



2006
Year 11
Yearly Science Examination
Hurlstone Agricultural High School

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet, Periodic Table, and Formulae Sheets are provided at the back of this paper

Write your name below.

TIC: Mr Pitt

All sheets must be handed in separately at the end of the examination.

Name _____

Tick Fernandez Pitt Robson

Marks

Total marks (70)

This section has two parts, Part A and Part B

Part A

Total marks (10)

- Attempt Questions 1 – 10
- Allow about 20 minutes for this part

Part B

Total marks (60)

- Attempt Questions 11 – 23
- Allow about 1 hour and 40 minutes for this part

Part A**Use the multiple-choice answer sheet.**

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

(A) (B) (C) (D)

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) (B) (C) (D)

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

(A) (B) (C) (D)
correct
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correct

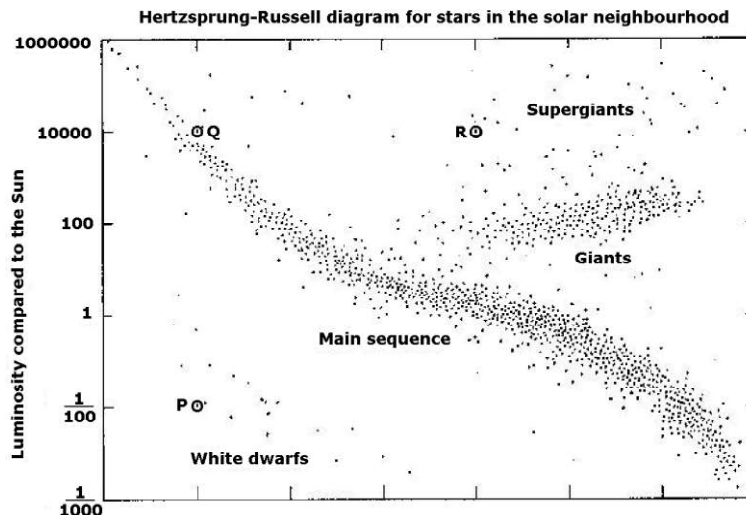
Total marks (10)

Attempt Questions 1 – 10

Allow about 20 minutes for this part

- Which of the following best describes the contribution of Isaac Newton to astronomy?
 - All planets orbit the sun with velocities proportional to the radius of orbit.
 - All planets orbit the sun due to the force of gravity.
 - All planets orbit the sun in elliptical orbits.
 - All planets orbit the sun with an orbital period proportional to the radius of orbit.
- In 1900, the Sun's source of energy was still a mystery. The problem was finally solved by Albert Einstein. Einstein solved the mystery having deduced which of the following?
 - The equivalence of energy and mass
 - The law of conservation of energy
 - The laws of gravity
 - The equivalence of impulse and momentum

The next two questions refer to the Hertzsprung – Russell diagram shown below



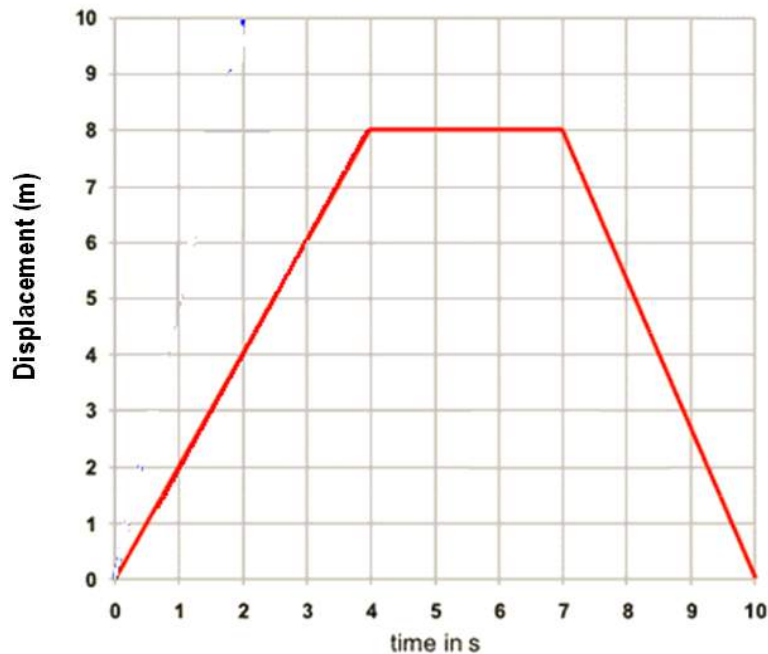
3. Identify the quantity that should be labelled on the horizontal axis.
 - (A) Colour
 - (B) Brightness
 - (C) Mass
 - (D) Temperature

4. Which of the following statements relates the distances from Earth to the stars P and Q if they appear equally bright when viewed from the Earth?
 - (A) Q is a million times further away than P.
 - (B) Q is a thousand times further away than P.
 - (C) P is a thousand times further away than Q.
 - (D) P is a million times further away than Q.

5. Which of the following is the main energy source of red giant stars?
 - (A) Hydrogen fusion
 - (B) Helium fusion
 - (C) Uranium fission
 - (D) Gravitational potential energy

6. Which of the following is the best definition of electric current?
 - (A) The rate at which charge flows through a circuit.
 - (B) The rate at which electrical energy is converted to other useful forms of energy.
 - (C) The voltage across a conductor divided by its resistance.
 - (D) The ratio of the force on a charge to the magnitude of that charge.

7. The following graph represents the motion of a person during a journey in a straight line.



Which of the following statements about the motion of the person is correct?

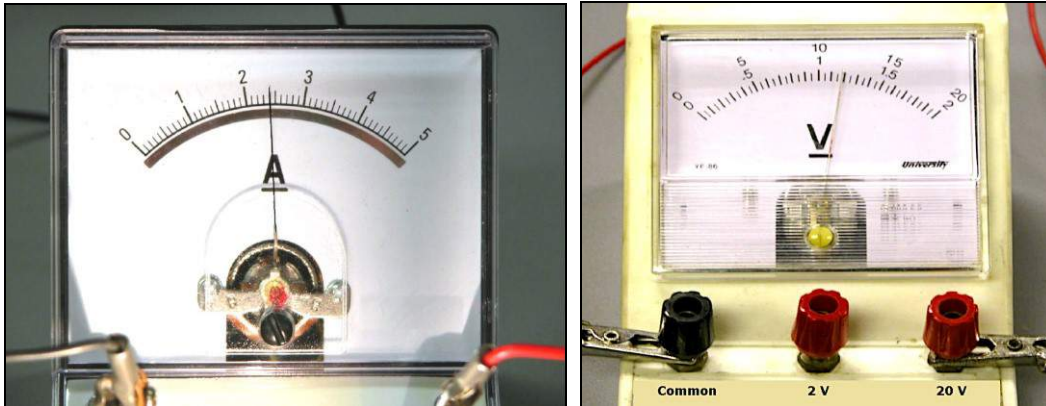
- (A) The total distance travelled was zero.
 - (B) The acceleration of the person was not the same during the first and last seconds.
 - (C) The average speed of the person in the last four seconds was 2.67 m s^{-1} .
 - (D) The minimum speed at which the person moved for more than 2 seconds was 2 m s^{-1} .
8. The Kingswood below was travelling at its maximum speed of 50 km h^{-1} west along a freeway and a Toyota, two kilometres in front of it was travelling east at 70 km h^{-1} .



At what velocity and how long after this time will the Toyota pass this car?

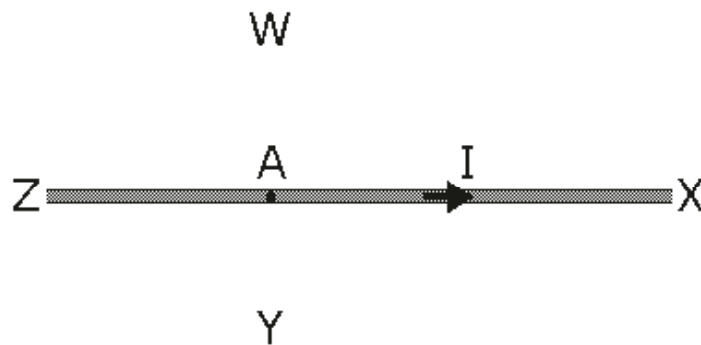
- (A) 120 km h^{-1} west after 30 seconds
- (B) 120 km h^{-1} east after 30 seconds
- (C) 20 km h^{-1} west after 360 seconds
- (D) 200 km h^{-1} east after 36 seconds

9. The following photographs show two meters correctly connected in a circuit consisting of a voltage source and a single lamp.



The energy produced by the lamp in 10 seconds is closest to

- (A) 28 watts
 (B) 30 watts
 (C) 28 joules
 (D) 288 joules
10. This diagram represents a wire resting on a desktop and carrying a current in the direction shown by the arrow. The view is shown looking down on the wire from above.



A magnetic compass was placed above the wire at A. In which direction would the north end of the compass needle point? Assume that the effect of the Earth's field is negligible.

- (A) Toward W
 (B) Toward X
 (C) Toward Y
 (D) Toward Z

***** End Part A *****

Part B

Total marks (60)

Attempt Questions 11 – 23

Answer Questions 11 – 23 in the spaces on the sheet provided.

11. The following diagrams illustrate two techniques which use waves to transmit information.

Figure 1: Amplitude Modulation

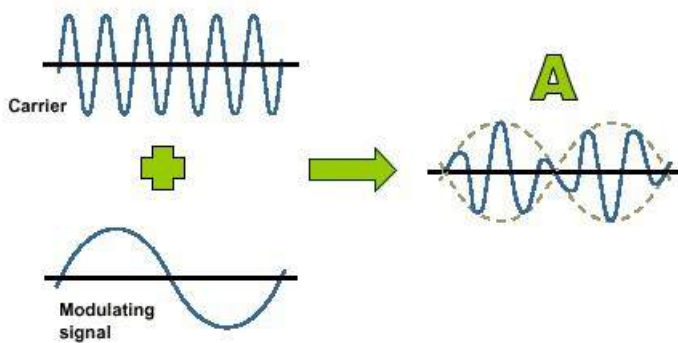
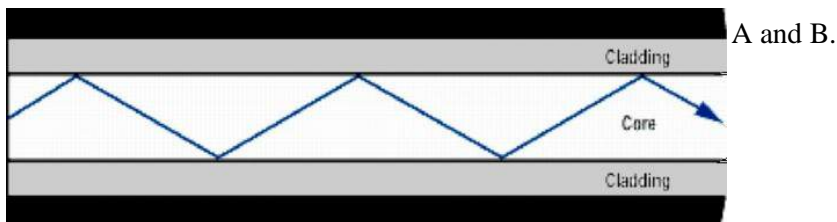


Figure 2: An Optical Fibre



(a) For each technique, identify the main principle underlying its operation. (2 marks)

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(b) Describe two effects on society of using amplitude modulation as a means of transmitting information. (2 marks)

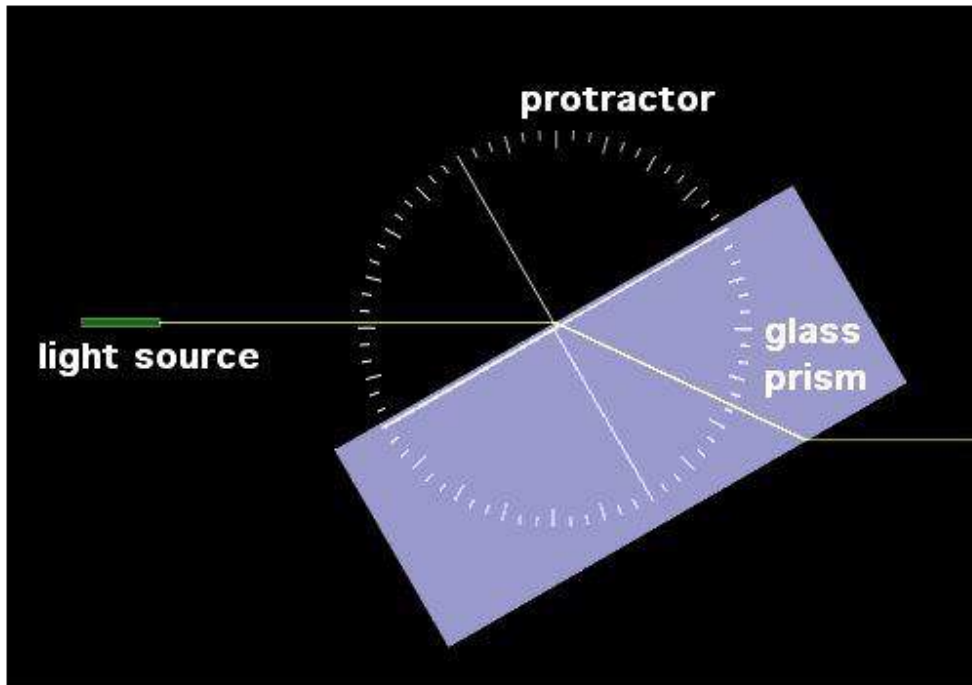
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12. Contrast the propagation of mechanical waves and electromagnetic waves (1 mark)

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13. The following image shows a ray of light travelling through a glass prism in a vacuum. A protractor has been superimposed on the image.



Calculate the velocity of the light in the glass prism. (3 marks)

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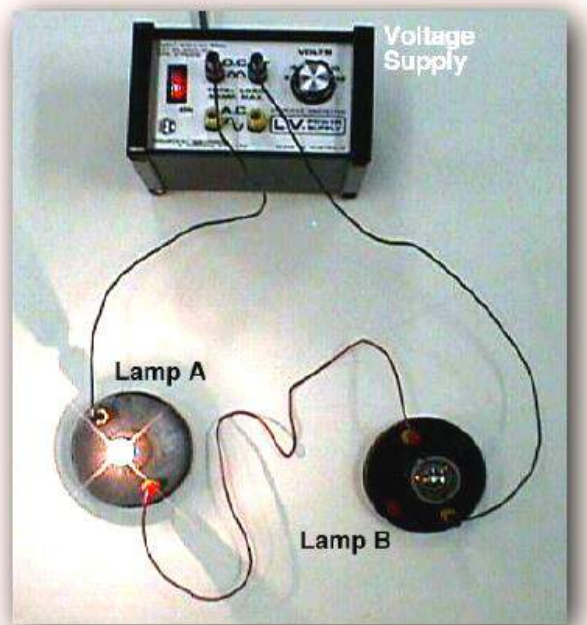
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EQUATIONS

$$v = f\lambda$$

$$n = \frac{c}{v} = \frac{\sin(i)}{\sin(r)}$$

14. Consider the following circuit which shows two lamps connected in series. Lamp A is glowing brightly and lamp B is glowing faintly.



- (a) Identify the property of the lamps that is responsible for the observed difference in their brightness. (1 mark)

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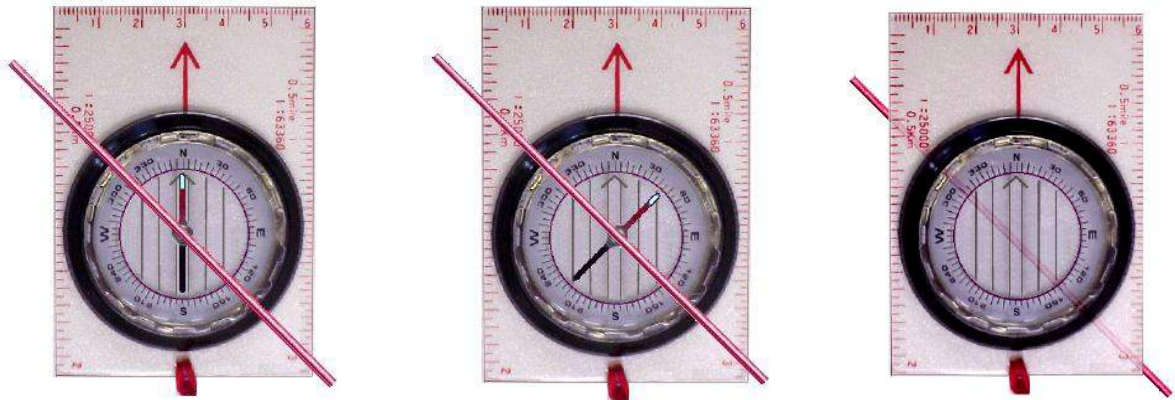
- (b) Qualitatively compare the voltages across each lamp. (1 mark)

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- (c) Predict what would be observed if the bulbs were swapped from one holder to the other. Justify your answer. (2 marks)

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15. The following three images show a compass with a copper wire connected to a DC voltage supply running diagonally. The image on the left shows the position of the compass needle with no current flowing through the wire. The middle image shows the behaviour of the compass when the wire is above the compass and the current is flowing. In the right hand image, the same current flows in the wire, but the wire is below the compass.

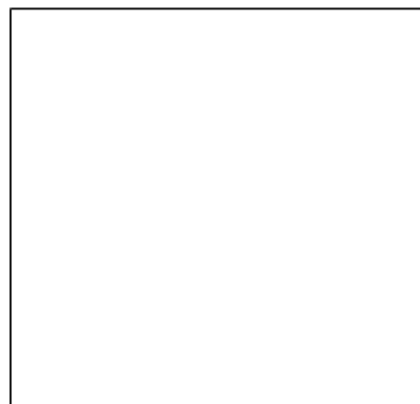
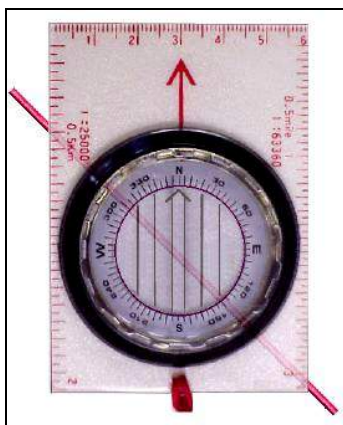


- (a) Describe one inference that can be made from the behaviour of the compass needle in the first diagram. (1 mark)

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- (b) On the diagram below (left), draw the orientation of the compass needle as it would appear in the right- hand image (above). (1 mark)

THE DIAGRAMS BELOW ARE FOR PARTS (b) AND (c) – BE CAREFUL!



- (c) In the box above (right) draw a diagram to represent the magnetic field surrounding a wire carrying a current into the page. (1 mark)

- (d) The behaviour of the compass needle in the middle and right-hand images indicates that there is a relationship between electricity and magnetism. With the aid of a diagram, clarify this relationship with reference to the current-carrying wire used in the experiment. (3 marks)

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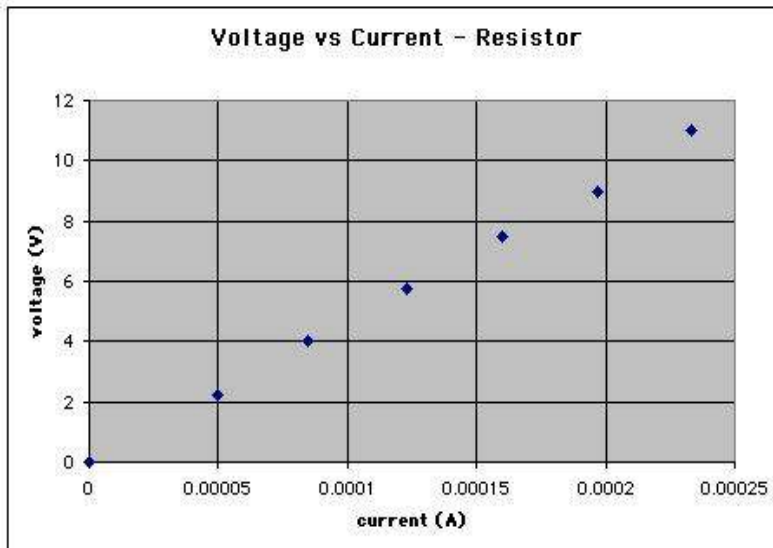
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16. The graph below shows the voltage-current relationship for an conductor that obeys Ohm’s law.



- (a) Draw a line of best fit on the graph. (1 mark)
- (b) Using the graph, calculate the resistance of the conductor. (3 marks)

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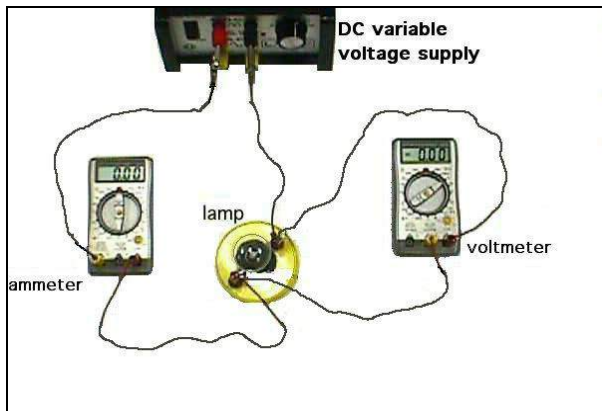
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(c) The image below shows an incandescent lamp connected to a variable DC power source.



Make a qualitative prediction of the shape of the graph of voltage against current for the light bulb. Justify your answer. (3 marks)

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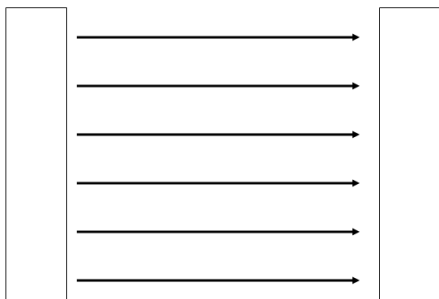
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17. Below shows the electric field between oppositely charged parallel plates



(a) Label the positive and negative plates that would produce the field shown. (1 mark)

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(b) Describe the motion of an electron placed between the plates. (2 marks)

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- (c) The magnitude of the electric field between the two plates is 9.5 V m^{-1} . Calculate the acceleration of a proton ($m_p = 1.673 \times 10^{-27} \text{ kg}$) placed mid-way between the plates. (3 marks)

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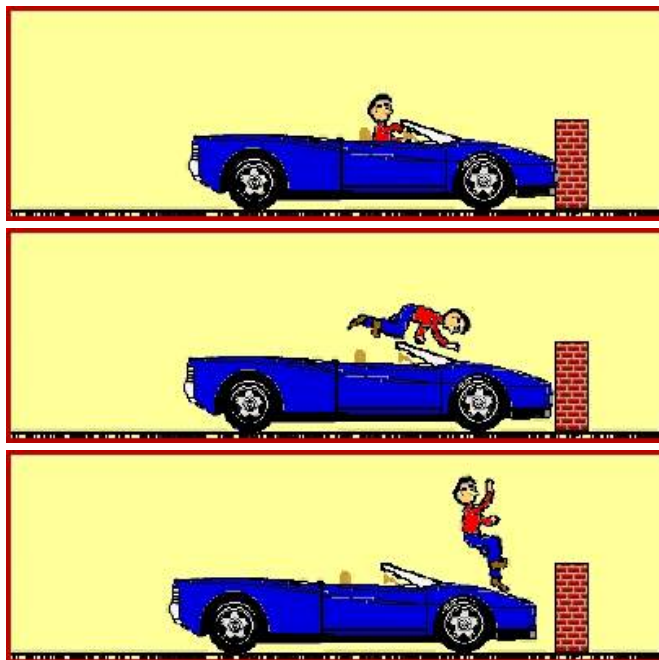
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18. Below is a sequence of images at showing a car and its driver at different times. The images represent the motion of an unrestrained driver when his car collides with a brick wall.



- (a) With reference to at least one of Newton’s Laws of motion, explain the motion of the driver illustrated in this sequence. (2 marks)

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- (b) With reference to the diagrams, assess the value to a driver of wearing a seatbelt in a collision. (2 marks)

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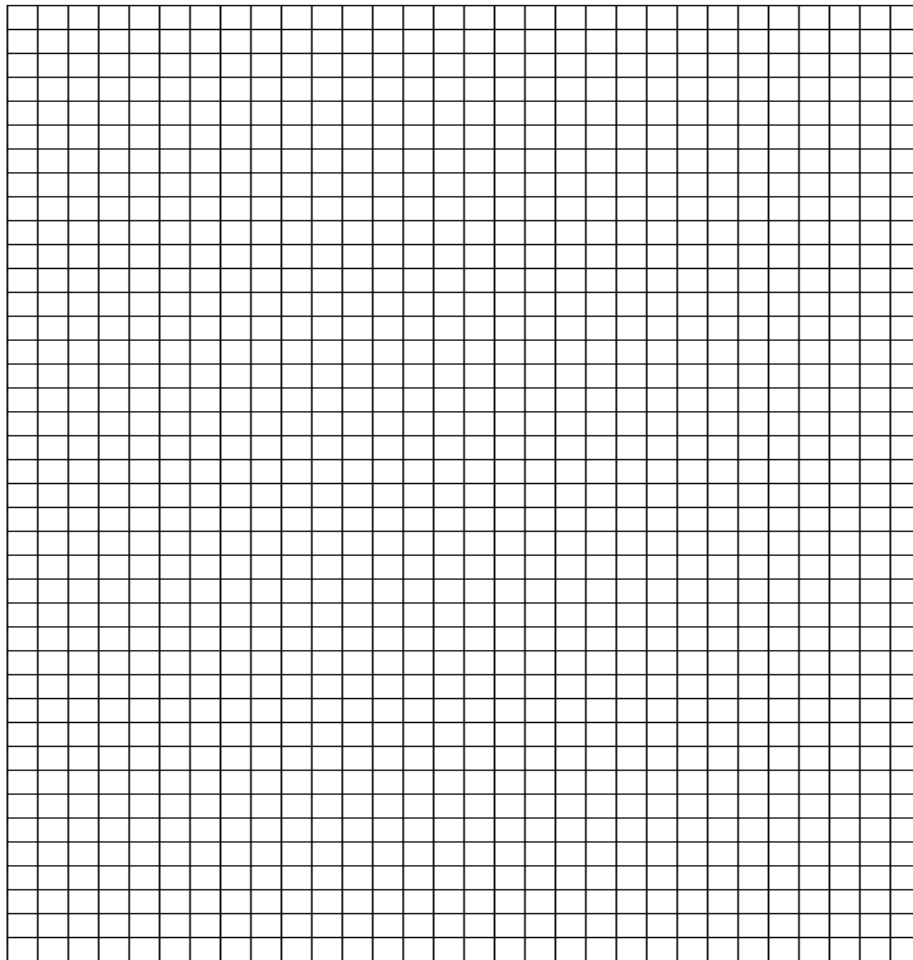
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19. The next question refers to the following description of the motion of an object.

“An object travelled north for 3 seconds with a speed of 5 m s^{-1} before stopping instantaneously for 2 seconds. It then began moving north again with a constant speed, covering a distance of 10 metres in 4 seconds. It stopped for a further 2 seconds before turning around and travelling south at a speed of 6 m s^{-1} for 5 seconds”.

(a) On the grid below, draw a displacement vs time graph which represents the motion. (4 marks)



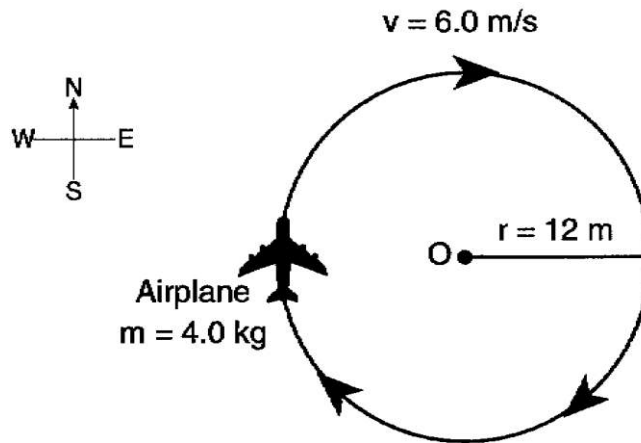
(b) Using the graph, calculate the velocity of the object between the times $t = 5 \text{ s}$ and $t = 9 \text{ s}$. (2 marks)

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(c) Calculate the average speed of the object over the whole trip. (2 marks)

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20. A remote-control battery-powered model plane flew in a horizontal circular path with a constant speed as shown in the diagram below.



(a) Identify two forces that significantly affect the motion of the model plane (1 mark)

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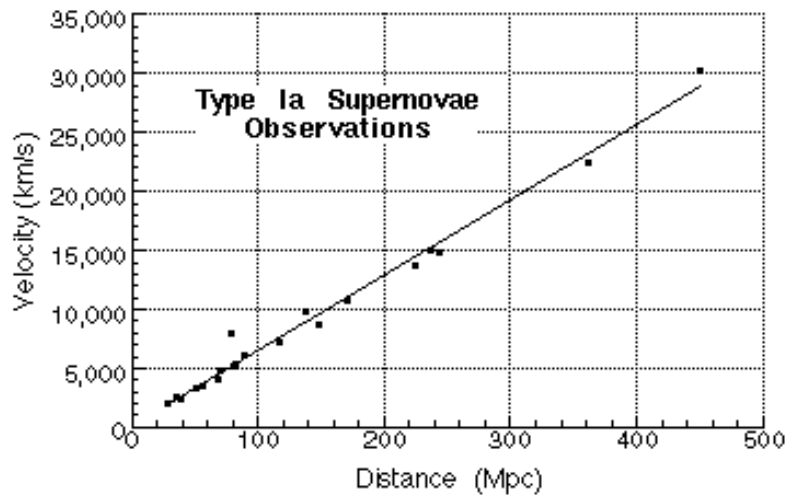
(b) A student stated that, “*since the plane is moving with a uniform speed, the net force acting on it must be zero, in accordance with Newton’s first law of motion*”. Assess this statement. (3 marks)

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(c) With the aid of a diagram, outline the initial effect on path of the plane if its velocity is increased. (2 marks)

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21. The graph below depicts the relationship between the velocities of type Ia supernovas (a type of very bright star) and their distance from Earth. All the velocities are away from the Earth



- (a) Describe the relationship in words (1 mark)

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- (b) Explain why observations such as these provide strong evidence for the Big Bang theory about the origin of the universe. (2 marks)

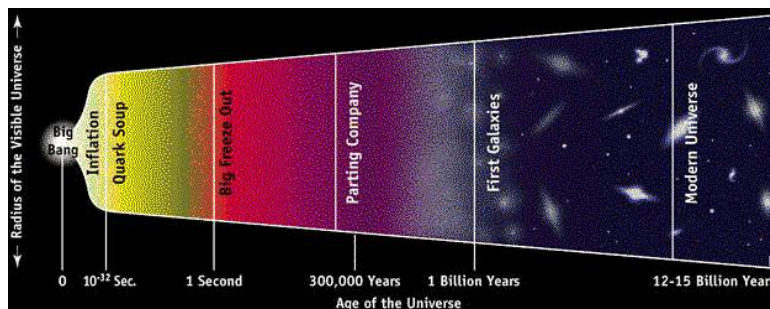
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- (c) The diagram below is a possible time line of events that occurred after the big bang.



(This question continues over the page)

Initially after the big bang, there was no matter in the universe, only vast amounts of energy. With reference to the work of Albert Einstein, describe the formation of simple elements that occurred in the first few seconds of the universe.

(2 marks)

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22. In the late 1600s Isaac Newton introduced a theory that was extensively used to explain the motion of planets. Outline Newton's theory and explain how it was able to account for the motion of the planets of the solar system.

(3 marks)

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23. Identify one vehicle technology that contributes to the avoidance of collisions or the reduction in the effect of collisions and outline the physical principle behind this technology.

(3 marks)

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END

Answer Sheet

Part A

- 1. (A) (B) (C) (D)
 - 2. (A) (B) (C) (D)
 - 3. (A) (B) (C) (D)
 - 4. (A) (B) (C) (D)
 - 5. (A) (B) (C) (D)
 - 6. (A) (B) (C) (D)
 - 7. (A) (B) (C) (D)
 - 8. (A) (B) (C) (D)
 - 9. (A) (B) (C) (D)
 - 10. (A) (B) (C) (D)
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Examiners' use only

Total Multiple choice _____/10

Part B _____/60

Total for paper _____/70

Marking Criteria

Question 11a	
Criteria	Marks
Correctly identifies the main principle for each technique (Superposition and total internal reflection respectively)	2
Correctly identifies one principle	1

Question 11b	
Criteria	Marks
Thorough description of two relevant effects (eg effective communication over long distances, talk-back radio etc)	2
Identifies two relevant effects OR thorough outline of one effect on society	1

Question 12	
Criteria	Marks
Outlines a significant difference between the two types of waves (eg. mechanical waves require a medium for propagation whereas EM waves do not)	1

Question 13	
Criteria	Marks
Chooses the correct equation and substitutes reasonable values of i and r appropriately to determine correct final answer including units ($v = 2.06 \times 10^8 \text{ m.s}^{-1}$)	3
Chooses the correct equation and substitutes appropriately but does not determine the correct final answer (because either or both values of i and r are incorrect OR a calculation error)	2
Chooses the correct equation	1

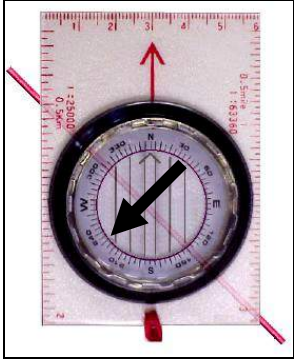
Question 14 a	
Criteria	Marks
Correctly identifies resistance	1

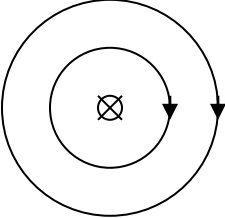
Question 14 b	
Criteria	Marks
States that the voltage across lamp A is greater than the voltage across lamp B	1

Question 14 c	
Criteria	Marks
Correctly predicts that bulb A would still glow brightly and bulb B would still glow faintly and justifies their answer with specific reference to the fact that the position in the circuit is irrelevant – power output is determined by V and I for each bulb and this is unchanged since their resistances remain the same.	2

Correctly predicts that bulb A would still glow brightly and bulb B would still glow faintly	1
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Question 15 a	
Criteria	Marks
States that the compass needle is pointing in the direction of the Earth's magnetic field OR that when no current is flowing through the wire, no magnetic field is induced.	1

Question 15 b	
Criteria	Marks
	1
Arrow or bar clearly drawn to point in the direction shown above.	

Question 15 c	
Criteria	Marks
	1
Diagram shows a circular magnetic field with arrows to indicate it is in a clockwise direction when seen from above	

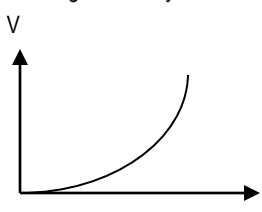
Question 15 d	
Criteria	Marks
Response clearly outlines that a magnetic field is induced when an electric current flows through a wire AND that this field is perpendicular to the direction of the current and circular in shape for a straight conductor (a diagram should be drawn to illustrate this) AND a link made between the behaviour of the compass needle in this experiment and the above observations	3

Marking Criteria

Response clearly outlines that a magnetic field is induced when an electric current flows through a wire AND that this field is perpendicular to the direction of the current and circular in shape for a straight conductor (a diagram should be drawn to illustrate this) OR Response clearly outlines that a magnetic field is induced when an electric current flows through a wire AND a link made between the behaviour of the compass needle in this experiment and the above observations	2
Response clearly outlines that a magnetic field is induced when an electric current flows through a wire	1

Question 16 a	
Criteria	Marks
Straight line drawn using a ruler with points equally spaced on either side of it.	1

Question 16 b	
Criteria	Marks
Correctly calculates gradient of line of best fit using two points on the line and links this to the equation $R = V/I$ to show that this is the resistance OR Correctly calculates the resistance using $R = V/I$ for at least two different points on the line and averages the values.	3
Calculates gradient of line of best fit using points not on the line and links this to the equation $R = V/I$ to show that this is the resistance OR Correctly calculates the resistance using $R = V/I$ for one point on the line.	2
Calculates the resistance using $R = V/I$ using a point not on the line but in the data	1

Question 16 c	
Criteria	Marks
States that the graph is parabolic clearly indicating which way it curves (see below) AND <div style="text-align: center;">  </div> Justifies the statement by explaining that the resistance of the filament increases as its temperature increases and therefore the rate of increase of current will slow as the voltage	3

increases.	
States that the graph is parabolic and justifies the statement by explaining that the resistance of the filament increases as its temperature increases	2
States that the graph is parabolic OR States that the graph is a straight line and justifies this by describing the filament as an ohmic conductor and hence V is directly proportional to I .	1

Question 17 a	
Criteria	Marks
Identifies that the left plate is positive and the right plate is negative	1

Question 17 b	
Criteria	Marks
States that the electron ACCELERATES towards the positive plate	2
States that the electron moves towards the positive plate	1

Question 17 c	
Criteria	Marks
Correctly calculates the electric force using $F = qE$ (1.52×10^{-19} N) and substitutes the value into the equation $F = ma$ to successfully calculate the acceleration (9.09×10^8 m.s ⁻² towards negative plate)	3
Correctly calculates the electric force using $F = qE$ (1.52×10^{-19} N) and substitutes the value into the equation $F = ma$ but does not successfully calculate the acceleration OR Uses $F = qE$ but does not correctly calculate the electric force. The value is then used appropriately to calculate the acceleration.	2
Uses $F = ma$ to calculate an acceleration.	1

Question 18 a	
Criteria	Marks
Identifies an appropriate law (Newton's First) and clearly links the motion of the driver out of the car with this law (eg car experiences a force but driver continues to move in a straight line at the speed the car was travelling at)	2
Explains the motion of the driver correctly but does not link it to an appropriate law.	1

Question 18 b	
Criteria	Marks
Outlines that the seatbelt will apply a force which prevents the driver being propelled out of his seat and makes a clear judgement of the value	2

Marking Criteria

of this in terms of preventing injury.	
Outlines that the seatbelt will apply a force which prevents the driver being propelled out of his seat but no judgement of value	1

Question 19 a	
Criteria	Marks
Labels quantities on both axes AND shows units for both variables, includes suitable scales on both axes, plots points correctly AND draws in correct line.	4
2 of the above [note 2 part to each criterion]	3
Any 4 correct components of graph	2
Any two correct components of graph	1

Question 19b	
Criteria	Marks
Shows a calculation and correct answer (2.5 m s ⁻¹ NORTH) that clearly relates to the gradient of the graph	2
Has only the correct answer without direction OR method is correct and a direction is stated	1

Question 19 c	
Criteria	Marks
Writes formula and substitutes correct values and has correct answer, 3.4375 m/s	2
Correct formula and process but incorrect values used for distance or time	1

Question 20 a	
Criteria	Marks
Identifies TWO forces which could include; the force of gravity, air resistance, lift, centripetal force, thrust provided by engines (half marks not awarded for one correct)	1

Question 20 b	
Criteria	Marks
Makes a judgement that the statement is false based on the argument that the velocity is constantly changing and this requires a net force (centripetal in the case of circular motion).	3
States that the statement is wrong AND that there is a centripetal force OR that the plane is accelerating (or velocity changing)	2
Makes one correct statement about circular motion or the forces acting, relevant to the plane's motion	1

Question 20 c	
Criteria	Marks

Uses a diagram to clarify the fact that if the velocity (only) is increased, the radius of the path increases. [A really good answer would state a greater centripetal force would be required and in the absence of this and relate this to $F = mv^2/r$.]	2
Indicates that the path would change with the radius becoming larger.	1

Question 21a	
Criteria	Marks
States that the velocity is directly proportional to the distance	1

Question 21b	
Links the expansion of the universe clearly to the fact that the most distant objects are the most distant BECAUSE they have been travelling faster since the big bang.	2
Makes a significant statement about the importance of observations.	1

Question 21c	
Links Einstein's equation, $E=mc^2$, to the conversion of energy to matter after the big bang. (a description of element formation is not required, equation ONLY gets zero)	2
States that Einstein concluded that matter and energy were related by $E=mc^2$ OR states that after the big bang, energy was converted to matter.	1

Question 22	
Criteria	Marks
Identifies the theory of gravity and states that there is a centripetal force of attraction between the planets and the sun, which causes the planets to travel in their orbits.	3
Identifies the theory of gravity and states that there is a force of attraction between the planets and the sun.	2
Identifies the theory of gravity	1

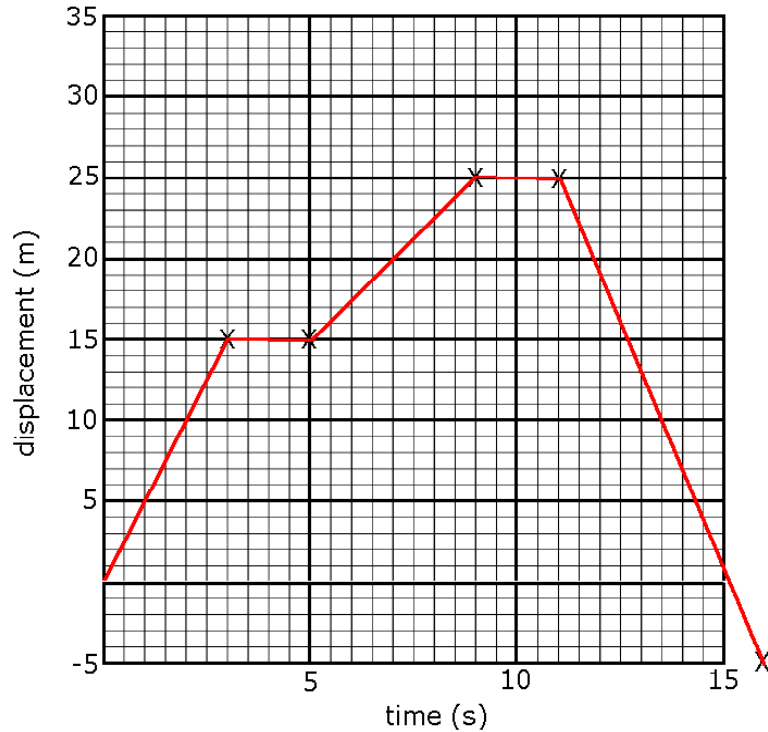
Question 23	
Criteria	Marks
Identifies a technology and links more than a single relevant idea in describing the underlying principle.	3
Describes one aspect of the physical principal behind the technology that has been identified.	2
Identifies a vehicle safety technology	1

Marking Criteria

Sample Answers:

Q19a

Displacement - Time Relationship



Q20b: Because the **velocity** of the plane is constantly changing due to its changing **direction**, a net force is required. This force is towards the centre of the circle (it is called centripetal). The student's statement is therefore incorrect.

Q23: One vehicle technology that contributes to the reduction in the effects of collisions is the crumple zones found in the front and rear of a vehicle. Since stopping distance is inversely proportional to the force experienced by the passengers, by increasing the stopping distance, an effect provided by the crumple zones, it decreases the force on the occupants. Thus crumple zones reduce the effect of collisions on the passengers.

MULTIPLE CHOICE ANSWERS:

1. B
2. A
3. D
4. A
5. B

6. A
7. C
8. B
9. D
10. C