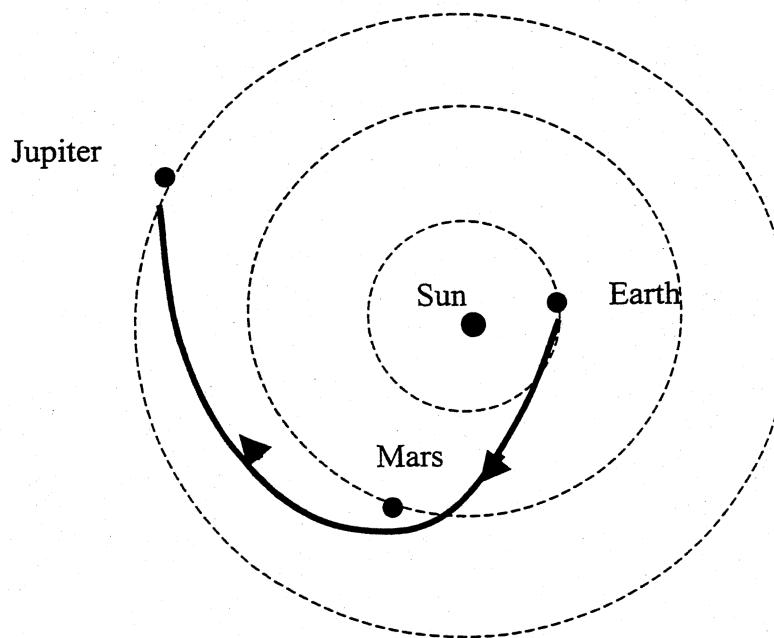
3



A projectile is fired from point X and travels in a parabolic path returning to ground after passing through points Y and Z. Which of the following statements is correct?

- (A) By the conservation of momentum, the momentum at Y equals the momentum at Z
- (B) The energy at Z will be greater than the energy at Y because the earth's gravity force has acted on the projectile for a greater time
- (C) By gravitational field theory, the force acting on the projectile at Y is less than the force acting on the projectile at Z
- (D) The horizontal velocity of the projectile remains constant throughout the entire motion

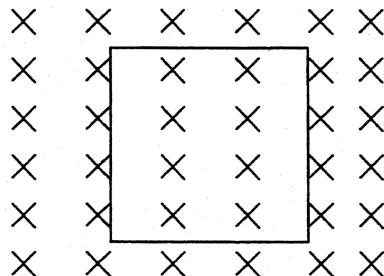
4 The following diagram shows the trajectory of a spacecraft on a mission to Jupiter from Earth:



What can be said about the spacecraft as it passes Mars?

- (A) It is slowed down due to atmospheric friction
- (B) It is slowed down by Martian gravity
- (C) It is sped up by the slingshot effect
- (D) It wastes fuel to escape the gravity of Mars

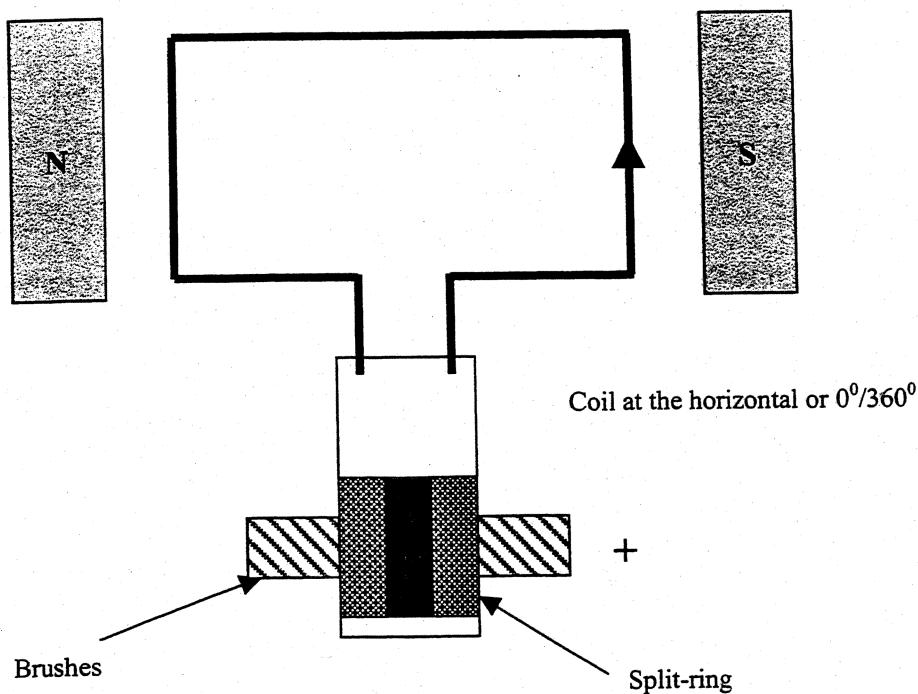
- 5 The Michelson-Morley experiment failed to support the idea that there is an aether in space. What was the observation made during the experiment that suggested this result?
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- 6 A simple motor has n turns in the armature, and has an area of $A \text{ m}^2$. A current of I amps is passed through the armature which sits at 0° in a magnetic field of strength $B \text{ T}$. Determine the torque if the area and the current is doubled, and the armature now makes an angle of 60° .
- (A) 2 x original torque
(B) 4 x original torque
(C) Original torque
(D) $1/2 \times$ original torque
- 7 The following diagram shows a loop of wire (side lengths = 5cm) that has a magnetic field cutting through it so that the field lines run perpendicular to the surface of the loop. (Given that the area of a circle is $A = \pi r^2$)



Which of the following changes would result in the greatest increase in the magnetic flux?

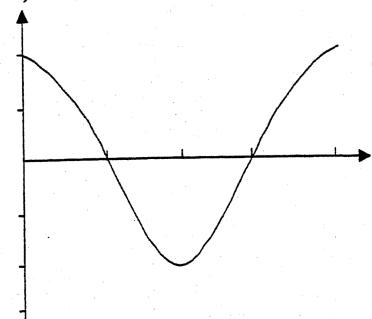
- (A) Doubling the magnetic field strength
(B) Decreasing the area of the loop by half
(C) Making the loop into a circular shape with radius 3cm
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8 The following set up was used to generate electric current.

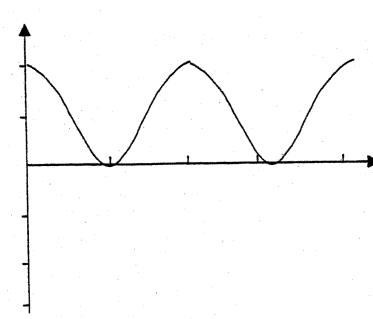


Assuming the coil starts at the horizontal, which of the following graphs best shows the current generated through a 360° rotation.

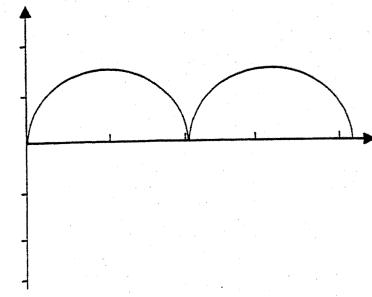
(A)



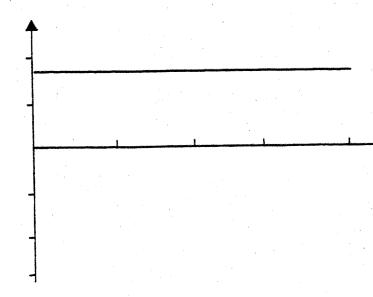
(B)



(C)



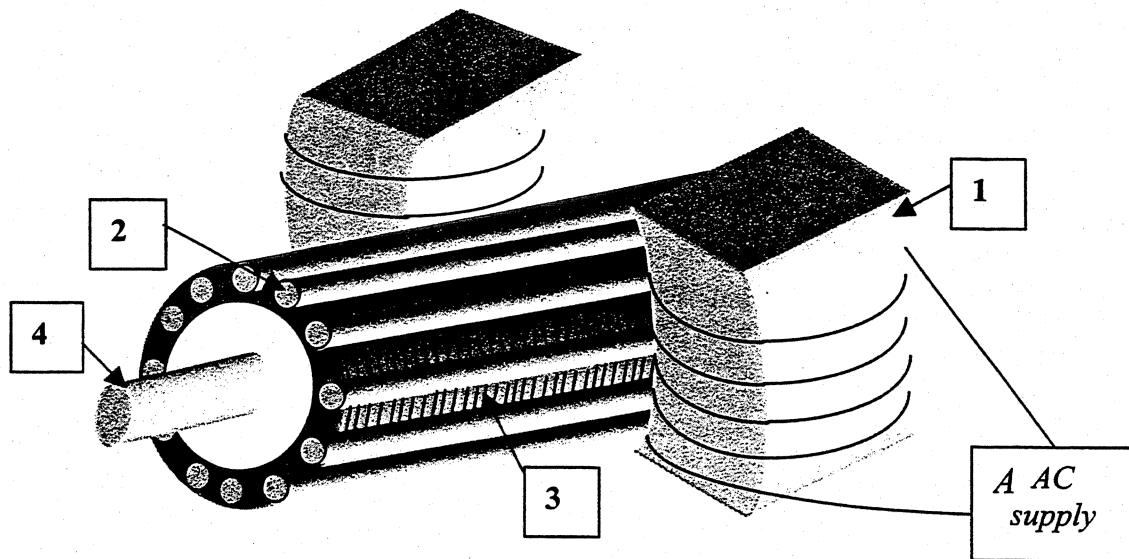
(D)



9 What is the role of a transformer in an electricity sub station?

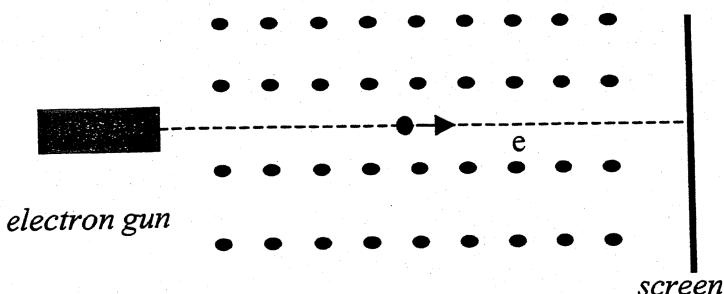
- (A) To step down the current for household use
- (B) To step down the voltage for household use
- (C) To step up the current to conserve energy
- (D) To step down the voltage to conserve energy

10 The name given to the labeled features of an AC motor below are correct in which of the following options?



	1	2	3	4
(A)	Shaft	magnet	squirrel cage	laminated core
(B)	laminated core	Shaft	magnet	squirrel cage
(C)	squirrel cage	laminated core	Shaft	magnet
(D)	magnet	squirrel cage	laminated core	Shaft

- 11 An electron is fired from an electron gun towards a screen as shown:



The electron is observed to move horizontally in a straight line at a speed of 6.2×10^{18} m/s.

What is the magnitude of the magnetic field perpendicular to the velocity of the electron which would prevent the electron from accelerating under the influence of Earth's gravity?

- (A) 7.28×10^{-23} T
- (B) 1.26×10^{-8} T
- (C) 8.92×10^{-30} T
- (D) 1.23×10^{-7} T

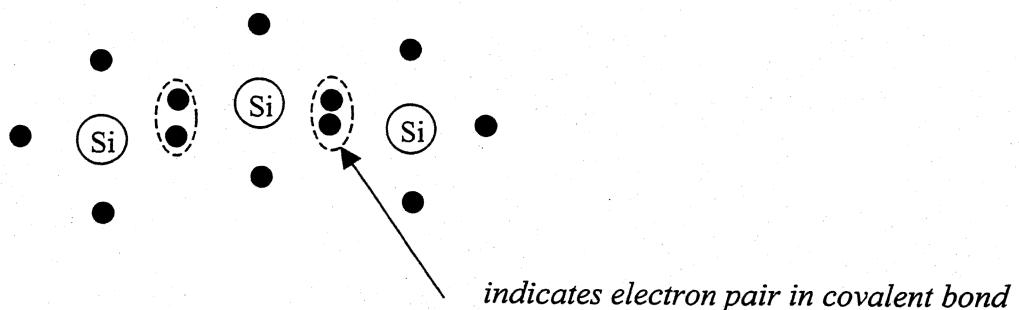
- 12 Einstein explained the phenomenon of the photoelectric effect using the idea that light is quantised. Which behaviour of solar cells backs up this idea?

- (A) Increasing the intensity of light increases the emf produced
- (B) Increasing the frequency of the light increased the current produced
- (C) No current is evident below a particular frequency
- (D) Kinetic energy of the electrons increases as the light intensity increases

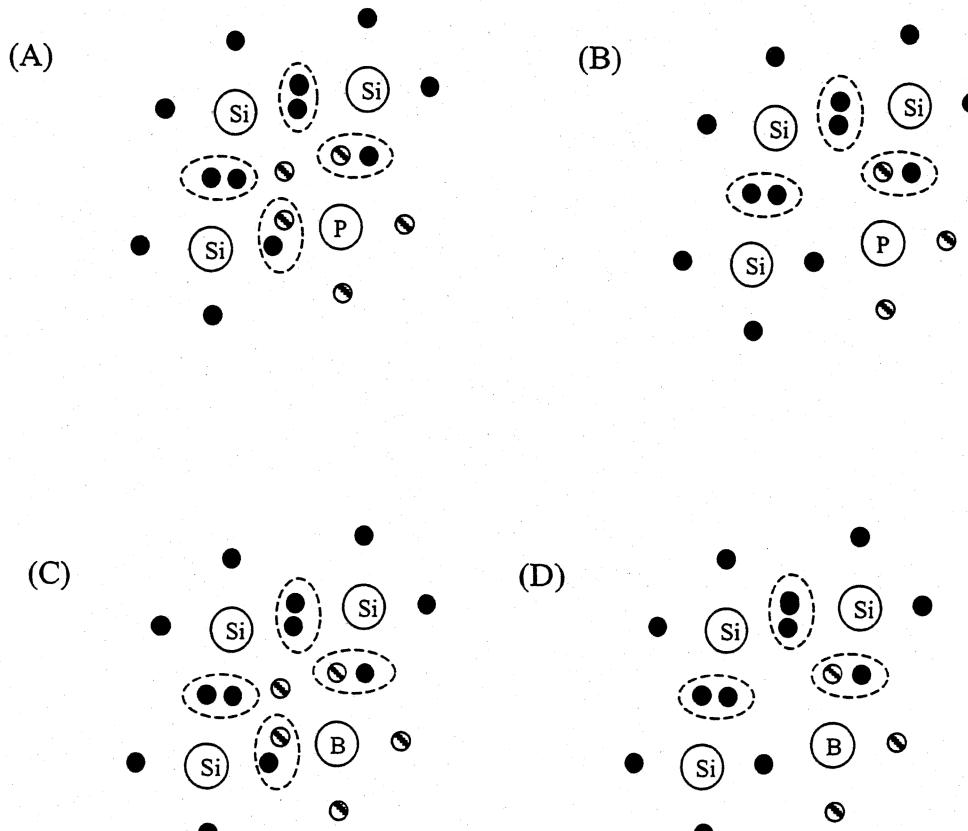
- 13 Conductors have a large number of free electrons in the conduction band compared to semiconductors and insulators. The number of free electrons in semiconductors can be increased. How this can be achieved and why, is best described by which of the following alternatives?

- (A) Raising the temperature which gives the electrons enough energy to jump into the conduction band
- (B) Shining light onto the material giving the electrons a higher frequency and ability to move
- (C) Shining UV light onto the surface of the material giving the electrons the ability to jump the forbidden gap into the valence band
- (D) Applying a potential difference to the material in order to move the electrons to the valence band

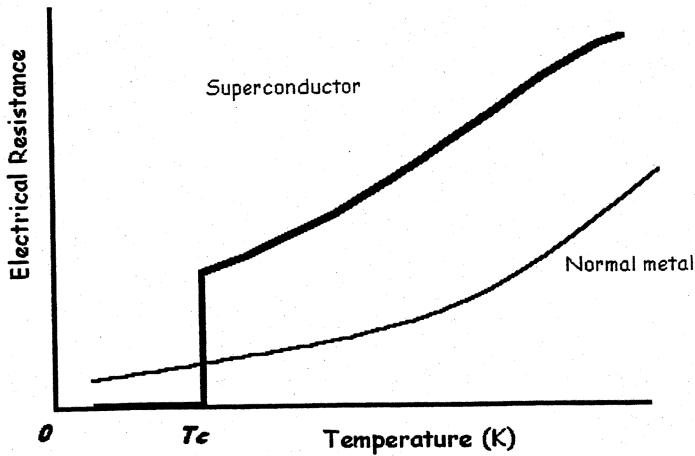
- 14 Below is a diagram showing the electrons in the outer shell of three silicon atoms.



When silicon is with other atoms, it bonds covalently. Which of the following diagrams best shows how silicon would bond when it is doped to form an n-type semiconductor?



15 Use the graph to answer the following question.



$$T_c = \text{Critical temperature}$$

Which of the following statements best describes what is occurring in the superconductor when temperature $< T_c$.

- (A) Resistance is reduced to zero because of the eddy currents being produced in a magnetic field that is generated by the superconductor
- (B) Pairs of electrons, known as Cooper pairs, are able to move through the lattice of positive particles distorting the shape of the lattice and therefore decreasing resistance to zero
- (C) Electrons are forced to jump from the atomic lattice structure and induce a current in nearby materials
- (D) A junction diode can be created using the superconductor to stop the flow of current in one direction, but not effecting the flow of current in the other

Section I

Part B

60 marks

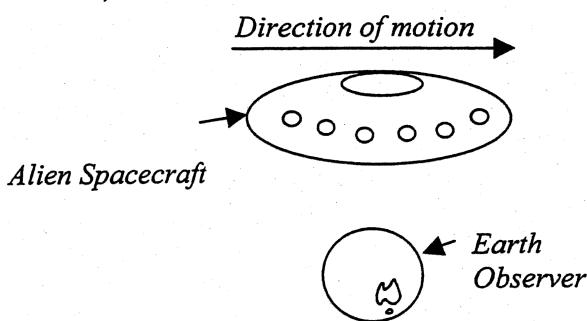
Attempt Questions 16–28

Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

Question 16 (5 marks)

Marks



An observer on Earth observed an alien spacecraft passing by as shown in the diagram above. The observer photographed it then made measurements and found it to be 25 m long and 10 m high. NASA tracked the vehicle on their radar and found that it had a speed of $0.8c$.

- (a) Calculate the length of the space craft as measured by the observer on Earth. 2

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- (b) What was the height of the spacecraft as measured by the aliens on board? 1

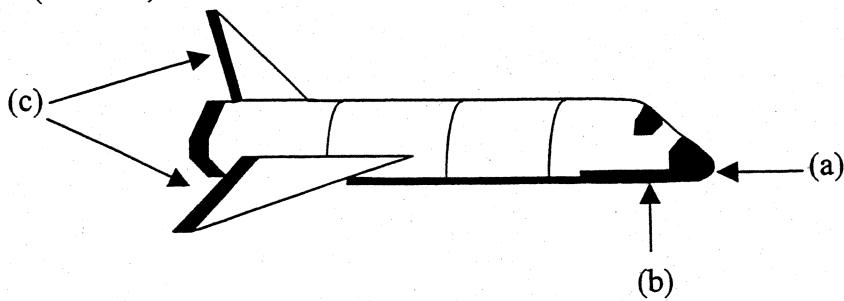
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- (c) The spacecraft took some Earthlings, did some experiments and then returned them to Earth. One of those captured reported he was on the craft for 10 hours. For how long did his family experience him missing? (Assume it continued at the same speed and did not need to stop.) 2

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Question 17 (6 marks)

Marks



- (a) Identify TWO features from the diagram of the Space Shuttle above that aid in the safe re-entry and landing of the humans. 2

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- (b) Discuss how the features identified in part (a), in conjunction with others built into the Space Shuttle will make re-entry safer. 4

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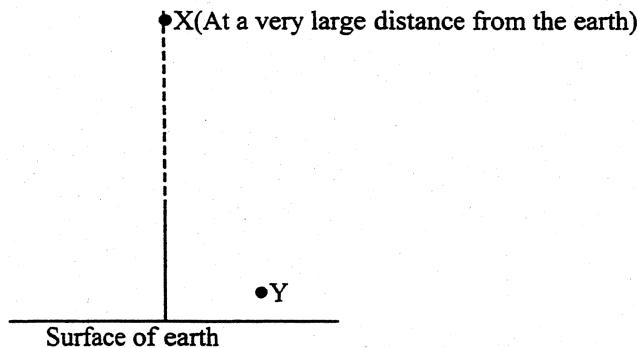
Question 18 (5 marks)**Marks**

The gravitational potential energy at a point is defined *as the work done to move an object from a very large distance away to that point in the gravitational field.*

- (a) Apply this statement with reference to a meteor that is moving towards Earth from a long distance away. 3

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- (b) X is a point at a very large distance from the Earth's surface. Y is a point 1 kilometre above the Earth's surface. 2



Calculate the potential energy of the meteor that is moving from point X to Y if the mass of the meteor is 300kg.

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Question 19 (4 marks)

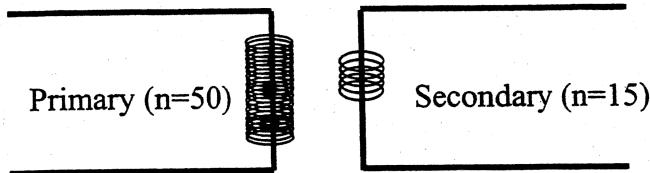
Marks

4

During the course of your study, you studied one of the following scientists, Tsiolkovsky, Oberth, Goddard, Esnault-Pelterie, O'Neill or von Braun. Choose ONE of these scientists and analyse the contributions that he made to the development of the exploration of space.

Question 20 (7 marks)**Marks**

In the picture below, the transformer has 50 turns in its primary coil and 15 in the secondary coil.



- (a) If the initial primary voltage is 240V, calculate the output voltage of this transformer. 1

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- (b) Explain why it is necessary to transmit electricity at high voltages. 3

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- (c) Outline where and how a transformer similar to the one above could be used to assist in the transmission of high voltages (approximately 35KV) to homes requiring only a 240V supply. 2

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- (d) Identify ONE other location in which this type of transformer is commonly used within a household. 1

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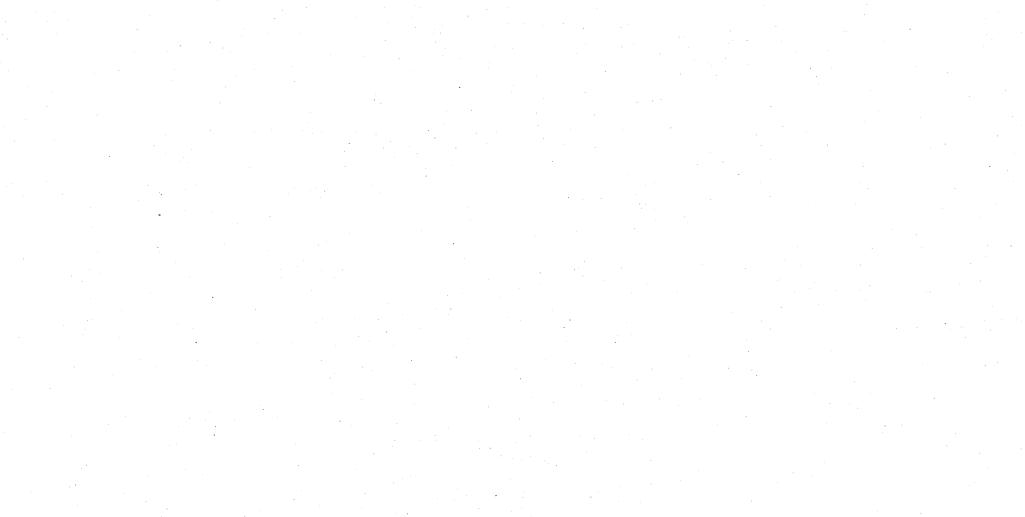
Question 21 (4 marks)**Marks**

In the course of your studies, you were required to plan and perform a first hand investigation to predict and verify the effect of a number of factors that effect the generation of electric current.

These factors included:

- (i) the distance between the coil and the magnet
- (ii) the strength of the magnet and
- (iii) the relative motion between the coil and magnet.

- (a) Draw a labelled diagram of your equipment with notes to show how each of the above factors was tested. 2

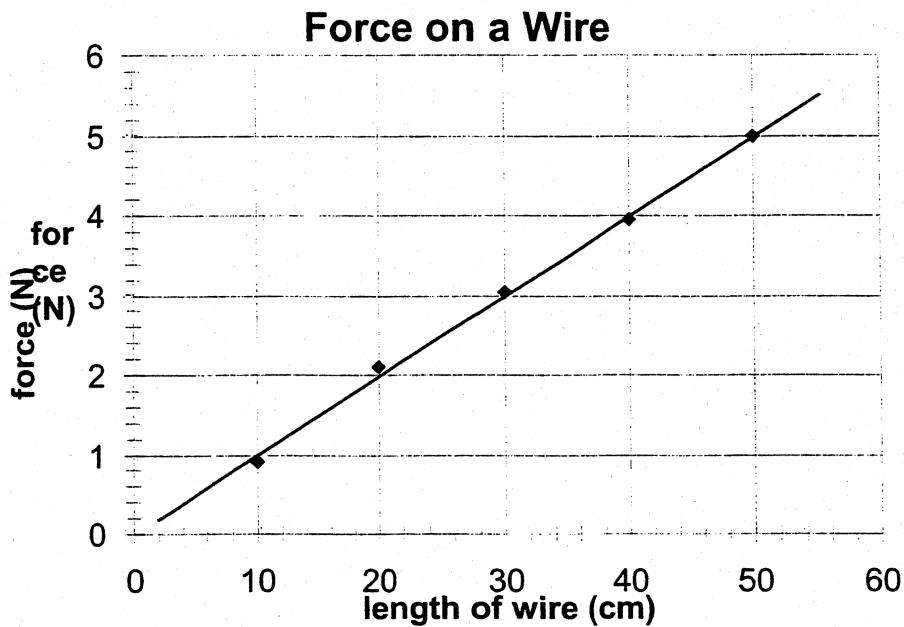


- (b) Describe the effect that you found that each factor has on the generation of current. 2

Question 22 (4 marks)**Marks**

A student performed an experiment to measure the force on a wire within a magnetic field (**B**). The student varied the length (**l**) of the wire and graphed the results, which are shown below.

The magnetic field was at an angle of 90° to the wire. The current through the wire was 2.5A.



- (a) Use the gradient of the line of best fit drawn by the student to calculate the value of **B**, the magnetic field intensity.

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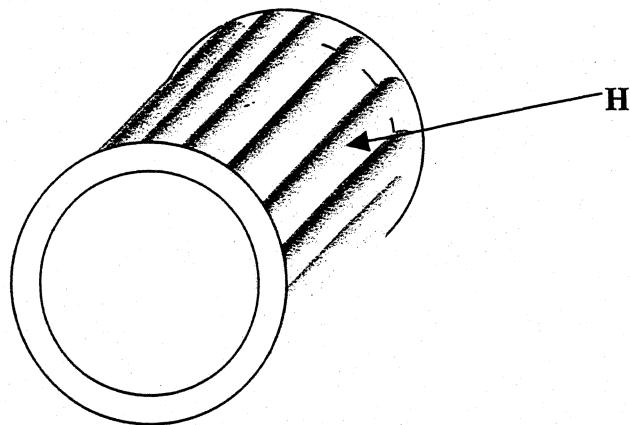
- (b) Describe the effect on the force on the wire of turning the wire slowly until the wire is parallel to the direction of the magnetic field.

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Question 23 (3 marks)

Marks



The diagram above shows a part of an AC induction motor. Explain the function of the part labeled H in the diagram.

3

Question 24 (2 marks)

Explain how induction electric brakes work.

2

Question 25 (6 marks)

Marks

Assess the impact of the discovery of the photoelectric effect on the development of the particle model of light.

6

Question 26 (6 marks)

Magnetic levitation is being investigated and tested for use in a number of areas, including transportation systems.

2

- (a) Explain the term “magnetic levitation”.

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- (b) Describe the benefits and limitations of magnetic levitation as used in maglev trains.

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Question 27 (3 marks) **Marks**

The size of electronic devices has decreased due to the introduction of semiconductors. Discuss ONE factor other than size that makes semiconductors better than the technology they replaced.

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Question 28 (5 marks)

Outline how Einstein and Planck's views of Science differed in relation to Science research being influenced by society and politics. 5

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End of Section I

Section II – Options

Total marks – 25

Attempt ONE question from Questions 29–33

Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

	Pages
Question 29 Geophysics	21
Question 30 Medical Physics	22-23
Question 31 Astrophysics	24
Question 32 From Quanta to Quarks	25
Question 33 The Age of Silicon	26-27

Question 32 – Quanta to Quarks (25 marks)**Marks**

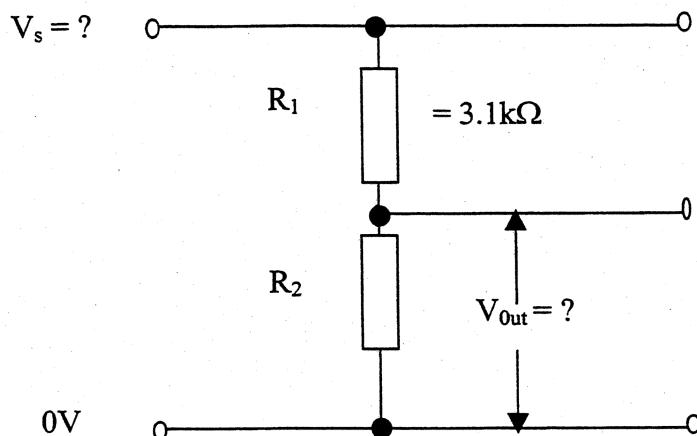
- | | | |
|---------|---|---|
| (a) (i) | Cyclotrons and linear accelerators can be used to accelerate many particles but not neutrons. Discuss why is this so? | 1 |
| (ii) | Name the FOUR fundamental forces of nature. | 2 |
| (b) (i) | Define binding energy. | 1 |
| (ii) | Determine the ionisation energy of the hydrogen atom. Give the answer in electron volts (eV). | 3 |
| (c) (i) | Describe how you carried out an investigation to observe radiation emitted from a nucleus with a Wilson Cloud Chamber or similar device, relate your results. | 8 |
| (ii) | State a difference between controlled and uncontrolled nuclear reactions. | 1 |
| (d) | State what are TWO essential properties of radio isotopes and give ONE example of a radio isotope and how it is used. | 4 |
| (e) | Assess the significance of the Manhattan Project to society. | 5 |

End of Question 32

Question 33 – Age of Silicon (25 marks)

Marks

- (a) State ONE difference between an integrated circuit and a transistor. 1
- (b) Silica is a very commonly used material in electronics because it has properties that are desirable.
Name ONE such property and explain why it is so desirable in electronics. 2
- (c) (i) Define a potential divider. 1
- (ii) Below is a diagram of a potential divider: 3



Total current flowing through the potential divider = 1.5A
Total resistance = 5Ω

From the information given, calculate the voltage supplied, V_s and voltage out V_{out} .

- (d) Items such as solar cells, switches and light meters in cameras are considered to be input transducers. Explain why this can be said. 8
- (e) Identify the gates that are used to make a half adder. 1

Question 33 continues on page 27

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2701-1

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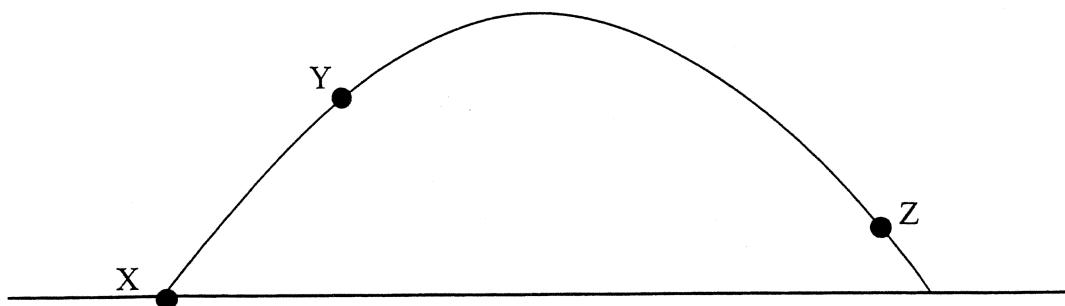
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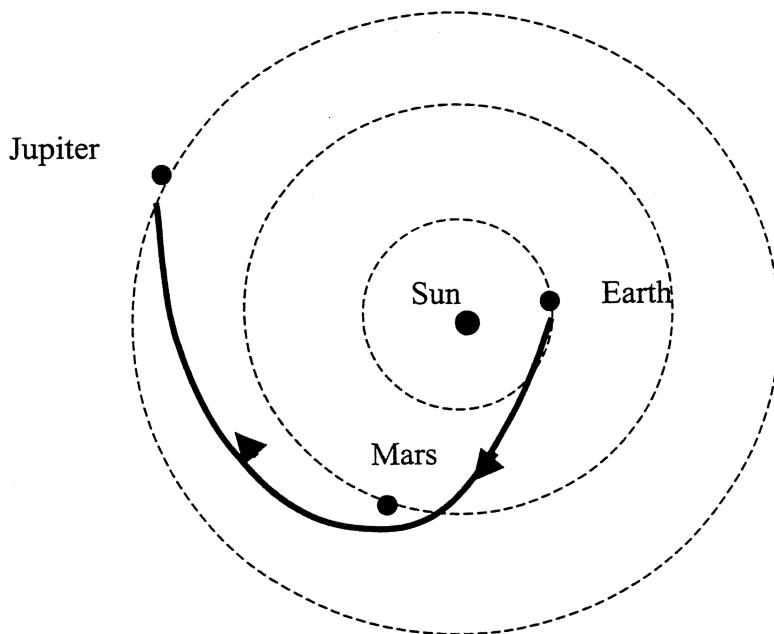
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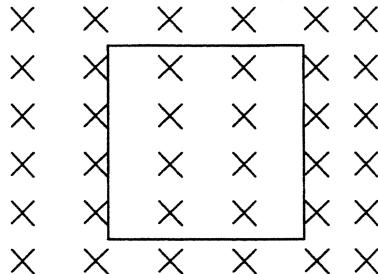
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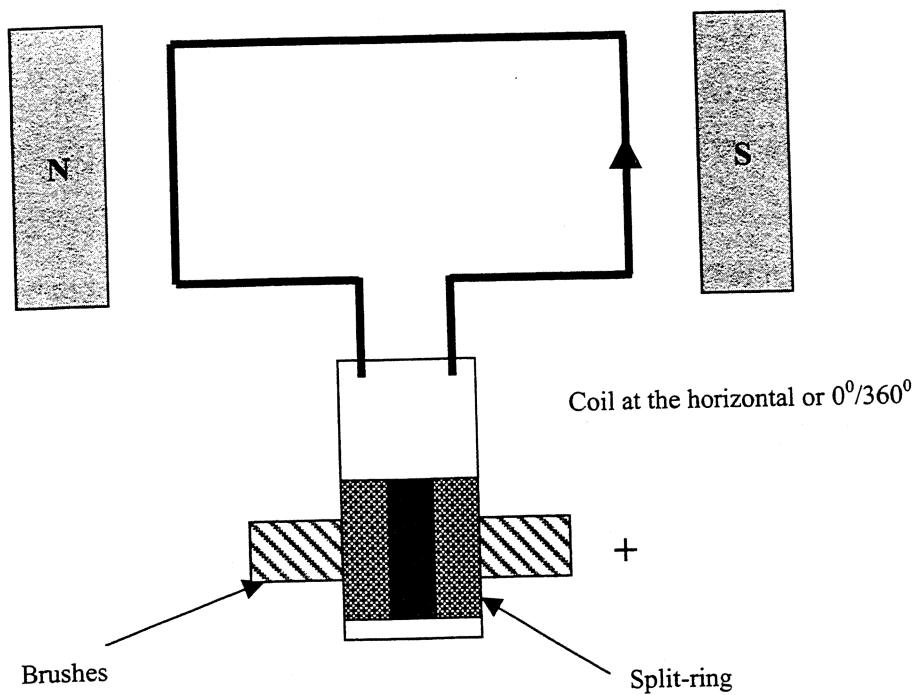
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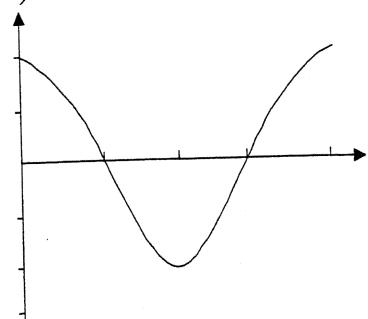
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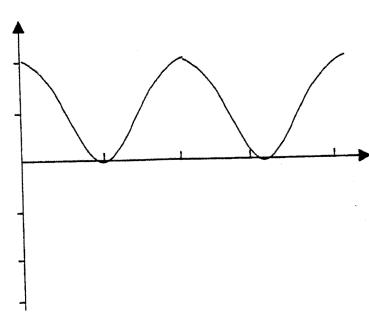


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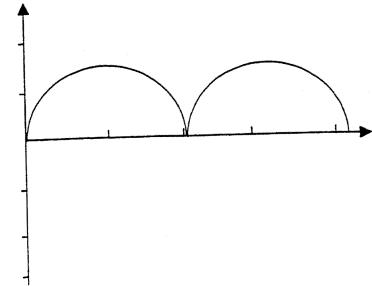
(A)



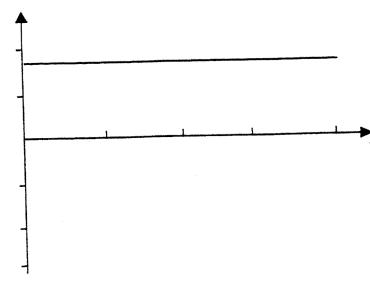
(B)



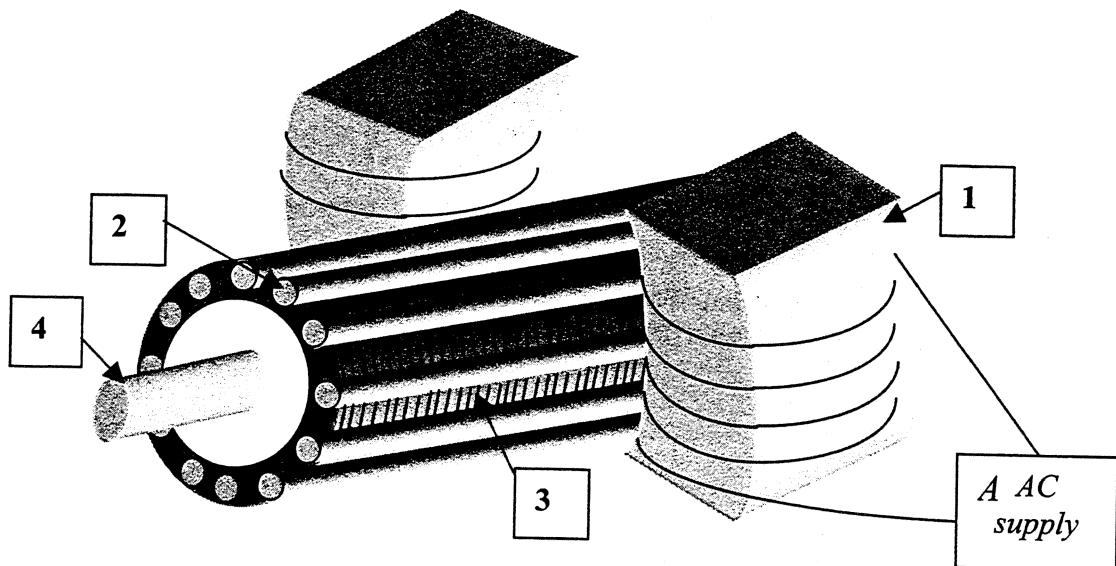
(C)



(D)

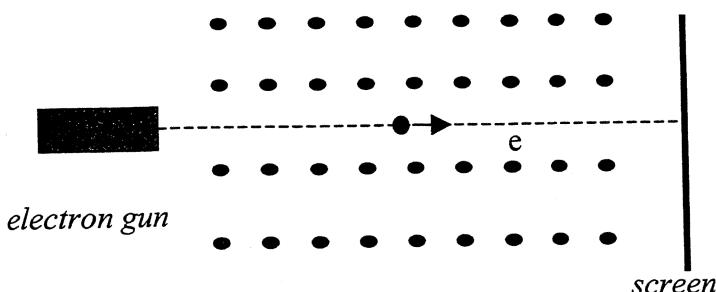


- 9 What is the role of a transformer in an electricity sub station?
- To step down the current for household use
 - To step down the voltage for household use
 - To step up the current to conserve energy
 - To step down the voltage to conserve energy
- 10 The name given to the labeled features of an AC motor below are correct in which of the following options?



	1	2	3	4
(A)	Shaft	magnet	squirrel cage	laminated core
(B)	laminated core	Shaft	magnet	squirrel cage
(C)	squirrel cage	laminated core	Shaft	magnet
(D)	magnet	squirrel cage	laminated core	Shaft

- 11 An electron is fired from an electron gun towards a screen as shown:



The electron is observed to move horizontally in a straight line at a speed of 6.2×10^{18} m/s.

What is the magnitude of the magnetic field perpendicular to the velocity of the electron which would prevent the electron from accelerating under the influence of Earth's gravity?

- (A) 7.28×10^{-23} T
- (B) 1.26×10^{-8} T
- (C) 8.92×10^{-30} T
- (D) 1.23×10^{-7} T

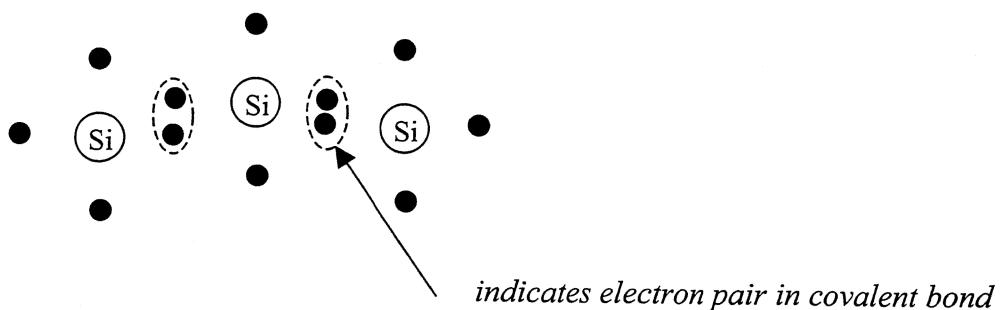
- 12 Einstein explained the phenomenon of the photoelectric effect using the idea that light is quantised. Which behaviour of solar cells backs up this idea?

- (A) Increasing the intensity of light increases the emf produced
- (B) Increasing the frequency of the light increased the current produced
- (C) No current is evident below a particular frequency
- (D) Kinetic energy of the electrons increases as the light intensity increases

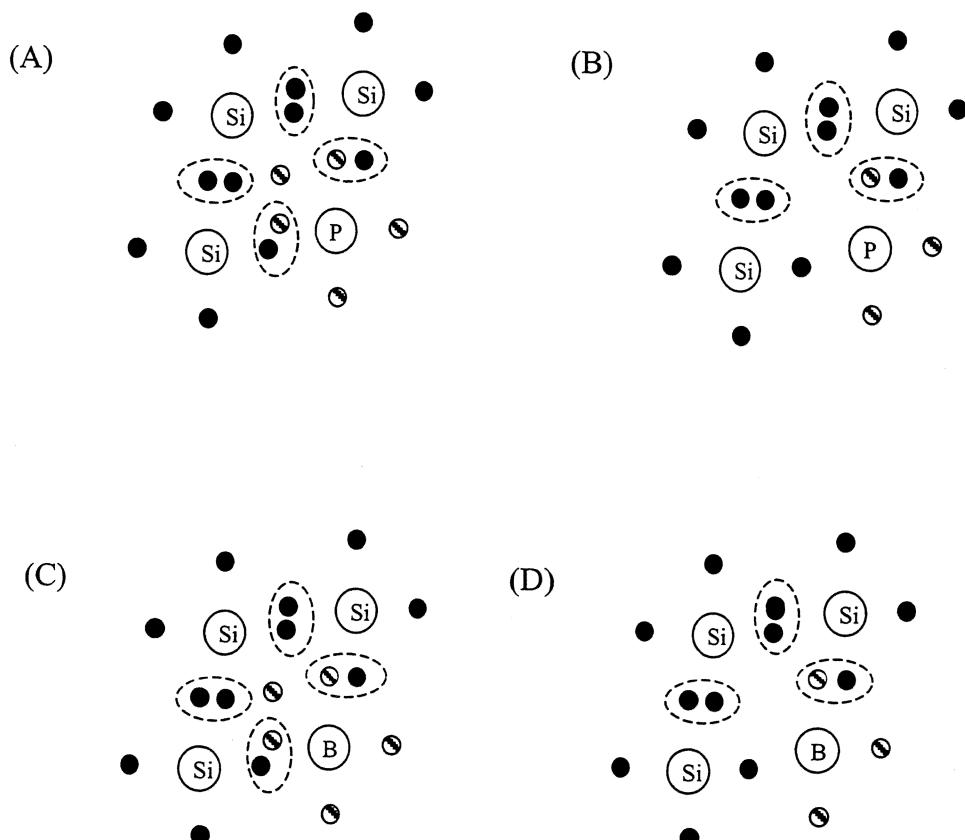
- 13 Conductors have a large number of free electrons in the conduction band compared to semiconductors and insulators. The number of free electrons in semiconductors can be increased. How this can be achieved and why, is best described by which of the following alternatives?

- (A) Raising the temperature which gives the electrons enough energy to jump into the conduction band
- (B) Shining light onto the material giving the electrons a higher frequency and ability to move
- (C) Shining UV light onto the surface of the material giving the electrons the ability to jump the forbidden gap into the valence band
- (D) Applying a potential difference to the material in order to move the electrons to the valence band

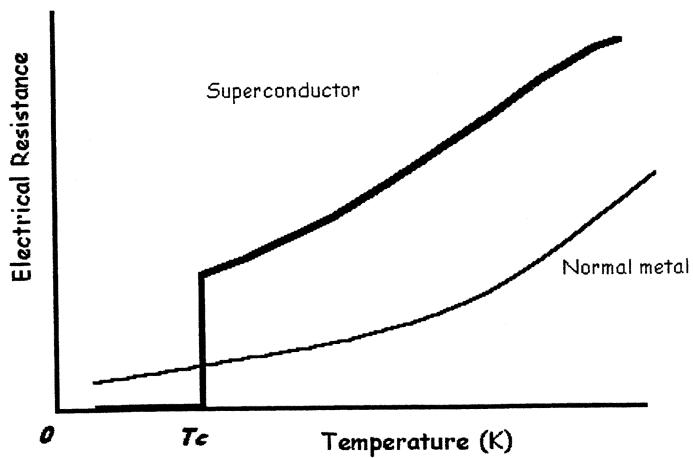
- 14 Below is a diagram showing the electrons in the outer shell of three silicon atoms.



When silicon is with other atoms, it bonds covalently. Which of the following diagrams best shows how silicon would bond when it is doped to form an n-type semiconductor?



15 Use the graph to answer the following question.



$$T_c = \text{Critical temperature}$$

Which of the following statements best describes what is occurring in the superconductor when temperature $< T_c$.

- (A) Resistance is reduced to zero because of the eddy currents being produced in a magnetic field that is generated by the superconductor
- (B) Pairs of electrons, known as Cooper pairs, are able to move through the lattice of positive particles distorting the shape of the lattice and therefore decreasing resistance to zero
- (C) Electrons are forced to jump from the atomic lattice structure and induce a current in nearby materials
- (D) A junction diode can be created using the superconductor to stop the flow of current in one direction, but not effecting the flow of current in the other

Section I

Part B

60 marks

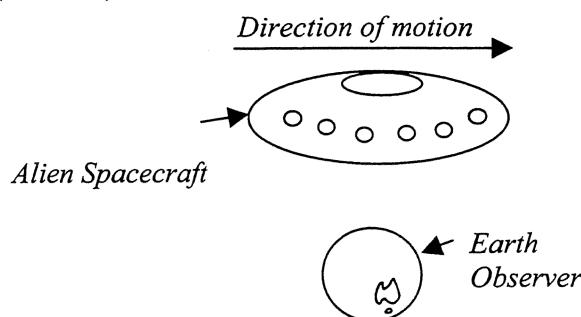
Attempt Questions 16–28

Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

Question 16 (5 marks)

Marks



An observer on Earth observed an alien spacecraft passing by as shown in the diagram above. The observer photographed it then made measurements and found it to be 25 m long and 10 m high. NASA tracked the vehicle on their radar and found that it had a speed of 0.8c.

- (a) Calculate the length of the space craft as measured by the observer on Earth.

2

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- (b) What was the height of the spacecraft as measured by the aliens on board?

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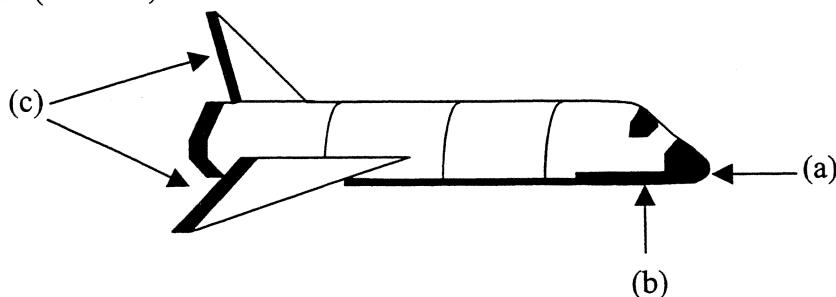
- (c) The spacecraft took some Earthlings, did some experiments and then returned them to Earth. One of those captured reported he was on the craft for 10 hours. For how long did his family experience him missing? (Assume it continued at the same speed and did not need to stop.)

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Question 17 (6 marks)

Marks



- (a) Identify TWO features from the diagram of the Space Shuttle above that aid in the safe re-entry and landing of the humans.

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- (b) Discuss how the features identified in part (a), in conjunction with others built into the Space Shuttle will make re-entry safer.

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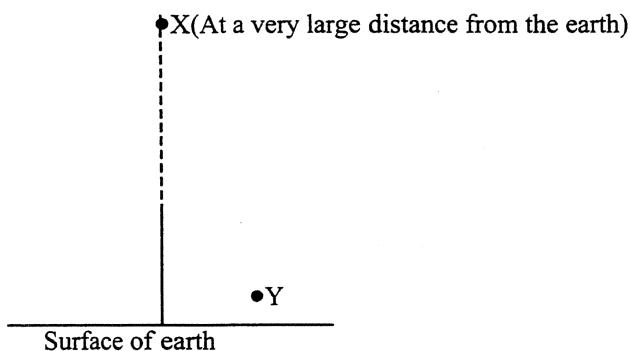
Question 18 (5 marks)**Marks**

The gravitational potential energy at a point is defined *as the work done to move an object from a very large distance away to that point in the gravitational field.*

- (a) Apply this statement with reference to a meteor that is moving towards Earth 3 from a long distance away.

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- (b) X is a point at a very large distance from the Earth's surface. Y is a point 1 2 kilometre above the Earth's surface.



Calculate the potential energy of the meteor that is moving from point X to Y if the mass of the meteor is 300kg.

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Question 19 (4 marks)

Marks

During the course of your study, you studied one of the following scientists, Tsiolkovsky, Oberth, Goddard, Esnault-Pelterie, O'Neill or von Braun. Choose ONE of these scientists and analyse the contributions that he made to the development of the exploration of space.

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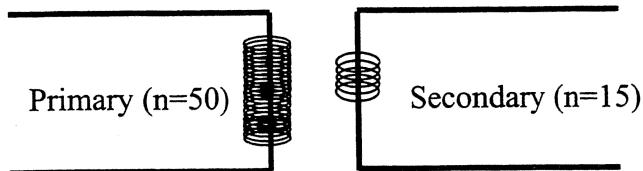
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Question 20 (7 marks)**Marks**

In the picture below, the transformer has 50 turns in its primary coil and 15 in the secondary coil.



- (a) If the initial primary voltage is 240V, calculate the output voltage of this transformer.

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- (b) Explain why it is necessary to transmit electricity at high voltages.

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- (c) Outline where and how a transformer similar to the one above could be used to assist in the transmission of high voltages (approximately 35KV) to home requiring only a 240V supply.

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- (d) Identify ONE other location in which this type of transformer is commonly used within a household.

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Question 21 (4 marks)	Marks
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In the course of your studies, you were required to plan and perform a first hand investigation to predict and verify the effect of a number of factors that effect the generation of electric current.

These factors included:

- (i) the distance between the coil and the magnet
- (ii) the strength of the magnet and
- (iii) the relative motion between the coil and magnet.

(a) Draw a labelled diagram of your equipment with notes to show how each of the 2 above factors was tested.

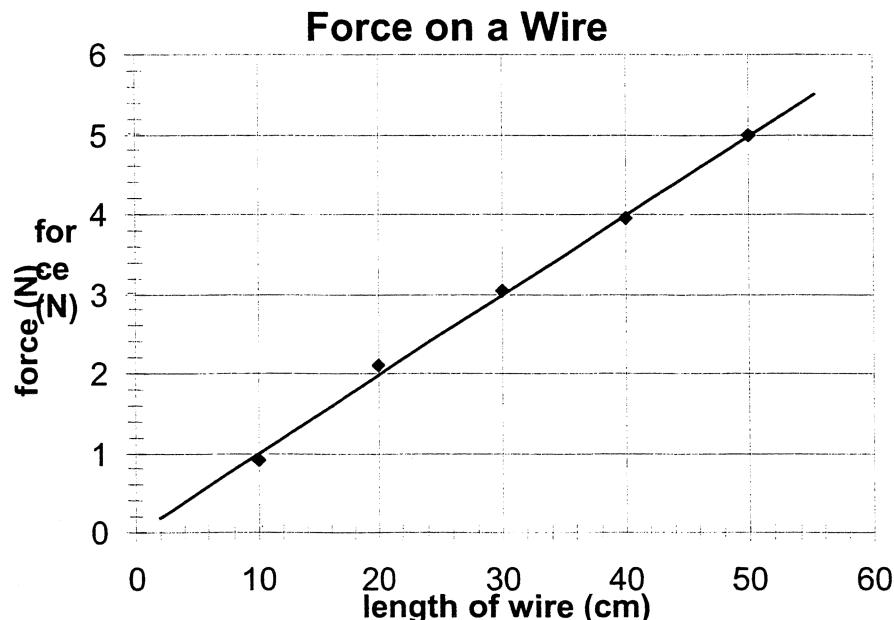
(b) Describe the effect that you found that each factor has on the generation of 2 current.

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Question 22 (4 marks)**Marks**

A student performed an experiment to measure the force on a wire within a magnetic field (**B**). The student varied the length (**l**) of the wire and graphed the results, which are shown below.

The magnetic field was at an angle of 90° to the wire. The current through the wire was 2.5A.



- (a) Use the gradient of the line of best fit drawn by the student to calculate the value of **B**, the magnetic field intensity.

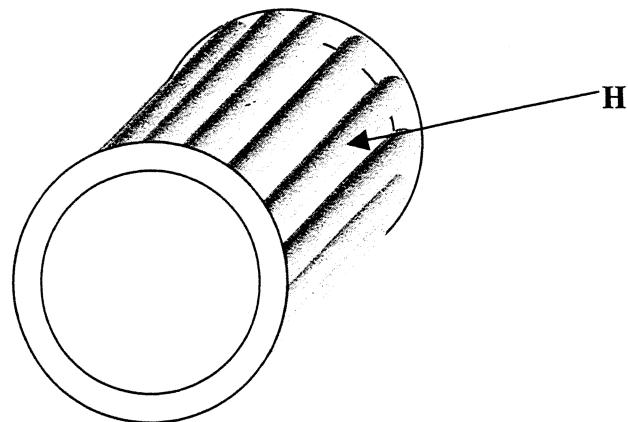
3

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- (b) Describe the effect on the force on the wire of turning the wire slowly until the wire is parallel to the direction of the magnetic field.

1

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Question 23 (3 marks)**Marks**

The diagram above shows a part of an AC induction motor. Explain the function of the part labeled H in the diagram. 3

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Question 24 (2 marks)

Explain how induction electric brakes work. 2

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Question 25 (6 marks) **Marks**
Assess the impact of the discovery of the photoelectric effect on the development of the particle model of light. **6**

Question 26 (6 marks)

Magnetic levitation is being investigated and tested for use in a number of areas, including transportation systems.

- (a) Explain the term “magnetic levitation”.

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- (b) Describe the benefits and limitations of magnetic levitation as used in maglev trains. 4

Question 27 (3 marks)	Marks
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The size of electronic devices has decreased due to the introduction of semiconductors. 3
Discuss ONE factor other than size that makes semiconductors better than the technology they replaced.

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Question 28 (5 marks)

Outline how Einstein and Planck's views of Science differed in relation to Science research being influenced by society and politics. 5

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End of Section I

Section II – Options

Total marks – 25

Attempt ONE question from Questions 29–33

Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

	Pages
Question 29 Geophysics	21
Question 30 Medical Physics	22-23
Question 31 Astrophysics	24
Question 32 From Quanta to Quarks	25
Question 33 The Age of Silicon	26-27

Question 29 – Geophysics (25 marks)		Marks
(a) (i)	Describe the function of a gravimeter.	1
(ii)	Give TWO reasons why Earth's gravity may vary between two points on its surface.	2
(b) (i)	Define the term <i>palaeomagnetic</i> .	1
(ii)	Describe the type of information obtained from any ONE of the following principle methods used in geophysics: seismic, gravitational, magnetic, palaeomagnetic, electrical, electromagnetic, radiometric or geothermal. Clearly identify which method you refer to.	3
(c) (i)	Explain the benefits of geophysical methods in mineral exploration and environmental monitoring.	8
(ii)	Contrast ONE property of P waves and S waves.	1
(d)	Explain the role of remote sensing techniques in monitoring climatic conditions on Earth.	4
(e)	Summarise the geophysical evidence that supports the theory of plate tectonics.	5

End of Question 29

Question 30 – Medical Physics (25 marks)**Marks**

- (a) Describe why gel is rubbed onto the skin before an ultrasound transducer is used.

1

- (b) The table below contains information that relates to the questions that follow:

Material	Density ($\text{kgm}^{-3} \times 10^3$)	Acoustic Impedance (10^6 rayls)
Air	0.001	0.0004
Water	1.00	1.54
Bone	1.85	7.80
Muscle	1.06	1.70
Fat	0.93	1.38
Blood	1.00	1.61

- (i) Calculate the percentage of an ultrasound beam that is reflected when it passes from the muscle of the stomach to the fat that surrounds it.

2

- (ii) Calculate the speed of sound in bone.

1

- (c) Crystals are located within an ultrasound transducer. Describe the piezoelectric effect and how ultrasound is produced.

3

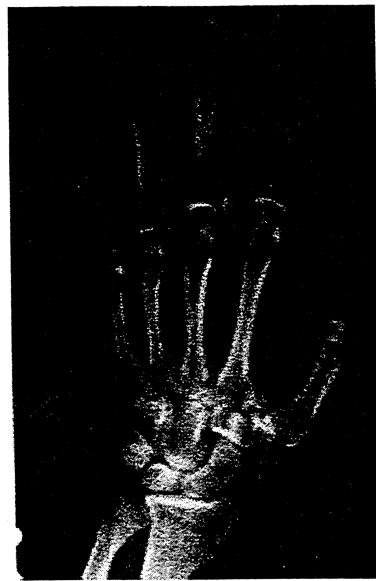
Question 30 continues on page 23

Question 30 (continued)	Marks
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- (d) Image A and B have been produced using different imaging techniques.



A



B

Compare the images in the scans above.

8

- (e) PET scans are produced by introducing radioisotopes into the body. Discuss what happens when a positron collides with an electron within the tissues of the body. **1**
- (f) Discuss the difference in structure and function of the coherent and incoherent bundles of an endoscope. **4**
- (g) MRI and CT both produce images showing ‘slices’ through the body. Compare these two imaging techniques. **5**

End of Question 30

Question 31 – Astrophysics (25 marks)**Marks**

- (a) (i) Define the term ‘binary star’. 1
- (ii) Describe the observations of an astronomer on Earth to identify an astrometric binary star. 2
- (b)
- | Star | Apparent Magnitude | Distance (parsecs) |
|------------|--------------------|--------------------|
| Vega | +0.04 | 8.1 |
| Canopus | -0.72 | 29.9 |
| Betelgeuse | +0.41 | 184 |
- (i) Identify which star is the brightest as seen from Earth. 1
- (ii) Calculate the absolute magnitude of Vega. 3
- (c) Outline the key stages in a stars life in terms of the physical processes involved and identify the nuclear reactions that occur at each stage. 8
- (d) A plot is made of the energy released at all wavelengths of a black body of 200K. If the body was heated to a temperature of 1000K identify how the plots would vary. 1
- (e) (i) Discuss some of the problems associated with ground-based Earth astronomy. 4
- (ii) Discuss how the development of interferometry has improved the resolution and sensitivity of ground-based astronomy. 5

End of Question 31

Question 32 – Quanta to Quarks (25 marks)		Marks
(a) (i)	Cyclotrons and linear accelerators can be used to accelerate many particles but not neutrons. Discuss why is this so?	1
(ii)	Name the FOUR fundamental forces of nature.	2
(b) (i)	Define binding energy.	1
(ii)	Determine the ionisation energy of the hydrogen atom. Give the answer in electron volts (eV).	3
(c) (i)	Describe how you carried out an investigation to observe radiation emitted from a nucleus with a Wilson Cloud Chamber or similar device, relate your results.	8
(ii)	State a difference between controlled and uncontrolled nuclear reactions.	1
(d)	State what are TWO essential properties of radio isotopes and give ONE example of a radio isotope and how it is used.	4
(e)	Assess the significance of the Manhattan Project to society.	5

End of Question 32

Question 33 – Age of Silicon (25 marks)

Marks

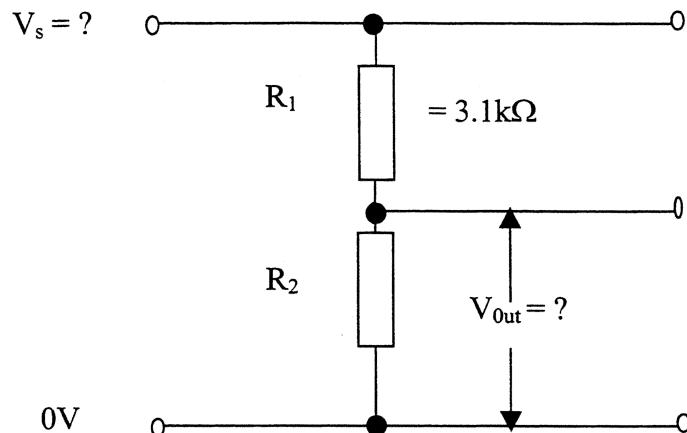
- (a) State ONE difference between an integrated circuit and a transistor. 1

- (b) Silica is a very commonly used material in electronics because it has properties that are desirable.

Name ONE such property and explain why it is so desirable in electronics. 2

- (c) (i) Define a potential divider. 1

- (ii) Below is a diagram of a potential divider: 3



Total current flowing through the potential divider = 1.5A

Total resistance = 5Ω

From the information given, calculate the voltage supplied, V_s and voltage out V_{out} .

- (d) Items such as solar cells, switches and light meters in cameras are considered to be input transducers. Explain why this can be said. 8

- (e) Identify the gates that are used to make a half adder. 1

Question 33 continues on page 27

Question 33 (continued)

Mark

- (f) A school has decided to install a security system on the computer room. To be able to use the computer the following requirements must be met: 4

A student swipes an ID card or enters a user name and a password. The student must then select their teacher's name from a list, if they are registered in this class, they will then be permitted to use the computer.

Design a logic system that achieves the above security. Draw it and the truth table.

- (g) Describe the function and properties of an ideal amplifier. 5

End of Question 33

End of paper

EXAMINERS

S Woodward (convenor)	Oakhill College, Castle Hill
Br V Cotter	La Salle House, Castle Hill
M Campbell	Oakhill College, Castle Hill
R Farr	Brigidine College, St Ives
P Wacher	Queenwood School for Girls, Mosman



CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2003 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

PHYSICS – MARKING GUIDELINES

PLEASE NOTE that the answers supplied are only guides and sample answers (where provided) are not necessarily the only correct answer.

Section I

Total marks – 75

Questions 1-15 (1 mark each)

1. B	2. C	3. C	4. C	5. B	6. D	7. A	8. A	9. B	10. D
11. C	12. A	13. D	14. A	15. A					

Question 16 (5 marks)

(a) (2 marks)

Outcomes Assessed: H6, H8

Criteria	Band	Marks
• Correctly calculates the answer	3	2
• Uses correct equation	2	1
OR		
• Recognises that it is longer		

Sample Answer

$$\begin{aligned}L_o &= 25\text{m} \\v &= 0.8c \\L_v &=? \\L_v &= L_o \sqrt{1 - \frac{v^2}{c^2}} \\&= 25 \sqrt{1 - \frac{(0.8)^2}{c^2}} \\&= 15\text{m}\end{aligned}$$

(b) (1 mark)

Outcomes Assessed: H6, H8

Criteria	Band	Marks
• Correctly states that height doesn't change	3	1

Sample Answer

10m - the only changes in length happen in the direction of motion.

(c) (2 marks)

Outcomes Assessed: H6, H8

Criteria	Band	Marks
• Correctly calculates the answer	3	2
• Uses correct equation OR	2	1
• Recognises that it is longer	2	1

Sample Answer

$$t_o = 10\text{hrs} = 36000\text{s}$$

$$v = 0.8c$$

$$t_v = ?$$

$$t_o = t_v \sqrt{1 - \frac{v^2}{c^2}}$$

$$\begin{aligned} t_v &= \frac{t_o}{\sqrt{1 - v^2/c^2}} \\ &= \frac{36000}{\sqrt{1 - 0.64}} \\ &= 60\,000\text{ s OR } 16.67\text{ hrs} \end{aligned}$$

Question 17 (6 marks)

(a) (2 marks)

Outcomes Assessed: H3, H7

Criteria	Band	Marks
• Two features shown correctly identified	3	2
• One feature shown correctly identified	2	1

Sample Answer

1. Special heat shield tiles on the base of the shuttle
2. Blunt nose shape

(b) (4 marks)

Outcomes Assessed: H3, H7

Criteria	Band	Marks
<ul style="list-style-type: none"> • Uses the features identified in part (a) • Includes extra features • Discusses what each of these features does • Links the feature to assisting the human occupant live 	4/5	3-4
<ul style="list-style-type: none"> • States what the features mentioned in part (a) does AND EITHER • Links the feature to the assistance of the human living OR • Names extra features and how they assist 	2/3	1-2

Sample Answer

The blunt nose cone assists in spreading heat over a larger area. This results in the shuttle heating up at a slower rate. This increases the time that the human occupants are seated in a lower temperature, increasing the comfort and safety level. The second feature that is shown is the heat tiles that cover the base of the shuttle. These tiles are designed to ablate (vaporise). To do this requires a large amount of heat, thus taking the heat away from the cabin in which the humans are located. Again, this increases the comfort and safety for the occupants by keeping the temperature down.

Other features that assist in the safe reentry of the occupants include the angle of reentry. By controlling the shuttle to come through a precise angle between $3-5^{\circ}$, the shuttle optimises the amount of heat that is created by friction with the air (and thereby slowing the craft down) and not creating too much friction, by coming in too steep (and causing the shuttle to bounce off the atmosphere). The shuttle has a parachute that is deployed on landing to slow the shuttle down further. This allows the shuttle to come to a gradual stop over the descent and therefore reduces the strain on the occupants.

Question 18 (5 marks)

(a) (3 marks)

Outcomes Assessed: H7, H9, H11T

Criteria	Band	Marks
• Correctly defines work, relates work to distance and to gravitational potential energy. Answer is in terms of the meteor	5	3
• Defines work and gravitational potential energy, refers to the meteor	4	2
• Reiterates statement with reference to meteor	3	1

Sample Answer

$$GPE = - \frac{GMm}{r}$$

this is used to calculate the Gravitation potential energy that the meteor has. Where M is the mass of the Earth, m is the mass of the meteor and r is the distance through which the meteor moves. Since a change in GPE is work, and work = F.s we can say that as the meteor moves through a distance r, it has changed its GPE and thereby has had work done on it. To do this work requires a force. The force in this case is the gravitational pull that exists between the two masses.

(b) (2 marks)

Outcomes Assessed: H7, H9

Criteria	Band	Marks
• Correct answer using formula and substituted values	3	2
• Correct formula and substitution of values	2	1

Sample Answer

$$GPE = - \frac{GMm}{r}$$

$$= \frac{6.67 \times 10^{-11} (6 \times 10^{24}) (300)}{1000}$$

$$= -1.2 \times 10^{14} \text{ J}$$

Question 19 (4 marks)

Outcomes Assessed: H1, H2, H3, H4

Criteria	Band	Marks
<ul style="list-style-type: none"> • Scientist matched with correct contributions • Contributions are described • Clear link to how the contributions help develop exploration of space 	5	4
<ul style="list-style-type: none"> • Scientist matched with correct contributions • Contributions are described. • An attempt to link to how the contributions help develop exploration of space 	4	3
<ul style="list-style-type: none"> • Scientist matched with correct contributions • Contributions are described 	3	2
• Scientist matched with one correct contribution	2	1

Sample Answer

Goddard developed the first liquid fuel rocket. This allowed for a much more efficient engine. To do this though, he had to overcome the heat produced during combustion. He did this by specially designed nozzles that allowed the liquid to cool the rocket on the way through. This revolutionised rocketry and is still used today.

Goddard continued to develop the rocketry world by using gyroscopes to guide the rockets and vanes to control them with vanes in the thrusters. This moved rockets from projectiles to controllable, steerable objects.

One of Goddard main contributions is the fact that he could make science practical. He developed and successfully created the idea of a payload which has made rocketry commercially viable.

Question 20 (7 marks)

(a) (1 mark)

Outcomes Assessed: H7, H9

Criteria	Band	Marks
• Correctly calculates the value of V_s	3	1

Sample Answer

$$V_p = 240V \quad n_p = 50 \quad n_s = 15 \quad V_s = ?$$

$$\begin{aligned} \frac{V_p}{V_s} &= \frac{n_p}{n_s} \\ V_s &= \frac{V_p n_s}{n_p} \\ &= \frac{240 (15)}{(50)} \\ &= 72V \end{aligned}$$

(b) (3 marks)

Outcomes Assessed: H6, H7, H9

Criteria	Band	Marks
• Mention power loss and supported by formula	4/5	3
• Power loss over a large distance		
• Losses decreased when current is lower		
• States formula to support need for low current	3/4	2
• Distance factor added as issue		
• States distance or current as contributing factors	2	1

Sample Answer

Power is proportional to the current flowing in a wire given by the formula $P=I^2R$. According to Ohm's Law voltage and current are inversely proportional to each other, therefore an increase in the voltage in a wire of constant resistance will decrease the current, and the subsequent power loss. A higher current will increase the amount of power lost in the transmission and therefore effects the efficiency of the production of the electricity.

(c) (2 marks)

Outcomes Assessed: H3, H6, H7

Criteria	Band	Marks
• Substation mentioned and identified as a step down	4	2
• Number of turns in primary and secondary coils correctly identified to achieve this		
• Ratio of $n_p : n_s$ for the numbers supplied is calculated		
• Identified as a step down transformer in a substation	2/3	1
• Number of turns in primary and secondary coils correctly identified to achieve this		

Sample Answer

Such a transformer would be found in a substation close to the home. This is a step down transformer and as such requires the number of turns in the primary coil to be higher than those in the secondary coil.

When the supplied voltage (V_p) is 35 000V and is required to be 240V (V_s) in the home, the ratio of $n_p:n_s$ needs to be as follows:

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$\frac{35000}{240} = \frac{n_p}{n_s} = 145:8$$

(d) (1 mark)

Outcomes Assessed: H3

Criteria	Band	Marks
• Gives a correct example of a transformer found in a common household	2	1

Sample Answer

Transformer is used in the power connection of a laptop to an outlet.

Question 21 (4 marks)

(a) (2 marks)

Outcomes Assessed: H2, H9, H11, H13

Criteria	Band	Marks
• Diagram that will correctly allow the factors to be measured as current is generated	3/4	2
• Notes to show what is changed during the experiment in order to achieve the aim		
• Diagram that will correctly allow the factors to be measured as current is generated	2/3	1

(b) (2 marks)

Outcomes Assessed: H2, H9, H11, H13

Criteria	Band	Marks
• Each factor correctly listed with the effect on the generation of current when it is increased and decreased	3/4	2
• At least one factor correctly listed with effect on the generation of current when it is increased and decreased	2/3	1

Sample Answer

Distance between coil and magnet - increased: less current produced, decreased: more current produced

Strength of magnet - increased: more current produced, decreased: less current produced

Relative movement between coil and magnet - faster = more I, slower = less I

Question 22 (4 marks)

(a) (3 marks)

Outcomes Assessed: H9

Criteria	Band	Marks
• Calculates the gradient from the graph	5/6	3
• Correctly interpret the meaning of the gradient mathematically		
• Correctly calculates the value of B		
• Calculates the gradient from the graph	4/5	2
• Correctly interpret the meaning of the gradient mathematically		
• Calculates the gradient from the graph	2/3	1
OR		
• Correctly interpret the meaning of the gradient mathematically		

(b) (1 mark)

Outcomes Assessed: H9

Criteria	Band	Marks
• Describes the force to be decreasing to zero	2/3	1

Sample Answer

a)

$$\begin{aligned} F &= Bil \\ \text{gradient of graph} &= F/I \\ &= BI \\ 5N/0.5m &= B \times 2.5 \\ 10Nm^{-1} &= 2.5B \\ B &= 10/2.5 T \\ &= 4 T \end{aligned}$$

- b) The force would reduce to zero.

Question 23 (3 marks)

Outcomes Assessed: H7, H9

Criteria	Band	Marks
• Explains that this part of the squirrel cage is where currents are induced by the changing magnetic field, which is produced by an alternating current flowing through surrounding coils. Since current is induced then a magnetic field is also produced which repels the field that created it and so makes the squirrel cage turn	5	3
• Identifies that current is induced in this part of the squirrel cage due to changing magnetic fields	3/4	2
• Names the whole device as the squirrel cage	2	1

Sample Answer

The part labelled H is the squirrel cage. Current is induced in this metal structure as the magnetic field is made to change in the structure surrounding it. This is created as an alternating current is passed through the coils in the electromagnet.

When the current is induced in the squirrel cage, a magnetic field is also created. According to Lenz's Law, the magnetic field produced is such that it opposes the change, this creates motion turning the squirrel cage.

The turning motion created is the turn within the motor.

Question 24 (2 marks)

Outcomes Assessed: H3, H9, H13

Criteria	Band	Marks
• Correctly explains the process of induction bringing a train to a standstill	3	2
• Mention of induction in braking system	2	1

Sample Answer

A metal disc makes the brake. It is positioned within a magnetic field. As the disc moves, eddy currents are induced in the disc. The current that is induced will setup a magnetic field that opposes the original change (this is determined by Lenz's Law). The result is in slowing and eventual stopping of the metal disc, thereby braking the train.

Question 25 (6 marks)

Outcomes Assessed: H1, H3, H10, H13

Criteria	Band	Marks
<ul style="list-style-type: none"> • Thorough description of the relevant observations made from photoelectric effect experiments • Thorough interpretation of results leading to development of the particle model • Particle model (i.e. $E=hf$) described • Impact assessed well 	5/6	5-6
<ul style="list-style-type: none"> • Description of most of the relevant observations made from photoelectric effect experiments 	3/4	3-4
AND/OR		
<ul style="list-style-type: none"> • Sound interpretation of these results leading to the development of the particle model 		
AND/OR		
<ul style="list-style-type: none"> • Particle model described or outlined 		
<ul style="list-style-type: none"> • Basic description of an observation made from photoelectric effect experiments with interpretation of result 	2/3	1-2
OR		
<ul style="list-style-type: none"> • Particle model described or outlined 		

Sample Answer

“Photoelectric effect experiments show that below a certain frequency of incident light (known as the threshold frequency), electrons are not emitted from the surface of the metal. Further, the maximum kinetic energy of emitted electrons, measured by the stopping voltage, is proportional to the frequency of the incident light, while the intensity of the radiation has no effect on this kinetic energy, only on the current produced. These observations can only be explained by a particle model of light, with each particle known as a photon having an energy proportional to its frequency, or $E=hf$. The results require a particle model of light, which up until this time had been overlooked for the wave model by most scientists of the time.”

Question 26 (6 marks)

(a) (2 marks)

Outcomes Assessed: H4, H5, H7

Criteria	Band	Marks
• Explanation to how force is produced and what it achieves.	3/4	2
• Reference to lifting due to magnetic field	2/3	1

Sample Answer

Magnetic levitation is when a magnetic field is used to produce a force which raises an object so that it is no longer in contact with the surface beneath it.

(b) (4 marks)

Outcomes Assessed: H4, H5, H7

Criteria	Band	Marks
• More than one benefit AND limitation is mentioned and described.		4
• More than one benefit OR limitation described		3
• One benefit AND limitation mentioned OR		2
• One benefit OR limitation described		
• One benefit OR limitation mentioned		1

Sample Answer

Benefits of magnetic levitation include: reduction of friction to zero between the train and the track; smooth, quiet running of the train; allows for very high speeds of the train. Limitations of magnetic levitation include: very expensive to build the track (and train); only maglev trains can operate on the track; high electric current required means superconductors needed for efficient operation which need to be kept cooled.

Question 27 (3 marks)**Outcomes Assessed: H3, H4, H13**

Criteria	Band	Marks
• States one factor that makes semiconductors better • States that semiconductors replaced thermionic devices • Describes the difference between the two in terms of the stated factor	5	3
• States one factor that makes semiconductors better AND • Names thermionic devices	3/4	2
• States one factor that makes semiconductors better OR • Names thermionic devices	2	1

Sample Answer

Thermionic devices worked by moving electrons from the cathode to the anode. To do this efficiently, the electrons need to encounter as little resistance as possible. This was achieved by placing the setup in a vacuum. This made the device fragile and expensive. Small vibrations from the heating and general movement of the machinery broke the seals on the vacuum, making them less efficient or useless as air interrupted the movement of the electrons. Solid state devices do not need vacuums to work. The electrons are moved by a voltage difference through the material. They are therefore not as fragile.

Question 28 (5 marks)**Outcomes Assessed: H1, H3, H4, H5**

Criteria	Band	Marks
<ul style="list-style-type: none">• Views of Einstein and Planck stated• Influence on views identified as being society or politics• Statements on how society and politics influence research are used to support Einstein and Planck view	5	4-5
<ul style="list-style-type: none">• Views of Einstein and Planck stated• Statements on how society and politics influence research• Statements linked to Einstein and Planks views	3/4	2-3
<ul style="list-style-type: none">• Views of Einstein and Planck stated <p>OR</p> <ul style="list-style-type: none">• Statements on how society and politics influence research	2	1

Sample Answer

Both Planck and Einstein were German scientists during World War II. This gave rise to a dilemma – to stay and assist in the scientific research no matter what it was being used for, or leave and take knowledge with you.

Planck had decided to stay on at the institute in Germany and continue to develop scientific theories that were being used in the war. Planck continued to research what was funded by the government and what they were requesting.

Einstein left and lead an anti war campaign from America. A pacifist and believer in the truth, Einstein believed in research being free of political powers, being able to discover as knowledge became available.

Question 29 – Geophysics (25 marks)

(a)(i) (1 mark)

Outcomes Assessed: H9

Criteria	Band	Marks
• Description of gravimeter's function given	2/3	1

Sample Answer

A gravimeter measures the strength of Earth's gravitational field.

(a)(ii) (2 marks)

Outcomes Assessed: H9

Criteria	Band	Marks
• Two reasons given	3/4	2
• One reason given	2/3	1

Sample Answer

Earth's gravity may vary between two points due to variations in the density of the underlying rocks, or by a difference in the distance of the surface from the center of the earth.

(b)(i) (1 mark)

Outcomes Assessed: H2, H9

Criteria	Band	Marks
• Definition of palaeomagnetic given eg “ ”	2/3	1

Sample Answer

The record of the Earth's magnetic field embedded in rocks as they formed.

(b)(ii) (3 marks)

Outcomes Assessed: H1, H5, H9, H10

Criteria	Band	Marks
• Good detail provided in description of the information obtained from principle method – eg nature of information, usefulness and applications of such information	4/5	3
• Some detail provided in description of information obtained from principle method – eg nature of information and/or usefulness	3/4	2
• Description of information obtained from named principle method very basic – naming only	2/3	1

Sample Answer

Seismic information is used to find variations in the density of rocks and to locate boundaries between rock layers with different densities. Such information may lead to the discovery mineral, oil or gas deposits or fault lines. Seismic information is obtained by recording sound waves produced from explosions detonated at precisely known locations.

(c)(i) (8 marks)

Outcomes Assessed: H1, H3, H4

Criteria	Band	Marks
• Clear explanation of the benefits of a number of different geophysical methods in both mineral exploration and in environmental monitoring is provided, showing a thorough understanding of the processes involved	5/6	7-8
• Good explanation of the benefits of more than one different geophysical method in both mineral exploration and in environmental monitoring is provided, showing a sound understanding of the processes involved	4/5	5-6
• Some explanation of at least one geophysical method in mineral exploration and/or in environmental monitoring is provided, showing some understanding of the processes involved	3/4	3-4
• A geophysical method is mentioned and its role in mineral exploration or environmental monitoring is outlined	1/2	1-2

(c)(ii) (1 mark)

Outcomes Assessed: H8

Criteria	Band	Marks
• A property of P waves is contrasted with a property of S waves	3/4	1

Sample Answer

eg *P waves will travel through a liquid medium, however S waves will not.*

(d) (4 marks)

Outcomes Assessed: H1, H3, H9, H10

Criteria	Band	Marks
• A number of different remote sensing techniques are described and their roles in environmental monitoring are clearly explained in detail	5/6	4
• More than one remote sensing technique is described and their roles in environmental monitoring are explained	4/5	3
• An appropriate remote sensing technique is identified and its use is outlined	2/3	2
• An appropriate remote sensing technique is identified	1/2	1

(e) (5 marks)

Outcomes Assessed: H2

Criteria	Band	Marks
• Most pieces of geophysical evidence which support the theory of plate tectonics are summarised well	5/6	5
• More than one piece of geophysical evidence supporting the theory of plate tectonics are summarised in detail	3/4	3-4
• One piece of geophysical evidence supporting the theory of plate tectonics is summarised either briefly or in some detail	1/2	1-2

Question 30 – Medical Physics (25 marks)

(a) (1 mark)

Outcomes Assessed: H8 H13

Criteria	Band	Marks
• States that the gel has an acoustic impedance similar to water so that there is no reflection of the ultrasound before it enters the body	2	1

Sample Answer

The gel has an acoustic impedance similar to water so that there won't be an air skin interface which would cause most ultrasound to be reflected before entering the body.

(b)(i) (2 marks)

Outcomes Assessed: H12 H13 H14

Criteria	Band	Marks
• Correct formula and substitution to get correct answer	3/4	2
• Correct formula used	2	1

Suggested Answer

29.8%

(b)(ii) (1 mark)

Outcomes Assessed: H12 H13 H14

Criteria	Band	Marks
• Correct formula and substitution to get correct answer.	3	1

Suggested Answer4216 ms⁻¹

(c) (3 marks)

Outcomes Assessed: H7 H13

Criteria	Band	Marks
• Correctly describes piezoelectric effect • Identifies that alternating voltage is required • States that the motion of the crystal causes the sound • Identifies the frequency range of ultrasound	4/5	3
• Correctly describes piezoelectric effect AND • States that the motion of the crystal causes the sound	3	2
• Describes the piezoelectric effect but only that they change shape when voltage is applied OR • States that the motion of the crystal causes the sound OR • Identifies the frequency range of ultrasound	2	1

Suggested Answer

Certain crystals (eg quartz) change shape when a voltage is applied across them and if their shape is changed by mechanical means they produce a voltage. This is called the piezoelectric effect. If an alternating voltage is applied then the crystal changes shape in one direction then the other. Frequency of the motion of the crystal is the same as the alternating voltage. Sound waves are emitted due to this motion. If the frequency is in the range of 1-10 MHz then ultrasound is produced.

(d) (8 marks)

Outcomes Assessed: H4 H10 H13

Criteria	Band	Marks
<ul style="list-style-type: none">Identifies both scans are of the hand. Identifies scan A as a bone scan and B as an X rayStates that Scan A used radioisotope and names the possible type, technetium 99 and B electromagnetic radiationStates the methods of detection gamma camera vs photographic filmStates that scan A can identify metabolic problems whereas B identifies structural problemsScan A is fuzzy due to many point sources of gamma radiation, whereas the X rays have one source and travel in one direction only	6	7-8
<ul style="list-style-type: none">Identifies both scans are of the handIdentifies scan A as a bone scan and B as an X rayStates that Scan A used radioisotope and B electromagnetic radiationStates the methods of detection gamma camera vs photographic film	4/5	5-6
<ul style="list-style-type: none">Identifies both scans are of the handIdentifies scan A as a bone scan and B as an X rayStates that Scan A used radioisotope and B electromagnetic radiation	3	3-4
<ul style="list-style-type: none">Identifies both scans are of the handIdentifies scan B as an X ray	2	1-2

Suggested Answer

Both scans are of hands.

Scan A is a bone scan.

Scan B is an X-ray.

Scan A - a radioisotope technetium 99, which emits only gamma rays, has been introduced into the patient's body. It accumulates in the bone that has a problem. A gamma ray detector is used to count the radiation being emitted from the body. It has accumulated in certain regions near the wrist where the patient's problems were occurring.

The gamma rays are being emitted in all directions from each point source in the patient so the image is somewhat fuzzy.

Scan B - electromagnetic radiation in the form of X-rays are fired at the patient. They pass through the soft tissues easily but are absorbed by bone, which leaves the photographic film behind the bone unexposed. This method is used to identify structural problems. The X rays are being fired in one direction through the tissues towards the film and the hand is close to the film so the image is sharp.

(e) (1 mark)

Outcomes Assessed: H7, H13

Criteria	Band	Mark
• Identifies that annihilation occurs producing gamma radiation	3	1

Suggested Answer

When a positron collides with an electron then they annihilate each other and two gamma rays are emitted in opposite directions.

(f) (4 marks)

Outcomes Assessed: H13

Criteria	Band	Mark
• Identifies that an endoscope consists of 2 bundles of optical fibres. Each bundle consists of about 400 fibres. States that in the coherent bundle the arrangement of the fibres at one end is identical to the arrangement at the other. Identifies that the coherent bundle brings the image from inside the patient to the eyepiece or TV screen. States that in the incoherent bundle the arrangement of the fibres at one end does not match the other end. Identifies that the incoherent bundle projects light into the patient	5	4
• States that in the coherent bundle the arrangement of the fibres at one end is identical to the arrangement at the other. Identifies that the coherent bundle brings the image from inside the patient to the eyepiece or TV screen. States that in the incoherent bundle the arrangement of the fibres at one end does not match the other end. Identifies that the incoherent bundle projects light into the patient	4	3
• Identifies that the incoherent bundle projects light into the patient. Identifies that the coherent bundle brings the image from inside the patient to the eyepiece	3	2
• Identifies that one provides light and the other delivers the image	2	1

Sample Answer

An endoscope consists of 2 bundles of optical fibres. Each bundle consists of about 400 individual fibres. In the coherent bundle the arrangement of the fibres at one end is identical to the arrangement at the other. The function of this bundle is to bring the image from inside the patient to the eyepiece or TV screen. In the incoherent bundle the arrangement of the fibres at one end does not match the other end. Its function is to project light into the patient which is then reflected off the tissues and back up the coherent bundle.

(g) (5 marks)

Outcomes Assessed: H4, H9, H10, H13

Criteria	Band	Marks
<ul style="list-style-type: none">• Identifies type of radiation used for both• Identifies that CT is an external source of radiation and that for MRI the external source causes the nuclei to emit radio waves when it is removed• Identifies that the frequency and intensity of the waves emitted in MRI are the important characteristics. For CT intensity is the important characteristic• States that MRI produces no harmful effects and CT the X rays are damaging ionizing radiation• CT scans and MRI are both used for detecting cancer. MRI is better for soft tissues. CT is better for solid structures MRI can distinguish between the white and grey matter of the brain	5	5
<ul style="list-style-type: none">• Three comparisons made	4	3-4
<ul style="list-style-type: none">• Two comparisons made	3	2
<ul style="list-style-type: none">• One comparison made	2	1

Sample Answer

A table would be good for this answer

Question 31 – Astrophysics (25 marks)

(a)(i) (1 mark)

Outcomes Assessed: H13

Criteria	Band	Marks
• Correct definition of a binary star	2	1

Suggested Answer

A binary star is a pair of stars that orbit each other about a common centre of mass

(a)(ii) (2 marks)

Outcomes Assessed: H3, H8

Criteria	Band	Marks
• Only one component can be seen and the binary star is inferred from the perturbation of the path of the visible star	3	2
• Mention of one of these ideas	2	1

Suggested Answer

An astronomer from Earth would be able to see a single star. The star would appear not to be in a fixed position, it would move around an invisible centre. When observed more closely, it appears to be revolving around an invisible mass. Kepler's law can be used to calculate the mass of the object that could cause this motion.

(b)(i) (1 mark)

Outcomes Assessed: H6, H7

Criteria	Band	Marks
• Correctly identifies the brightest star as seen from Earth	2	1

Suggested Answer

The brightest star as seen from Earth would be CANOPUS

(b)(ii) (3 marks)

Outcomes Assessed: H6, H7

Criteria	Band	Marks
• Successfully apply the formula for apparent magnitude (ie $IA/IB = 100 (mB-mA)/5$ or $M = m - 5\log(d/10)$)	4	3
• ALSO substitute the correct data from the table and calculate the correct value of +0.5		
• EITHER substitute the incorrect values OR fail to calculate the correct value	3/4	2
• ONLY able to identify the correct formula to be used	3	1

Suggested Answer

$$\begin{aligned}
 M &= m - 5 \log(d/10) \\
 &= 0.04 - 5 \log(8.1/10) \\
 &= 0.497
 \end{aligned}$$

(c)(8 marks)

Outcomes Assessed: H2, H7

Criteria	Band	Marks
An ideal response will contain the following, presented in a clear and concise manner: <ul style="list-style-type: none"> • identify the three main stages of the stars life (birth, lifespan/growth, death) • distinguish between the various forms of stars present at these stages, eg red giants, neutron stars giving a description of the physical appearance and nature of the various forms • identify the main areas of H-R diagrams, relating them to the stages of stars and the progression of stars through these stages • relate the size of a star to its length of gestation, and its lifespan • identify that in main sequence stars a fusion reaction of hydrogen to helium occurs, facilitated by a C-N-O catalyst reaction in stars in hotter stars • outline the process of red giants in burning helium, giving some understanding as to why this occurs • identify that supernova are fuelled by the burning of heavier elements up to iron 	6	8
• Seven of the above points mentioned in brief ie correct wording with little substance	5	7
• Six of the above points stated	4/5	6
OR		
• Four stated briefly and one other in detail		
OR		
• Three stated briefly and two others in detail		
• Five of the above points stated	4	5
OR		
• Three stated briefly and one other in detail		
OR		
• Two stated briefly and two others in detail		
• Four of the above points stated	2/3	4
OR		
• Two stated briefly and one other in detail		
• Three of the above points stated	2/3	3
OR		
• One stated briefly and one other in detail		
• Two of the above points stated	2	2
OR		
• One stated briefly and the other in detail		
• One of the above points stated	2	1

(d) (1 mark)

Outcomes Assessed: H10

Criteria	Band	Marks
<ul style="list-style-type: none">Identify that the peak of the plot will shift towards the lower wavelengths of light, and will increase in levels of energy radiated. (Important: it must be demonstrated that there is an understanding of the information presented in a graph of black body radiation not merely describe the shape of the graph.)	3	1

(e)(i) (4 marks)

Outcomes Assessed: H3, H5

Criteria	Band	Marks
<ul style="list-style-type: none">Identify the interference of the Earth's atmosphere on the EM Spectrum emitted by starsIdentify the waves of light emitted by stars are physically distorted by the Earth's atmosphereDiscuss how these impact on the resolution and sensitivity of the images gathered at the Earth's surfaceThe answer is presented in a clear and concise manner	2/5	4
<ul style="list-style-type: none">Three of the above points stated, no discussion	3/4	3
OR		
<ul style="list-style-type: none">Two stated, with one discussed	2/3	2
OR		
<ul style="list-style-type: none">One stated, and discussed	2	1

(e)(ii) (5 marks)

Outcomes Assessed: H3, H5

Criteria	Band	Marks
<ul style="list-style-type: none">Define interferometry as the adding of images produced by several telescopes to produce a more accurate imageMake specific reference to how the resolution and sensitivity of the image is improvedOutline that interferometry can be used with both radio and optical telescopesOutline that interferometry uses the interference patterns produced by the superposition of two out-of-phase signalsPresent a discussion in a clear and concise manner	2/5	5
<ul style="list-style-type: none">Four of the above points stated, no discussion	4/5	4
OR		
<ul style="list-style-type: none">Three stated, with two discussed	3/4	3
OR		
<ul style="list-style-type: none">Two stated, with one discussed	2/3	2
OR		
<ul style="list-style-type: none">One stated, and discussed	2	1

Question 32 – Quanta to Quarks (25 marks)

(a)(i) (1 mark)

Outcomes Assessed: H6

Criteria	Bands	Marks
• Neutrons identified as having no charge	2/3	1

Sample Answer

The action of the accelerator depends on the interaction between the charge on the particle and a magnetic or electric field. Neutrons have no charge so they cannot be accelerated in one of these machines.

(a)(ii) (2 marks)

Outcomes Assessed: H9

Criteria	Bands	Marks
• A simple statement of the four forces. Half a mark for each force Full name required	2/4	2

Sample Answer

The four forces are gravitation force, electromagnetic force, nuclear strong force and nuclear weak force.

(b)(i) (1 mark)

Outcomes Assessed: H7

Criteria	Bands	Marks
• Binding energy must be related to energy and/or mass lost	3/4	1

Sample Answer

Binding energy is energy lost (as mass defect) when nucleons combine.

OR

Binding energy is the work that must be done to detach a single particle from a structure. (Penguin dictionary)

(b)(ii) (3 marks)

Outcomes Assessed: H7

Criteria	Bands	Marks
Three criteria must be met: • Identify the formula which will be used • Fill in and solve correctly • Convert to electron volts	4/5	3

Sample Answer

$$\text{From } \frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right), \frac{1}{\lambda} = R_H(1 - 0) \text{ giving } \frac{1}{\lambda} = R_H \text{ making } \lambda = \frac{1}{R_H}$$

$$\begin{aligned} \text{From } E &= hf = \frac{hc}{\lambda} = 6.626 \times 10^{-34} \times \frac{3 \times 10^8}{\frac{1}{R_H}} = 1.988 \times 10^{-25} \times R_H \\ &= 1.988 \times 10^{-25} \times 1.097 \times 10^7 = 2.181 \times 10^{-18} \text{ J} \\ &= \frac{2.181 \times 10^{-18}}{1.602 \times 10^{-19}} \text{ ev} = 13.613 = 13.6 \text{ ev} \end{aligned}$$

(c)(i) (8 marks)

Outcomes Assessed: H2, H11, H13

Criteria	Bands	Marks
<ul style="list-style-type: none">Two marks for the description of the experiment including the need to provide refrigeration and saturation with alcohol vapourTwo marks for the explanation of tracks being formed by the rays ionising air molecules and the charged ions then attracting vapour molecules of alcoholTwo marks for the explanation of the identification of the alpha rays including both intensity and maximum distance travelledTwo marks for the explanation of the identification of the beta rays including both intensity and maximum distance travelled	5/6	8
<ul style="list-style-type: none">Proportional marks corresponding to the number of points listed from the points above	2/4	

Sample Answer

A petri dish was inverted and used to create an environment which was both refrigerated (using dry ice) and saturated with alcohol vapour (using methylated spirits).

The alpha and beta rays were provided by an appropriate radioactive source which was glued to the head of a pin which had been stuck into an ordinary bottle cork which meant the pin was horizontal and so also were the rays (approximately). Vapour tracks appeared in the petri dish and because the rays were not collimated they were radiated over a sector slightly less than 180° . The vapour tracks appeared because the rays caused ionisation of the air molecules and alcohol molecules were attracted to and condensed on the ions to form visible vapour tracks thus indicating the paths of the rays.

Some vapour tracks were about 1.5 to 2.5 cm long and were quite intense. These tracks were formed by alpha rays.

Some vapour tracks, although clearly defined, were less intense and were 6 to 10 cm long. These tracks were formed by beta rays.

(c)(ii) (1 mark)

Outcomes Assessed: H2, H11, H13

Criteria	Bands	Marks
<ul style="list-style-type: none">Clearly stated how controlled reaction can be achieved and how this differs from an uncontrolled reaction	2	1

Sample Answer

In an uncontrolled reaction, the neutrons that are released from an atom splitting, hit and split nearby atoms in a chain reaction, there is nothing slowing or blocking the outgoing neutrons.

In a controlled reaction, the number of neutrons that can continue from the split atom are limited. Being absorbed/slowed by a moderator.

(d) (4 marks)

Outcomes Assessed: H2, H11, H13

Criteria	Bands	Marks
<ul style="list-style-type: none">• One mark for naming each of the essential properties (2 marks total)• One mark for correctly naming a radio isotope• One mark for correctly describing a use of the radio isotope	3/4	4

Sample Answer

Radio isotopes are *radioactive* compounds or elements which contain atoms with the same *chemical properties* as their non-radioactive counterparts.

Tritium (${}^3_1\text{H}$) is one such element with the same chemical properties as hydrogen (${}^1_1\text{H}$) but which decays by beta-emission.

Tritium can be converted to water and added to a waterway thus tracing the path of the waterway in the ecosystem.

(e) (5 marks)

Outcomes Assessed: H1, H2, H7, H9, H10

Criteria	Bands	Marks
<ul style="list-style-type: none">• Define the Manhattan project• Clearly state changes that were brought about by the project• Explain how changes are significant to society• Link the effects of the project to the effect on society• Overall outcome stated	6	5

Sample Answer

The Manhattan project was joint work between the British and the Americans to develop atomic weapons in response to the threat that Germany posed.

At the time of the development of the project fission was known to be possible, but it was a handful of scientists that believed that this could be developed into a bomb. They brought this to the attention of the government in fear that the Germans would develop and use this first.

By the time the bomb was ready, the war was considered to be nearly over. Society was of the belief that it was a matter of time before it ended and there was no need to bring in weapons of such destructive power. Even the scientists who originally urged the government to develop the bomb now opposed its use.

The deadly and lasting effects of dropping the bomb on Hiroshima, devastated the world.

Many were outraged and united in a push for this to never happen again.

Many countries soon had the intelligence that was developed during the Manhattan project

Many nuclear tests of bombs have taken place since, leaving much radioactive waste. Many countries have developed power facilities from the knowledge of fission supplying countries with cheap efficient energy. Both good and bad effects have come from the development of the development of the Manhattan Project.

Question 33 – Age of Silicon (25 marks)

(a) (1 mark)

Outcome Assessed: H3

Criteria	Band	Marks
• One correct difference stated	2	1

Sample Answer

A transistor is a single component that has a general task. An integrated circuit has many transistors connected together to perform a specific task.

(b) (2 marks)

Outcome Assessed: H3, H4

Criteria	Band	Marks
• One desirable property listed and why it is good for electronics	3/4	2
• One desirable property listed	2/3	1

Sample answer

Silicon retains its properties at high temperatures. This means that there are less requirements in cooling the system it is placed in.

(c)(i) (1 mark)

Outcome Assessed: H7

Criteria	Band	Marks
• Correct definition of a potential divider	2/3	1

Sample Answer

A potential divider is defined to be a series of resistors that split incoming potential to create a smaller potential across a given component.

(c)(ii) (3 marks)

Outcome Assessed: H7

Criteria	Band	Marks
• Correctly determines V_{supplied} , R_2 and V_{out}	4/5	3
• Correctly calculates V_{supplied} or V_{out} and shows working for the other that is on the correct track	3/4	2
• Correctly calculates V_{supplied} or V_{out}	3	1

Sample Answer

$$I_T = 1.5A, \quad R_T = 5 \Omega$$

$$V = I_T R_T$$

$$V_s = 1.5(5) \\ = 7.5V$$

$$R_T = R_1 + R_2$$

$$R_2 = 5 - 3.1 \\ = 1.9 \Omega$$

$$V_{out} = \frac{R_2 V_{sup}}{R_T}$$

$$= \frac{1.9(7.5)}{5} \\ = 2.85V$$

$$\text{OR} \quad V_{out} = I_t \times R_2 \\ = 1.5 \times 1.9 \\ = 2.85V$$

(d) (8 marks)

Outcome Assessed: H3, H4

Criteria	Band	Marks
<ul style="list-style-type: none"> Define a transducer State how each item mentioned satisfies the definition Specify how each item works 	6	7-8
<ul style="list-style-type: none"> Defines a transducer States how all three items work 	4/5	5-6
OR		
<ul style="list-style-type: none"> a combination of how some work and how they satisfy the definition 		
<ul style="list-style-type: none"> Defines a transducer States how two items work OR one and how it satisfies the definition 	3/4	3-4
<ul style="list-style-type: none"> Defines a transducer States how one item works 	3	2
• Defines a transducer	2	1

(e) (1 mark)

Outcome Assessed: H7

Criteria	Band	Marks
<ul style="list-style-type: none"> Correctly identifies all THREE component types needed (This is a simple concept, students should be able to identify all three components – no half marks) 	2	1

Sample Answer

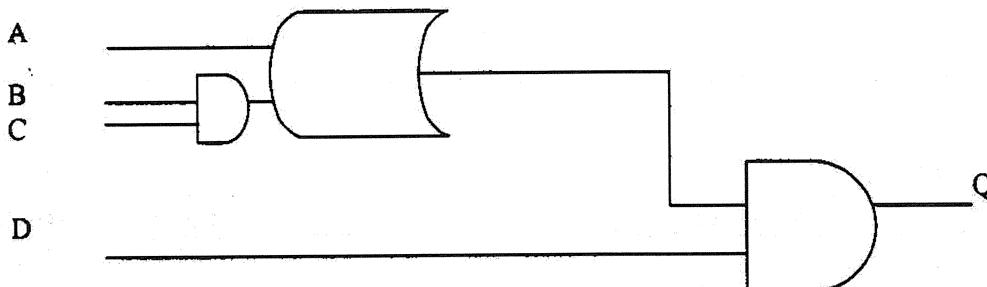
The three gates needed to create a half adder are an AND, NOT and OR gate.

(f) (4 marks)

Outcome Assessed: H2, H13

Criteria	Band	Mark
• Correct logic system to achieve outcome, correctly truth table drawn and filled out		4
• Correct logic system to achieve most of outcome AND correct truth table drawn and filled out		3
OR		
• Correct logic system to achieve all outcomes AND truth table almost fully correct		
• Logic system achieves part aim and truth table matches this		2
• Attempt at logic system that achieves part of the aim		1

Sample Answer



A (swipe card)	B (password)	C (user name)	D (Teacher's name)	Q
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0
0	0	0	1	1
0	0	1	1	1
0	1	0	1	1
0	1	1	1	1
1	0	0	1	1
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

(g) (5 marks)

Outcome Assessed: H1, H4, H7

Criteria	Band	Marks
• An ideal Amplifier defined • Properties listed • Functions identified • Each if the properties and functions described fully	4	4-5
• Lists properties and/or functions • Defines an ideal amplifier	2/3	2-3
• Defines an ideal amplifier	2	1

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