Student number...................................

Class ....

Teacher ....

Cheltenham Girls
High School

2011
Mid-course Examination

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 1 ½ hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the Multiple Choice Answer Sheet provided
- Write your Student Number at the top of each page you write
- Remove the multiple choice answer sheet from the end of the paper

Total marks – 60

Section I Pages 2 – 5
12 marks

- Attempt Questions 1 – 12
- Allow about 20 minutes for this part

Section II Pages 5 – 12
48 marks

- Attempt questions 13 – 23
- Allow about 1 hour and 10 minutes for this part

Section I - 12 marks
Multiple Choice questions

Attempt all questions **1** to **12**. Allow about 20 minutes to complete this Section.
Select the alternative A, B, C or D, that best answers the question and indicate your choice by clearly marking your answer in the appropriate place on the Multiple Choice Answer Sheet provided.

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1 A boy and a girl are sitting on a sofa. They move so that the distance between them is now one third of what it was before. How does the gravitational force of attraction between them change?

(A) one ninth as great.
(B) one third as great
(C) three times as great
(D) nine times as great

2 As the Apollo space capsule came back to the surface of Earth after completing a mission, it had to enter Earth's atmosphere with the right angle of approach. The main reason for this was that:

(A) its wings had to be oriented correctly so that it could gain lift to glide to the surface.
(B) it could bounce off if the angle is too shallow, or burn up if it is too steep.
(C) its approach must be very steep to ensure that the acceleration is not too great.
(D) all the heat it had developed while in orbit must be able to be dissipated.

3 A rock drops from a very high altitude towards the surface of the moon. Which of the following is correct about the changes that occur in the rock's mass and weight?

	MASS	WEIGHT
(A)	increases	decreases
(B)	increases	increases
(C)	remains constant	decreases
(D)	remains constant	increases

4 The Michelson-Morley experiment was unsuccessful in proving the existence of the aether because:

(A) the experiment was poorly designed.
(B) the measured speed of light is independent of the motion of the observer.
(C) at the time of the experiment the motion of the earth was cancelled by the motion of the solar system.
(D) the apparatus contracted due to its high speed through the aether.

5 The magnitude of the induced emf for a conductor moving through a magnetic field can be changed by all except:

(A) reversing the field direction
(B) increasing the speed of the conductor
(C) changing the angle of movement of the wire in the field
(D) increasing the strength of the field

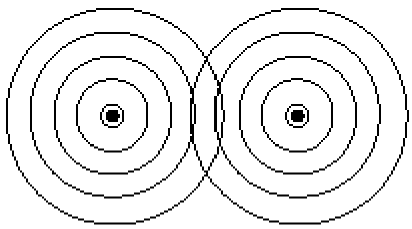
6 Consider all the planets in the solar system. It is true that:

(A) the planets further from the sun have shorter periods.
(B) the planets closer to the sun have lower orbital velocities.
(C) all planets have the same period.
(D) $\frac{r^3}{T^2}$ is the same for all planets.

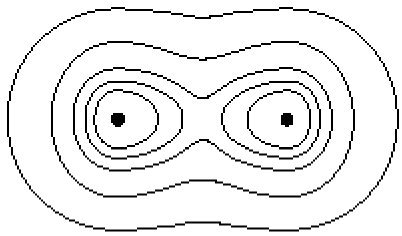
7 Two parallel wires carry currents in the same direction. The wires are viewed from the ends as shown in the diagram.

Which of the following diagrams best represents the magnetic field in the region near the wires?

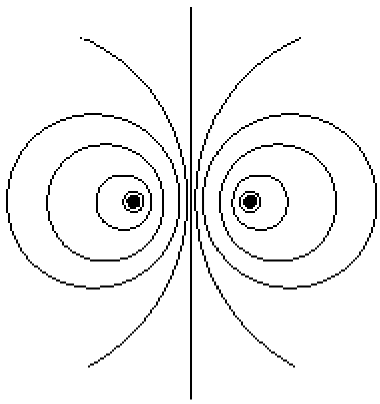
(A)



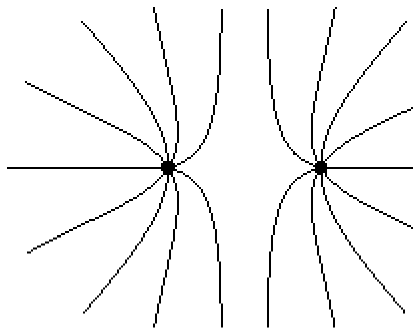
(B)



(C)



(D)



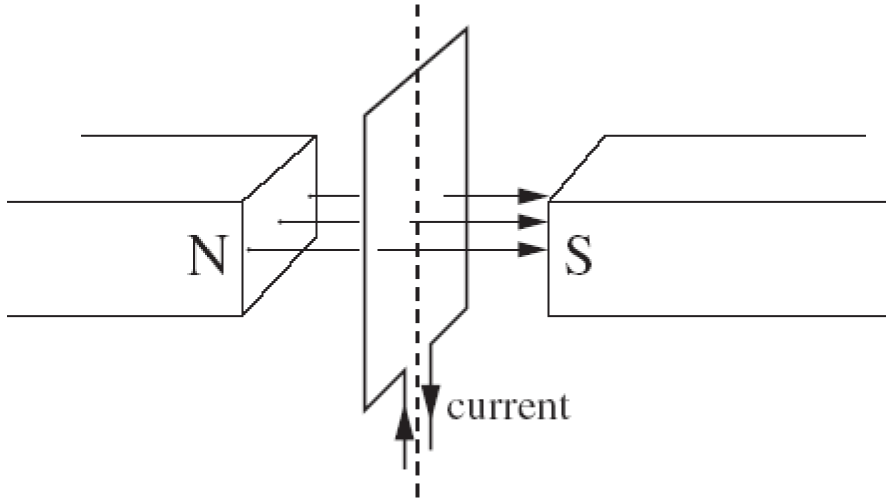
8 Which of the following is true of AC generators?

(A) They are only available in small power ratings
(B) They have a split-ring commutator
(C) They have slip rings
(D) They are less efficient than DC generators

9 A motor operating at full speed draws a current of 4.0 A when connected to a 240 V source. The motor has an armature resistance of 3.5 ohms. What is the back emf at full speed?

(A) 120 V
(B) 126 V
(C) 226 V
(D) 240 V

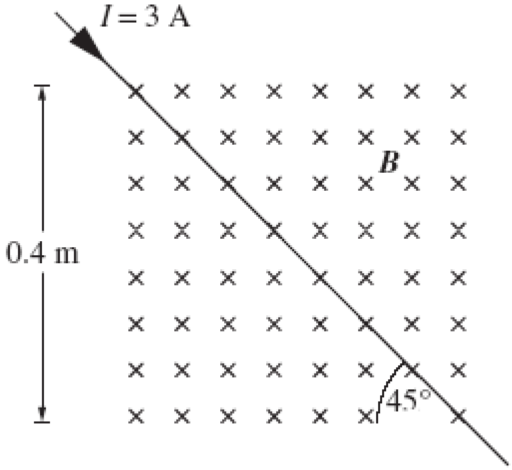
10 An electric motor is set up as shown



When current is supplied the coil does not turn. Which of the following is required for the coil to start turning?

(A) The magnetic field must be increased.
(B) The direction of the current must be reversed.
(C) The magnitude of the current must be increased
(D) The starting position of the coil must be changed.

11 A current carrying conductor passes through a square region of magnetic field, magnitude of 0.5 T, as shown in the diagram. The magnetic field is directed into the page.



What is the magnitude of the magnetic force on the conductor?

(A) 0.170 N
(B) 0.424 N
(C) 0.600 N
(D) 0.849 N

12 What minimum energy is required to raise a 1.7×10^3 kg lunar rover vehicle from the surface of the Earth (radius = 6 380 km) to a altitude of 5.22×10^6 m?

(A) 9.6×10^{11} J
(B) 1.0×10^{12} J
(C) 4.8×10^{12} J
(D) 1.1×10^{11} J

(End of Section I)

Section II Written Response questions - 48 marks

Attempt all Questions **13** to **23** – Marks for each question are shown
Allow about 1 hour and 10 minutes to complete this Section.

Answer the questions in the space provided.

Mark

13. Discuss TWO important design elements required in a spacecraft if it is to allow safe re-entry into the atmosphere. **4**

(i) ....

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(ii) ....

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14. (a) Compare a satellite that has a geostationary orbit to one that has a low earth orbit. **2**

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(b) Identify ONE advantage of a geostationary satellite over a low earth orbiting satellite. **1**

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(c) Scientists often choose to use a low earth orbiting satellite over a geostationary satellite for a particular application. Explain why they would choose the low earth orbiting satellite for an application of your choice. **2**

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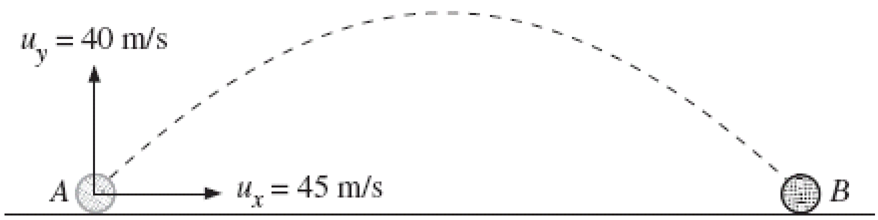
15 A football is kicked from level ground at point A with velocity components as shown on the diagram. It lands at point B.



(a) State the vertical component of the ball's velocity as it hits the ground. **1**

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(b) Find the ball's initial velocity. **2**

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(c) Calculate the ball's maximum height. **2**

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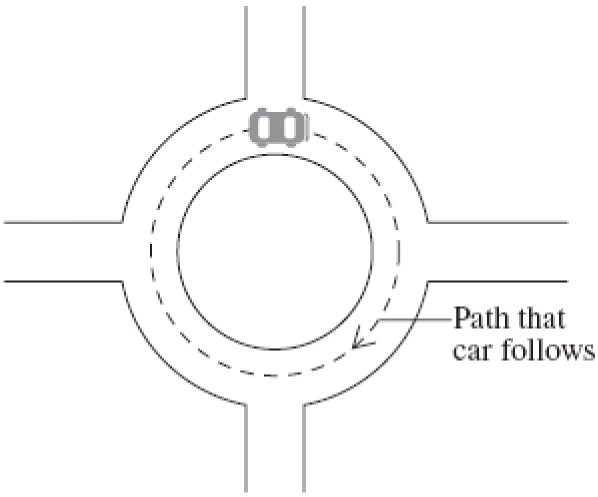
(d) Determine the ball's range, if it lands at point B shown on the diagram. **2**

16 A car travels around a roundabout at a constant speed of 8.5 ms^{-1}. The radius of its circular path is 18m. The total mass of the car is 1500 kg.



The driver of the car says to the passenger "This is just like a planet orbiting the sun."

(a) Draw three labelled arrows on the diagram above to show the direction of the car's velocity, the car's acceleration and the net force acting on the car. **2**

(b) Calculate the magnitude of the net force acting on the car. **1**

(c) Assess the driver's statement. Support your answer by contrasting the types of forces on the car and on a planet in orbit. **2**

Mark

17 A very important experiment was carried out at the end of the 1800's involving testing for the speed of the Earth through the aether.

(a) The experiment had a negative result. It was not until several years later that another scientist proposed a theory that made sense of this result. Identify the scientist and the name of his or her theory. **1**

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(b) Describe how the two light beams become perpendicular to each other at one stage of the experiment. You may use a diagram. **2**

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(c) Describe the expected observations if a *positive* result occurred in this experiment. **1**

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18 A student does a thought experiment. She imagines driving past the school in a sports car at 60% the speed of light. She has measured the length of the car at home in the garage as 5.000 m.

(a) She turns on the head lights. Compare the velocity of the light beam produced as measured by a passenger in the car and a physics teacher in the school. **1**

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(b) Calculate the length of the car as measured by a friend standing still in the in the school as the car passes. **3**

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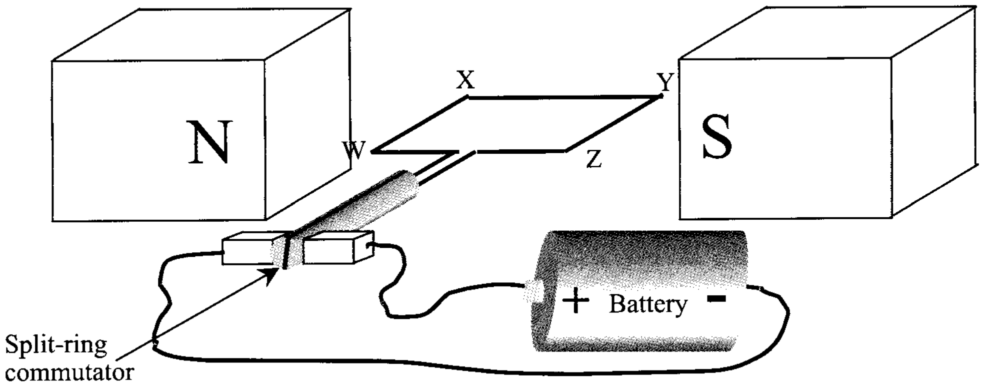
19 The diagram shows the basic structure of a simple D.C. electric motor. The loop of wire **WXYZ** is a square with the sides 15.0 mm in length.



The magnetic field strength between the poles of the magnets is 2.0 T and the battery supplies a current of 4.0 A.

(a) Calculate the magnitude of the torque that will act on the coil, and state the direction of rotation, as viewed in the diagram. **2**

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(b) Describe the change in the torque as the coil begins to rotate from the position shown, into a vertical position. Explain why this change occurs. **3**

Describe:

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Explain:

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20 Explain the operation of an induction cook top using relevant physical principles. Your answer should include a clearly labelled diagram. **4**

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21 A fan that ventilates an underground mine is run by a very large D.C. electric motor. This motor is connected in series with a variable resistor to protect the windings in the coil. **3**

When the motor is starting up, the variable resistor is adjusted to have a large resistance. The resistance is then lowered slowly as the motor increases to its operating speed.

Explain why no resistance is required when the motor is running at high speed, but a substantial resistance is needed when the motor is starting up.

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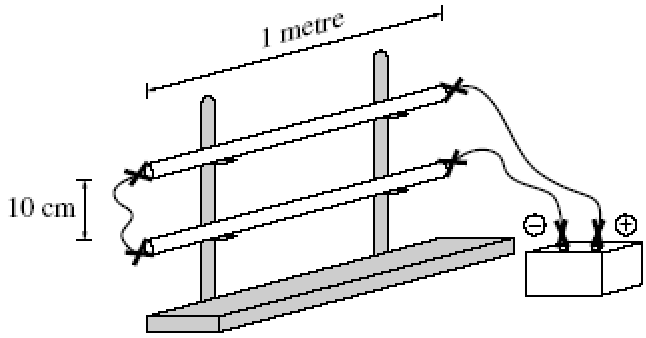
22 Two thin metal tubes one metre long were supported in a wooden rack as shown in the diagram. **3**



The two ends were connected together, then the other two ends were connected briefly to a car battery as shown in the diagram. It was observed that one of the tubes jumped upward as the connection was made.

Each tube has a mass of 1×10^{-2}kg, and the tubes lie on the rack 10 cm apart. Calculate the minimum current that flows when one tube jumps.

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23 Two solenoids (coils) with hollow cores are suspended using string so that they are hanging in the positions shown below. The solenoids are free to move in a pendulum motion. **4**

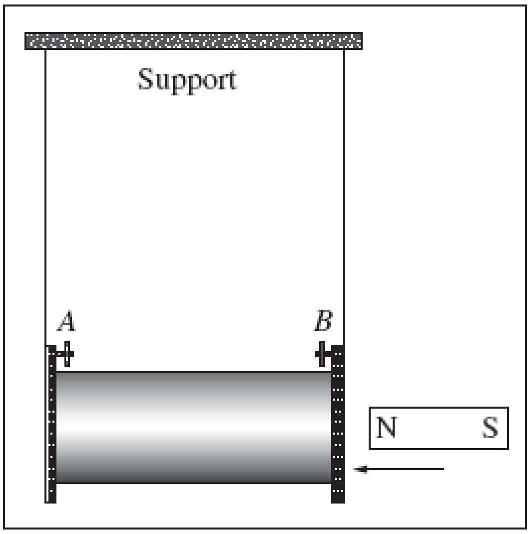

Figure 1 – First investigation

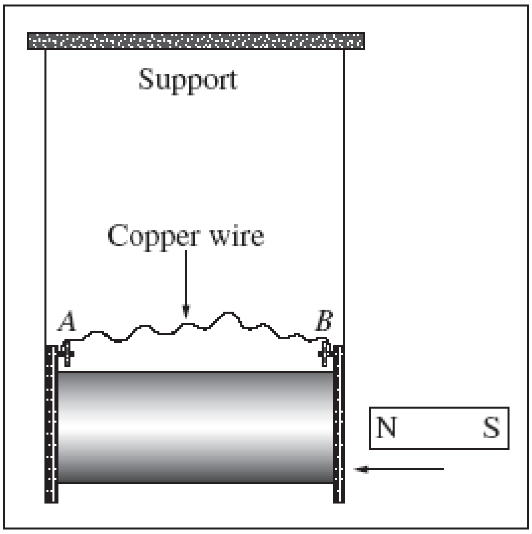

Figure 2 – Second investigation

In the first investigation shown in Figure 1, a strong bar magnet is moved towards the solenoid until the north end of the magnet enters the solenoid and then the motion of the magnet is stopped.

In the second investigation, shown in Figure 2, a thick copper wire is connected between the two terminals, *A* and *B*, at the ends of the solenoid. The motion of the magnet is repeated exactly in this second investigation.

Explain the effect of the motion of the magnet on the solenoid in the two investigations.

1 ....

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2 ....

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(End of Section II. End of paper.)

DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^{8} m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^{7} m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^{3} kg m^{-3}
Specific heat capacity of water	4.18×10^{3} J kg^{-1} K^{-1}

FORMULAE SHEET

$$v = f\lambda$$

$$I \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$E = \frac{F}{q}$$

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

$$P = VI$$

$$\text{Energy} = VIt$$

$$v_{av} = \frac{\Delta r}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} \quad \text{therefore} \quad a_{av} = \frac{v - u}{t}$$

$$\Sigma F = ma$$

$$F = \frac{mv^2}{r}$$

$$E_k = \frac{1}{2}mv^2$$

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

$$E_p = -G\frac{m_1 m_2}{r}$$

$$F = mg$$

$$v_x{}^2 = u_x{}^2$$

$$v = u + at$$

$$v_y{}^2 = u_y{}^2 + 2a_y \Delta y$$

$$\Delta x = u_x t$$

$$\Delta y = u_y t + \frac{1}{2}a_y t^2$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = \frac{Gm_1 m_2}{d^2}$$

$$E = mc^2$$

$$l_v = l_0\sqrt{1 - \frac{v^2}{c^2}}$$

$$t_v = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$m_v = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

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

$$d = \frac{1}{p}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100^{(m_B - m_A)/5}$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$c = f\lambda$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$\lambda = \frac{h}{mv}$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

$$A_0 = \frac{V_{\text{out}}}{V_{\text{in}}}$$

$$\frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_{\text{f}}}{R_{\text{i}}}$$

2011 YR 12 PHYSICS M.C.E. MARKING GUIDELINES AND SAMPLE ANSWERS

Section 1 – 12 multiple choice questions. One mark each 12 marks

Questions	1	2	3	4	5	6	7	8	9	10	11	12
Answer	D	B	D	B	A	D	B	C	C	D	C	A

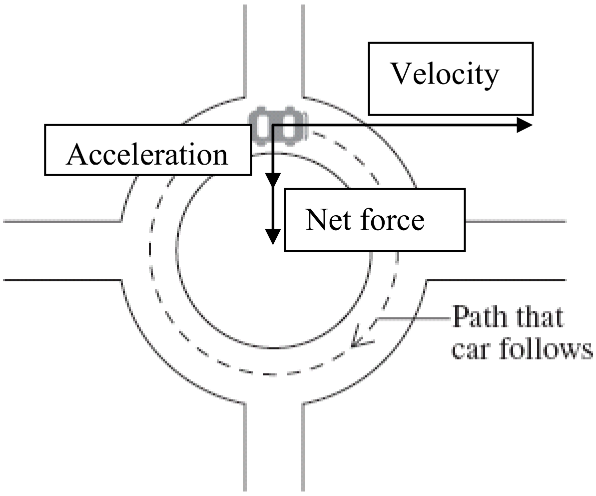
Section 2 – written response questions. 48 marks

Qu	**Sample Answers**/Marking Guidelines	Mark

Qu	Sample Answers/Marking Guidelines	Mark
13	<u>**SAMPLE ANSWER**</u> **(i) A heat shield such as tiles on the space shuttle or the ablating fibreglass shield on the Apollo craft protect the craft and occupants from the extreme temperatures caused by air friction on re-entry.** **(ii) The blunt nose shape of the Apollo craft and space shuttle create a shock wave ahead of the craft to dissipate heat produced by air friction.** **Or other**	**4**
	Identifies two features and explains the purpose of each clearly	4
	Identifies two features and explains the purpose of one clearly	3
	Identifies two features or identifies and explains one feature	2
	Identifies one feature	1

Qu	Sample Answers/Marking Guidelines	Mark
14	<u>**SAMPLE ANSWER**</u> **(a) Period 24h/1.5h, Alt high/low, Speed slow/fast or other**	**2**
	Compares two characteristics correctly	2
	Compares one characteristic correctly	1
	<u>**SAMPLE ANSWER**</u> **(b) A geostationary satellite remains above the same location on the equator allowing easier communication or other similar answer.**	**1**
	Identifies one correct advantage.	1
	<u>**SAMPLE ANSWER**</u> **(c) Monitoring bushfire activity as a l.e.o. satellite can take higher resolution photographs giving more detail.**	**2**
	Identifies and explains one application	2
	Identifies an application only or has poor explanation.	1

15	**SAMPLE ANSWER** **(a) $v_y = - u_y$ so $v_y = -40\ ms^{-1}$ (or $40\ ms^{-1}$ down)**	**1**
	Correct magnitude and direction	1
	SAMPLE ANSWER **(b) $u = u_x = u_y$ so magnitude $u = (40^2 + 45^2)^{1/2} = 60.2 = 60ms^{-1}$** **Direction $\tan^{-1}(40/45) =$ 41 degrees above the horizontal**	**2**
	Magnitude and direction correct	2
	One of the above correct	1
	SAMPLE ANSWER **(c) $v_y^2 = u_y^2 + 2a\Delta r_y$ so $0 = 40x40 – 19.6\Delta r_y$ so $\Delta r_y = 81.6$ (82) m**	**2**
	Correct answer including units and suitable working	2
	Correct but no units or incorrect with correct working and substitution	1
	SAMPLE ANSWER **(d) $\Delta r_y = u_yt + ½\ a_yt^2$ so $0 = 40t - 4.9t^2$ so $t = 8.16$ (8.2) s** **$\Delta r_x = u_xt$ so $\Delta r_x = 45x\ 8.16 = 367$ (370) m**	**2**
	Correct answer and working	2
	One part of solution correct	1

16	**SAMPLE ANSWER** **(a)** 	**2**
	3 correct arrows	2
	2 correct arrows	1
	SAMPLE ANSWER **(b) $F = mv^2/R$ so $F = 1500 x 8.5 x 8.5/18 = 6020 (6000)$ N**	**1**
	Correct answer with units	1
	SAMPLE ANSWER **(c) The centripetal force on the car is provided by friction between the tyres and the road whereas the centripetal force on the planet is provided by gravity. Therefore the driver's statement is partly correct. They both have centripetal forces but provided in different ways.**	**2**
	Correct contrasts (identifies both forces) and assessment statement	2
	Correct contrasts (identifies both forces) or identifies one force and has assessment.	1

17	**SAMPLE ANSWER** **(a) Einstein's theory of relativity**	**1**
	Identifies both correctly	1
	SAMPLE ANSWER **(b) By passing through a half silvered mirror placed at 45^o to the beam.**	**2**
	Describes or shows a half silvered mirror at 45^o and the incoming and outgoing beams	2
	Describes or shows a partially correct explanation	1
	SAMPLE ANSWER **(c) A change in the interference pattern viewed.**	**1**
	Correctly identifies a **change** in the interference pattern	1

18	**<u>SAMPLE ANSWER</u>** **(a) Both measure the same speed of light.**	**1**
	Correct answer.	1
	<u>SAMPLE ANSWER</u> **(b) $l_v = l_o$ sqr$(1 - v^2/c^2)$ so $l_v = 5(1\text{-}0.6^2)$ s0 $l_v = 4.0$m**	**3**
	Correctly identifies l_v and l_o; correctly substitutes in correct equation; correct answer	3
	Two of the above	2
	One of the above	1

19	**<u>SAMPLE ANSWER</u>** **(a) $\tau = nBIA\cos\theta$ so $\tau = 2x4x0.015x0.015\cos0$ so $\tau = 1.8 \times 10^{-3}$ Nm**	**2**
	Correct answer and units	2
	Correct answer	1
	<u>SAMPLE ANSWER</u> **(b) The torque reduces as the cos of the angle until it reaches zero in the vertical position. The forces on the loop do not change but the torque is reduced as the distance of the force from the axis of rotation is reduced τ = F x perp. dist.**	**3**
	Correct description and coherent explanation including equation	3
	Two of the above	2
	One of the above	1

20	**<u>SAMPLE ANSWER</u>** **LABELLED DIAGRAM showing A.C. source, coil, cooktop, lines of force penetrating cookware. (1) A.C. source creates a changing B field in coil. (2) Changing flux is produced in cookware. (3) Eddy current induced according to Faraday's law. (4) Heat produced in cookware due to resistance.**	**4**
	Diagram plus clear 4 step explanation or equivalent.	4
	4 of above	3
	3 of above	2
	2 of above	1

21	**<u>SAMPLE ANSWER</u>** **When running at high speed the motor generates a back emf that limits forward current. When starting up no back emf is generated and so a large current flows through the motor potentially causing damage by heating or overloading the circuit. The large resistance reduce this current at start up.**	**3**
	Identifies; back emf reduces current at full speed, current too large at startup due to no back emf, resistance reduces this current.	3
	Two of the above	2
	One of the above	1

22	**<u>SAMPLE ANSWER</u>** **W = F so mg = kI_1I_2/d so 0.01x9.8 = 2x$10^{-7}I^2$/0.1 so I = 221 A**	**3**
	Correct answer and units with correct method	3
	Wrong units or substitution or one wrong equation	2
	Two mistakes as above.	1

23	**<u>SAMPLE ANSWER</u>** **(1) The magnet will induce a N pole according to Lenz's law (to repel the magnet) but the current will only be momentary as there is no external circuit. Thus the coil will move slightly to the left.** **(2) The second coil will do the same thing but the motion will be greater since a current will flow in the completed circuit.**	**4**
	Each coil explained adequately, with the difference pointed out. (2 marks each)	4
	One only explained well, the other not adequate or unclear difference.	3
	One only explained well or each partially explained.	2
	One only partially explained	1