STUDENT NUMBER .....

GOSFORD HIGH SCHOOL

YEAR 12

PHYSICS

HALF YEARLY EXAM

2009

Time allowed: 2 hours plus 5 minutes reading time

Part A: 15 marks
Attempt questions 1-15
Allow about 30 minutes for this section

Part B: 55 marks
Attempt questions 16-27
Allow about 1 hour and 30 minutes for this section

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1. Planet X has twice the mass and half the radius of planet Y. What is the ratio of the weight of a 10 kg mass on planet X to its weight on planet Y?

(A) 1 : 1

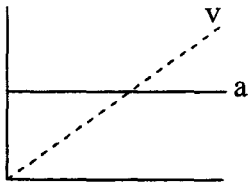
(B) 2 : 1

(C) 4 : 1

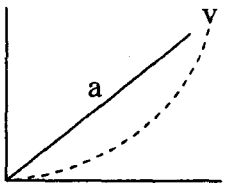
(D) 8 : 1

2. A rocket takes off from the launch pad with constant thrust. Which choice best shows how its acceleration and velocity change as it rises?

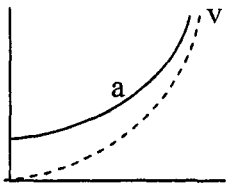
(A)



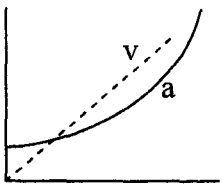
(B)



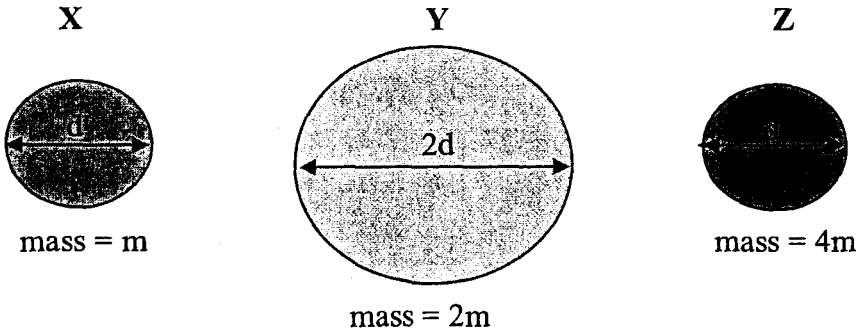
(C)



(D)



3. Consider the following planets, X, Y and Z.



What is the correct ratio of the escape velocity of these planets?

Note: $v_e = \sqrt{\frac{2GM}{r}}$

(A) X : Y : Z = 1 : 1 : 2

(B) X : Y : Z = 1 : 2 : 4

(C) X : Y : Z = 2 : 1 : 4

(D) X : Y : Z = 2 : 1 : 2

4. Two astronauts landed on a very small asteroid orbiting the Sun between Mars and Jupiter. They experienced almost negligible weight force. Which statement explains this?

(A) Because the asteroid is in a stable orbit around the Sun it will have zero mass.

(B) Because the asteroid is in a stable orbit around the Sun, the astronauts will apparently be weightless.

(C) Because the asteroid is very small it will have very small gravitational force.

(D) The gravitational force on the asteroid is balanced by an equal and opposite gravitational force on the astronauts.

5. Michelson and Morley expected to see a shift in an interference pattern in their experiment. They were destined to always get a null result. Why?

(A) A positive result would violate the principle of relativity.

(B) The Earth's speed through space is too small compared to the speed of light for the experiment to give a significant result.

(C) Any variation in the speed of light could be explained by experimental errors.

(D) Einstein had proven that the speed of light was constant in a particular medium.

6. Which of the following devices could be used to demonstrate the motor effect?

(A) Transformer

(B) Induction cooktop

(C) Generator

(D) Loudspeaker

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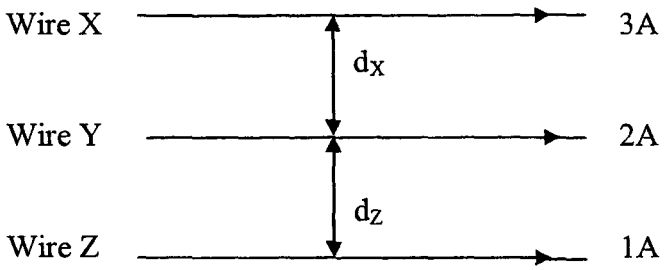
7. Three long parallel wires X, Y and Z are positioned in the same plane and conduct different currents in the same direction as shown. The current in wire X is 3A, in wire Y is 2A and in wire Z is 1A. Wires X and Y are separated by a distance d_X and wires Y and Z are separated by a distance d_Z.



What is the relationship between the distances if the force on wire Y is zero?

(A) $3\,d_X = d_Z$

(B) $d_X = 3d_Z$

(C) $5d_X = 2\,d_Z$

(D) $d_X = d_Z$

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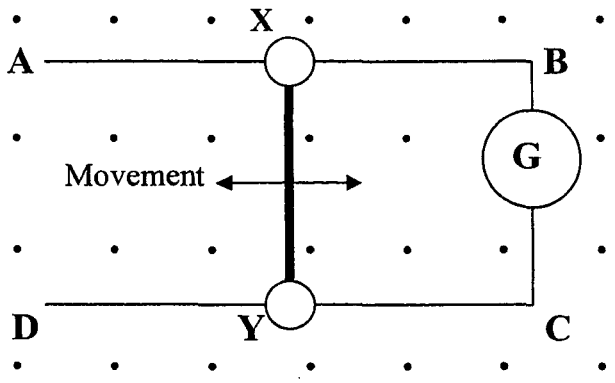
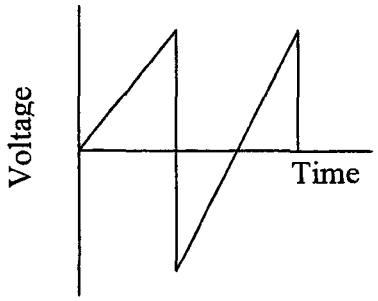
8. A conductor ABCD is situated in a magnetic field directed out of the page. The conductor has a galvanometer inserted in side BC and a conducting rod XY connects the sides AB and CD as shown. The rod XY is able to slide and is moved 5cm to the left, then10cm to the right and back to its initial position.

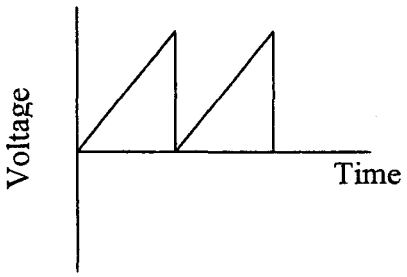


Which graph shows the possible voltage changes that could be observed on the galvanometer?

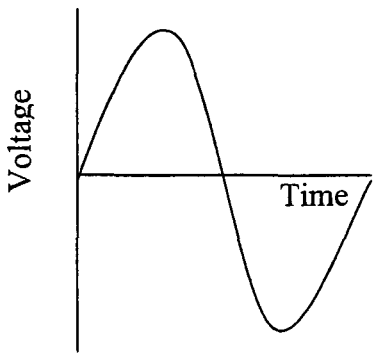
(A)



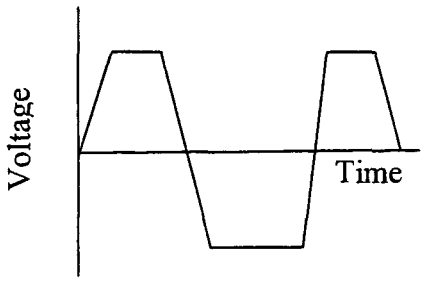
(B)



(C)



(D)



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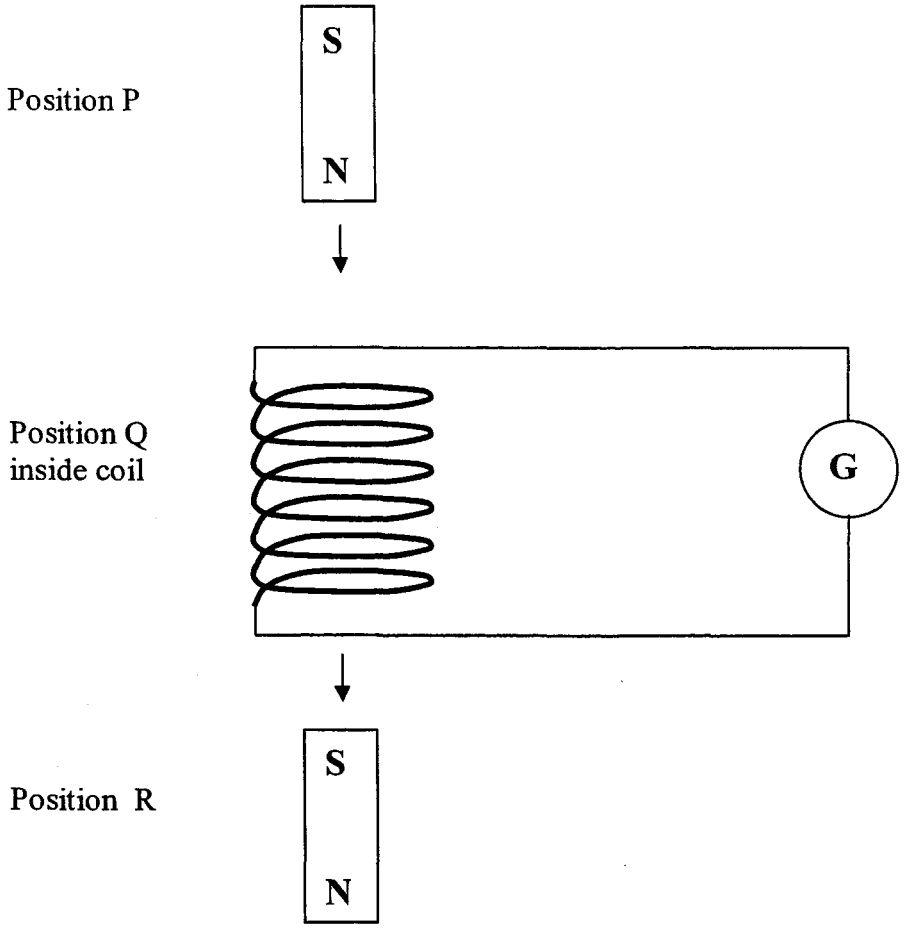
9. A magnet is dropped so that it moves through a coil that is suspended vertically. The coil is connected to a galvanometer.



Which alternative could describe the galvanometer needle deflection as the magnet moves from position P through Q to R?

	Position P	Position Q	Position R
(A)	To the right	No deflection	To the right
(B)	To the right	To the right	No deflection
(C)	To the right	No deflection	To the left
(D)	To the right	To the right	To the right

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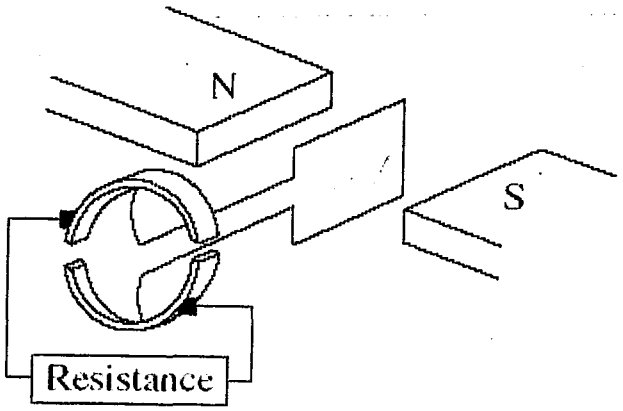
10. A electrician drills a hole into a wall using an electric drill. As he makes the hole, friction on the end of the drill causes the armature of the motor within the drill to slow down. How will the back emf and the current through the armature change as the drill slows down?

	Back emf	*Current*
(A)	Increase	Increase
(B)	Increase	Decrease
(C)	Decrease	Increase
(D)	Decrease	Decrease

11. The diagram below represents an electrical motor.



What type of current would be produced by the motor?

(A) DC of constant magnitude

(B) DC of varying magnitude

(C) AC

(D) None

12. What is the ratio of the number of coils in the primary to the number of coils in the secondary for a step up transformer?

(A) Less than one

(B) Less than or equal to one

(C) Equal to one

(D) Greater than one

13 The trailers on some large trucks use eddy current braking. An aluminium disc attached to the wheel rotates between the poles of an electromagnet. To brake, the electromagnet is energised by current from the truck's battery. The retarding force slows the truck down.

Which of the statements below best describes what happens to the kinetic energy removed from the truck as it slows down?

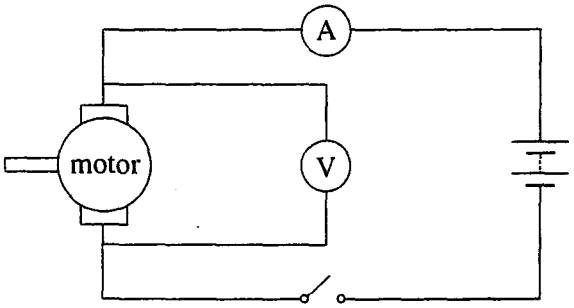
(A) Currents are induced in the electromagnet, which transfers the energy to the battery.

(B) Eddy currents are induced in the core of the electromagnet opposing the motion of the disc. The electromagnet heats up, radiating the energy away.

(C) Eddy currents are induced in the aluminium opposing the motion of the disc. The eddy currents cause the disc to heat up, radiating the energy away.

(D) The eddy currents in the disc attract it to the electromagnet and the friction removes the kinetic energy.

14 A small DC electric motor is connected to a test circuit as shown below.



When the motor is switched on and running freely, the voltmeter shows 6 V and the ammeter 1 A. A student now grasps the output shaft of the motor while it is running and slows it down. What would the most likely reading on the meters now be?

(A) ammeter: 2 A voltmeter: 8 V

(B) ammeter: 3 A voltmeter: 6 V

(C) ammeter: 1 A voltmeter: 6 V

(D) ammeter: 1 A voltmeter: 4 V

15 If you were to dismantle a transformer that is designed to produce an output of 12 V with a maximum safe current of 10 A from the 240 V power mains, then you would expect to find

(A) 480 turns of thin wire on the primary and 24 turns of thick wire on the secondary.

(B) 480 turns of thick wire on the primary and 24 turns of thin wire on the secondary.

(C) 24 turns of thin wire on the primary and 480 turns of thin wire on the secondary.

(D) a wire designed to carry 10 amps on the primary and a lot of turns on the secondary.

Section I – continued

Part B

Total marks (55)
Attempt questions 16 – 27
Allow about 1 hour 30 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

The period (T) of a pendulum is given by the equation:

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

where ℓ is the length of the pendulum and g is Earth's gravitational acceleration.

A group of scientists conducted an experiment on Earth to check the relationship between the period of the pendulum and its length. They then took their apparatus to the Moon and repeated the experiment.

(a) How would their results on the Moon be similar to those they obtained on Earth? **1**

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(b) Explain why their results would be similar in this way. **1**

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(c) How would their results on the Moon be different to those they obtained on Earth? **1**

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(d) Explain why their results would be different in this way. **1**

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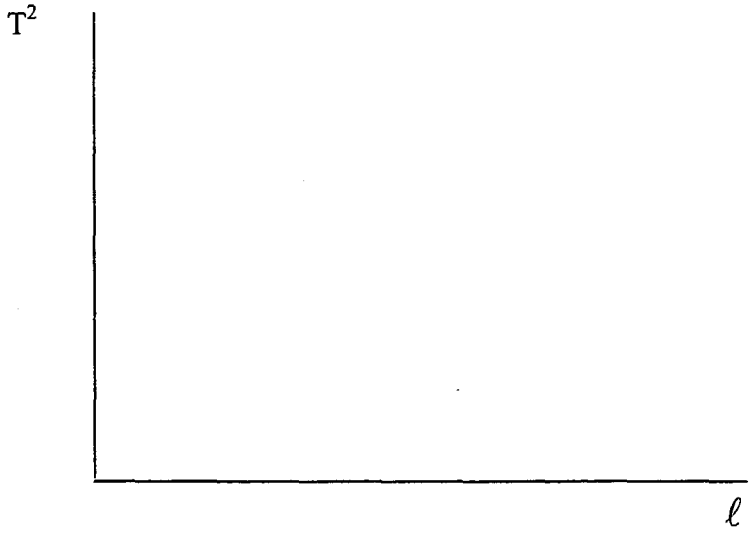
Question 16 continues on page 11

Marks

Question 16 (continued)

(e) Sketch TWO graphs on the axes below to compare the results the scientists would obtain for the relationship between the square of the period and the length of the pendulum on Earth and the Moon. Be sure to label EACH graph. **1**



Question 17 (5 marks)

Two students are 130 m apart. One holds a paint ball gun 1.2 m above the ground and fires a paint ball at the other. The ball leaves the gun at 40 ms^{-1} at an angle of elevation of 20°.

(a) Calculate the maximum height of the paint ball above its firing position. **2**

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(b) Calculate whether or not the ball hits the second student. **3**

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STUDENT NUMBER/NAME: .....

Marks

Question 18 (4 marks)

(a) Give TWO reasons to explain why the concept of g-force is useful. **2**

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(b) How would our exploration of the solar system be different if the slingshot effect did not exist? **2**

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Question 19 (6 marks)

A group of students did two experiments to determine the acceleration due to gravity.

Firstly, they dropped a ball from a vertical height of 3.0 m and measured the time of fall using a stopwatch. From this they calculated the average speed of the ball and hence its final speed and acceleration.

Next they set up a 3.0 m length of board with an angle of elevation of 20°. The board had a groove cut along its length the same curvature as the ball. They measured the time it took the ball to roll down the board. From this they calculated the average speed of the ball and hence its final speed and its acceleration down the slope. They then calculated a value for the acceleration due to gravity.

(a) Compare the accuracy of the time measurements in the experiments. **2**

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Question 19 continues on page 13

Marks

Question 19 (continued)

(b) Compare the validity of EACH experiment. **2**

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Question 20 (2 marks)

(a) After being created in the upper atmosphere by cosmic rays, mu mesons have speeds that exceed 2.95×10^8 ms^{-1}. An observer on Earth measures their lifetime as 1.221×10^{-5} s.
Calculate the lifetime of such a meson in its own frame of reference. **1**

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(b) Define an inertial frame of reference. **1**

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Question 21 (2 marks)

Describe TWO different ways in which motors are used in industry or the home to convert electrical energy into more useful forms of energy. **2**

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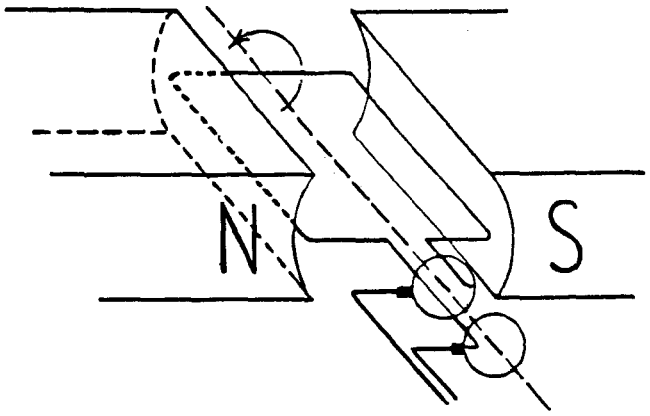
STUDENT NUMBER/NAME: .....

Marks

Question 22 (6 marks)

A rectangular coil of conducting wire is rotated in the magnetic field between the poles of magnets as shown.



(a) Propose ONE change to the experimental set up that would increase the electromotive force generated. **1**

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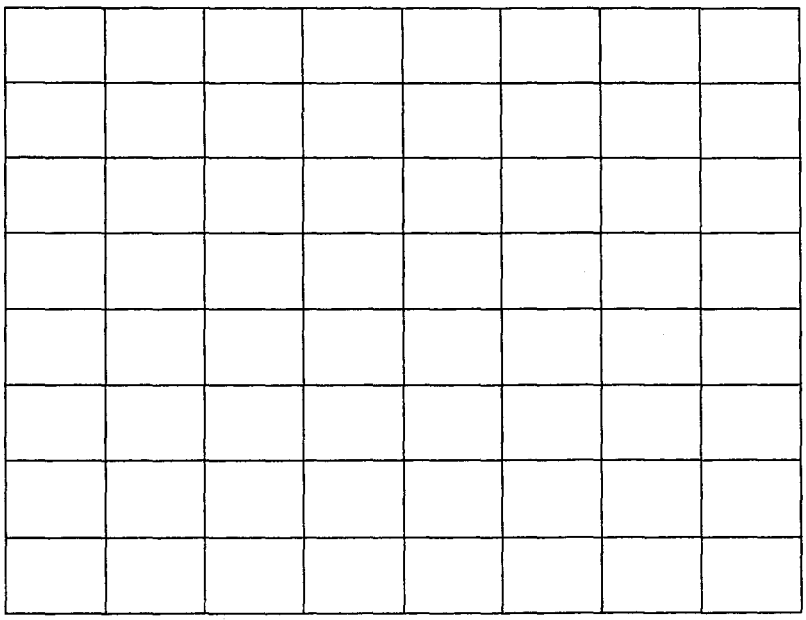
(b) Sketch a graph of the emf generated as the coil is rotated through one revolution beginning from the position shown at time t = 0. **1**



Question 22 continues on page 15

Marks

Question 22 (continued)

(c) Analyse the relationship between emf generated and the flux through the coil. **2**

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(d) Justify the difference in the energy required to rotate the coil when the coil is connected to a light globe compared to an open circuit as shown. **2**

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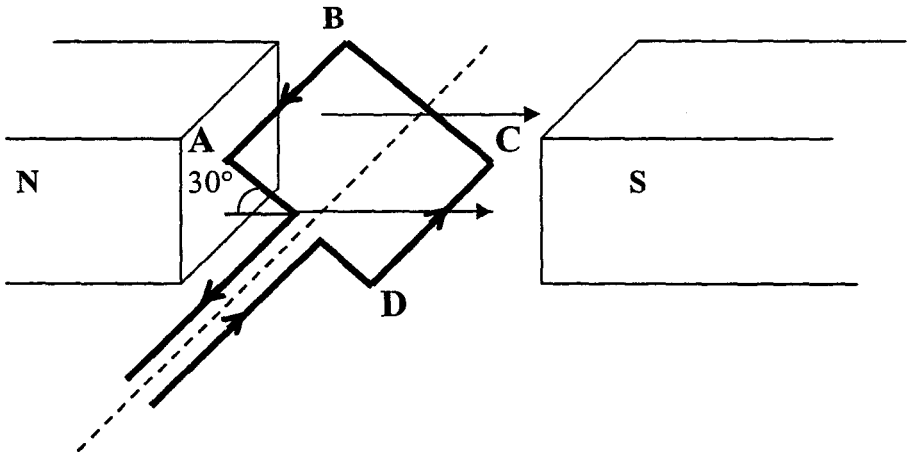
Marks

Question 23 (5 marks)

A rectangular coil of 20 loops is positioned between the poles of bar magnets and its plane makes an angle of 30° with the direction of the magnetic field as shown. The side AB measures 15 cm while the side BC measures 18 cm. The magnetic field between the poles of the magnets is 5.0 mT and the current through the coil is 25 mA.



(a) Calculate the magnitude and direction of the force on side AB when the coil is at an angle of 30° with the direction of the magnetic field as shown. **2**

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(b) Define *torque*. **1**

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(c) Calculate the torque acting on the coil when it is at an angle of 30° with the direction of the magnetic field as shown. **1**

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(d) Many motors do not contain permanent magnets. State how the magnetic field is produced. **1**

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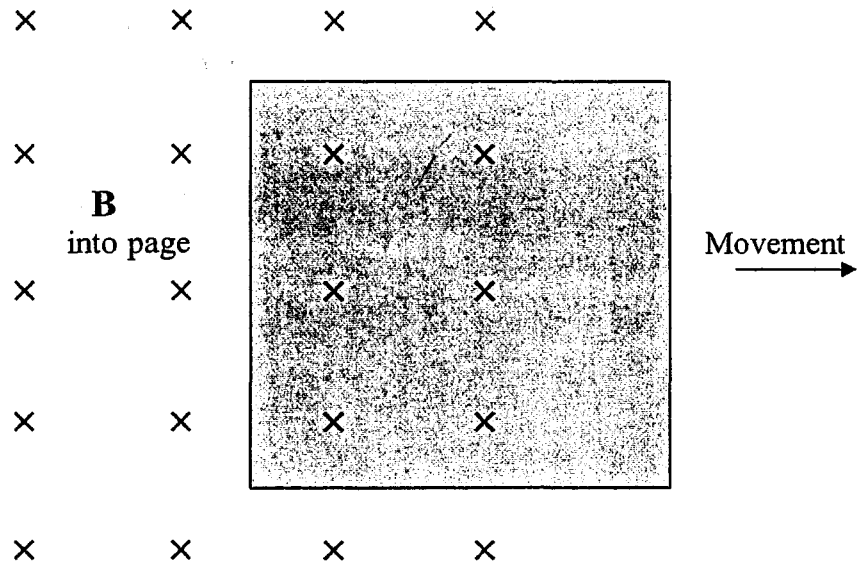
Question 24 (4 marks)

Part of a flat horizontal metal sheet is perpendicular to a magnetic field into the page, as shown. The sheet is moved out of the magnetic field at constant speed.



(a) Draw on the diagram the eddy current that is produced in the sheet as it moves out of the magnetic field. Include the direction of the current. **2**

(b) Using Lenz's Law, explain the production of the eddy current in the sheet. **2**

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Question 25 (5 marks)

Near the surface of the planet Mars, when a 4.0 kg rock is dropped from rest, it reaches a speed of 7.5 m s^{-1} in 2.0 s.

(a) What is the acceleration due to gravity near the surface of Mars? **2**

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(b) The planet Mars has an average radius of 3.4×10^6 m. What is the mass of Mars? **3**

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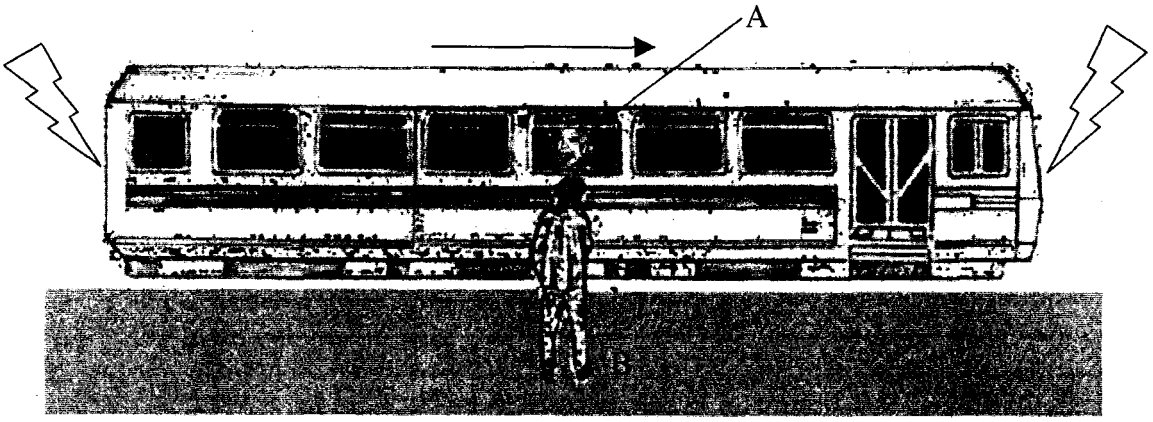
Question 26 (5 marks) **Marks**

Observer A sits in the middle of a train traveling at high speed past a railway station as shown in the picture below. Observer B stands on the station platform. Lightning strikes the front and back of the train at the moment observer A passes observer B. Analyse the statements of both observers regarding the order of the lighting strikes. **5**



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Question 27 (6 marks) **Marks**

(a) Describe ONE differences between AC and DC generators. **1**

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(b) Analyse the competing technologies of Edison and Westinghouse for the supply of domestic electricity. **5**

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2009 YEAR 12 HALF YEARLY ANSWERS

Multiple Choice

1)D 2)C 3)A 4)C 5)A 6)D 7)B 8)D 9)C 10)C 11)B and D (poor question- should have said generator not motor) **12)A 13)C 14)A 15)A**

Extended Response

16)
a) The period is still proportional to the $\sqrt{l}$ or T^2 is still proportional to l/g **(1)**
b) g is constant on the surface of the Moon and hence the pendulum equation is still obeyed.**(1)**
c) The period is greater on the moon for a pendulum with the same length.**(1)**
d) The acceleration due to gravity on the moon is less than that on earth and hence the period of the pendulum will be greater.**(1)**
e) Two straight lines passing through the origin with the gradient of the line for the moon being greater than the gradient for the line for the earth. **(1)**

17)
a) $u_y = 40\sin 20 = 13.68 ms^{-1}$
For the vertical component $v^2 = 2as + u^2$ and $v = 0$ at the top of the motion, hence
$S = -u^2/2a = 9.55m$ **(1 for using correct equation or 2 for correct answer)**
b) We need to calculate the total time of flight.
Time to go up from $v = at + u$ and assuming $v = 0$ at the top is $t = u_y/g = 1.396$ sec
Time to fall down: $s = 9.55 + 1.2 = 10.75m$, now $s = at^2/2 + ut$ and $u = 0$ and hance
$t = \sqrt{2s/a} = 1.481$ sec and hence the total time is $1.396 + 1.481 = 2.877$
Range = uxt = (40cos20)(2.877) = 108m and hence the boy will NOT be hit
(1 for calculating time of flight, 1 for saying it will not hit without proof, 3 for proof that it will not hit)

18)
a) g-force is a measure of the apparent weight of an object as a multiple of the object's weight on earth. g-force gives the effect of a particular acceleration instantly. The g-forces that cause injury to humans are well known and g-force gives an indication of the effect of a particular motion on human physiology. **(2 marks, 1 for each acceptable reason)**
b) The slingshot effect has enabled us to accelerate space probes to much higher velocities that we could obtain with normal chemical rockets. This has enabled probes to be sent to the outer planets in years rather than centuries. **(1 for a statement that the slingshot effect increases velocity and 1 for explaining why this is important)**

19)
a) The time measurement would have the same absolute error in both experiments but because the time measured to the second experiment is much greater the percentage error would be much smaller. **(1 noting the second method would be easier to time accurately and 1 for explaining why)**
b) The time error in the first experiment would be a significant fraction of the total time and hence the experiment would be unlikely to produce an accurate result. The time measurement in the second experiment would give a much more accurate value for the ball's acceleration down the plane. The problem with the second experiment is that some of the ball's initial KE goes into rotational energy and unless this was taken into account along with the effect of the gradient this experiment would also be invalid. **(2 marks, 1 for pointing out something about the validity of each experiment)**

20)
a) $t_o = t\sqrt{(1-v^2/c^2)} = 2.219 \times 10^{-6}$ sec (1 for correct answer)
b) An inertial frame of reference is one in which Newton's first law (OR Newton's laws) of motion is obeyed. **(1 mark)**

21)
Electric motors are used in many applications in industry and the home. For example:

Electric motors are used in lifts and cranes to convert electrical energy into kinetic energy and gravitational potential energy.

Electric motors are used in exhaust fans and cooling fans to convert electrical energy into the kinetic energy of air molecules.

Electric motors are used in washing machines to convert electrical energy into mechanical energy of rotation. **(2 marks, 1 mark for each application must state what the new form of energy is in each case)**

22)
a) Increase the rate of rotation, number of turns on the coil or the strength of the B field. The area of the coil could also be increased. **(1 mark)**
b) Cosine function $V = \cos\theta$. Should start with maximum positive or negative voltage.**(1)**
c)The EMF is equal to the rate of change of the magnetic flux passing through the coil. This means that when the flux through the coil is constant no EMF will be generated and the maximum EMF will be generated when the flux is changing fastest **(1 for EMF = d(BA)/dt or 2 marks for a statement correctly explaining the relationship)**
d) When current is drawn from the generator it is producing electrical energy. Because energy is conserved this electrical energy must come from the mechanical energy you need to put into the coil to turn it. OR When current flows Lenz's law states that it in a direction that will oppose the change, which means the generator becomes more difficult to rotate. **(2 marks, 1 for stating the current is increased or electrical energy used increased and one for relating this to the work that must be done either using Lenz's law or conservation of energy)**

23)
a) $F = nBIL = 20x0.005x0.025x0.15 = 3.75x10^{-4}$ N upwards **(1 mark for F = BIL or having the force up and 2 for correct numerical answer)**
b) Torque is the turning moment of a force. It is equal to the product of the force and perpendicular distance between the line of action of the force and the pivot. **(1)**
c) Torque = $BANI\cos\theta = 0.005x0.15x0.18x20x0.025x\cos30 = 5.84x10^{-5}$ Nm **(1)**
d) Electromagnets are used to generate the magnetic field. **(1)**

24)
a) Eddy current will move upwards in the sheet within the magnetic field and downwards in the sheet outside the B field. Hence the eddy current will move in a circular path in a clockwise direction. By first principles F =qvB or by Lenz's law. **(1 mark for circular current that runes up in the field and down outside it and 1 for correct direction in the field)**
b) Lenz's law states that the direction of the induced current will oppose the change that caused it. In this case a current moving upwards in the field will result in a force to the left which will oppose the motion of the copper sheet. **(1 for correct statement of Lenz's law and 1 for applying it correctly to explain the eddy currents generated in the copper plate)**

25)
a) $v = at + u$ and as $u = 0$ we can write $a = v/t = 7.5/2 = 3.75$ ms^{-2} **(1 for correct equation or 2 for the correct answer.)**
b) $mg = Gm_1m_2/r^2$ and hence $g = Gm_2/r^2$ or $m_2 = gr^2/G = 6.5 \times 10^{23}$ kg **(1 for correct equation or 2 for the correct answer.)**

26)
(5 marks for a clear explanation as below, 4 for a reasonable explanation supported by evidence from the special theory of relativity, 3 for realising that it was a thought experiment about simultaneity and a reasonable attempt to explain it, 2 for some attempt to explain simultaneity in this case with at least two correct observations, 1 at least one correct observation about the experiment.)

Example of a full mark answer

This is a thought experiment used to illustrate the relativity of simultaneity. Observer B will see the lightning strikes at each end of the train occur simultaneously as he and the lightning strikes are at rest. Observer A however will see the lightning hit the front of the train first as he will have moved a little in the direction of motion before the light strikes him. Observer A will therefore see the lightning strike the front of the train before the back. In A's frame of reference, he believes he is at rest and as the speed of light is constant his observation that the light from the front of the train reaches him first leads him to conclude that the lightning must have hit the front of the train first. Thus the two observers will disagree about whether the lightning strikes were simultaneous or not.

27)
a) DC generators have a split ring commutator, while AC motors have a slip ring commutator. OR another difference with the generators (not with the output they produce as this is restating the question)**(1)**

b) **(5 for a clear *analysis of AC and DC technologies* and their uses correctly tied to Edison and Westinghouse, 4 a reasonable analysis of the technologies, several correct points but a failure to present a coherent analysis of AC and DC tied to Edison and Westinghouse OR an excellent answer that concentrates on the battle of the currents alone, 3 a descriptive answer that fails to analyse that fails to analyse the technologies OR a good description of the contribution of Edison and Westinghouse but failure to analyse AC and DC technologies, 2 an answer that links Edison with DC and Westinghouse with AC or an analysis of AC and DC that fails to connect it with Edison and Westinghouse, 1 a correct statement about AC or DC OR realising that Edison worked with DC or Westinghouse with AC)**

Example of a full mark answer
b) Edison supported the use of direct current for the supply of domestic power, while Westinghouse supported the use of alternating current. Many domestic applications use DC and it can be supplied at lower voltages making it a little safer than AC. Because the current is not changing DC power lines can be placed near other structures, underwater and underground easily. The problem with DC in the 1890s when the battle of the currents raged between Edison and Westinghouse was that DC could only be transmitted over short distances because sending it at low voltages necessitated using high currents (as $P = IV$). Line loss is proportional to the square of the current ($P_{loss} = I^2R$)and thus the most efficient way to transmit electrical power over long distances is to use high voltages and low currents. In the 1890s there was no efficient method of increasing and decreasing DC voltages and consequently DC could not be used to transmit at high voltages and low currents. Because transformers can be used to change AC voltages up and down, simply and very efficiently, a transformer can be used to step up the AC voltage at the power station so that it can be transmitted at very high voltages and very low current minimising line loss. Step down transformers can then be used to reduce the voltage for domestic and industrial use.