ALEXANDER ROAD HIGH SCHOOL

JUNE 2016 3 HOUR

PHYSICAL SCIENCES MID-YEAR EXAM – PAPER 1

CO, KB, MH TOTAL = 150

GRADE 12

Instructions

- The question paper consists of 9 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided.
- Answer section B on the folio sheets and answer each question on a new side of a page.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- All relevant data can be found at the end of the question paper.
- Round off to two (2) decimal places where necessary.

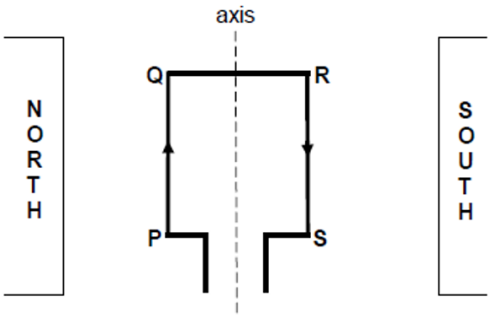
SECTION A

- Answer on the answer sheet -

QUESTION 1: Multiple choice

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down the letter (A–D) next to the question number on the attached ANSWER SHEET.

1.1 A rectangular current-carrying coil, PQRS, is placed in a uniform magnetic field with its plane parallel to the field as shown below. The arrows indicate the direction of the conventional current.



The coil will …

A rotate clockwise.

B remain stationary.

C rotate anti-clockwise.

D rotate clockwise and then anti-clockwise.

1.2 The definition of AC *rms* values is:

A The AC potential difference/current which dissipates the same amount of energy as DC.

B The potential difference/current which dissipates the same amount of energy.

C The DC potential difference/current which dissipates the same amount of energy as AC.

D The DC current which has the same amount of energy as AC current.

1.3 An alternating current with a peak value I and a constant direct current of 4 A has the same heating effect on two identical bulbs. What is the value of I?

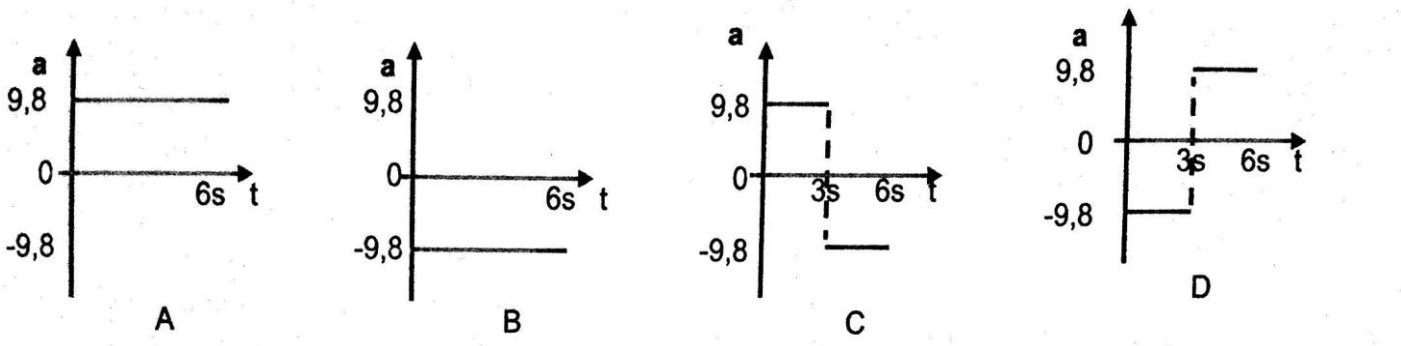
A $\sqrt{4}$ A

B $4\sqrt{2}$ A

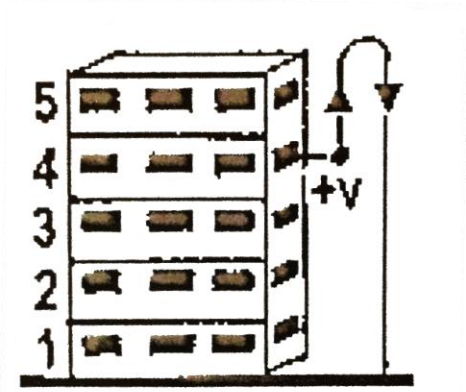
C 4 A

D 8 A

1.4 Which one of the following acceleration-time graphs best represents the motion of a stone which is projected upwards and is then caught at the same height after 6 s? Take up as the positive reference direction.



1.5 The figure shows the path of an object thrown vertically upward with an initial velocity v from the fourth storey of a tall building. Which one of the graphs best describes the variation of the object's velocity with time, taking upward velocity as positive?



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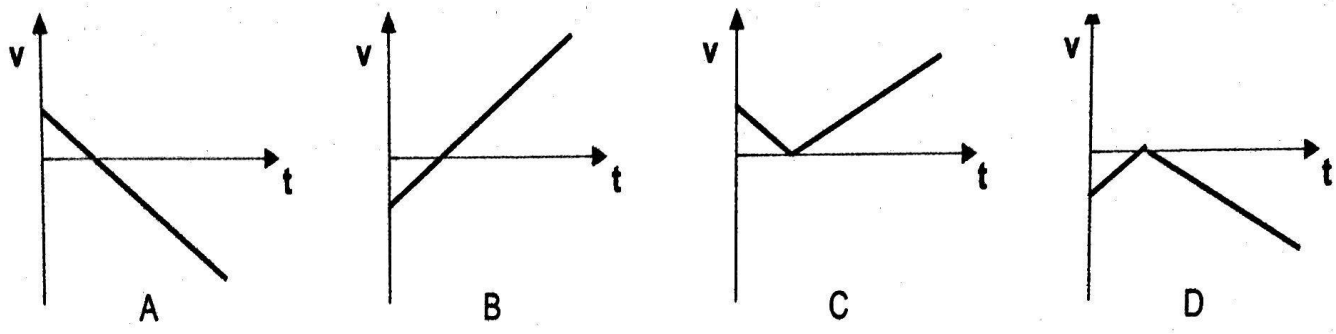


1.6 Motor car A of mass M tows motor car B of mass m. If the force exerted by car A is 1200 N and the tension in the rope is 400 N, then the ratio of M : m is:

A 3 : 2

B 2 : 3

C 1 : 2

D 2 : 1

1.7 A man of 80 kg stands on a bathroom scale in a lift. If it travels upwards with a constant velocity of 2 $m.s^{-1}$ the reading on the scale (in Newtons) will be:

A 784

B 944

C 624

D 0

1.8 Impulse can be defined as…

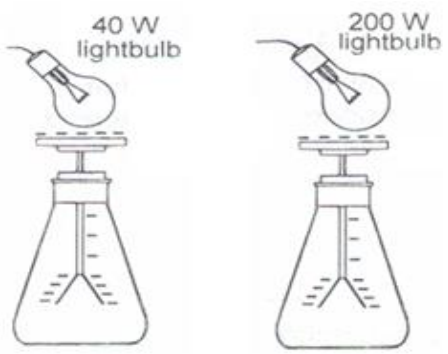
A. The product of the net force acting on an object and the interaction time resulting in a change of momentum.

B when object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object A

C The rate of change of momentum

D The net force acting on an object is inversely proportional to the rate of change of momentum.

1.9 Consider the following experiment:



A 40W light bulb is shone onto a zinc plate which has been placed on top of an electroscope which has been charged negatively. The leaf of the electroscope does not collapse. The 40W bulb is now replaced with a 200W bulb. How will this affect the experiment.

A The leaf will collapse quickly

B The leaf will not collapse

C The leaf will collapse slowly

D The kinetic energy of the electrons will decrease.

1.10 An electric motor drives a water pump which is submerged at the bottom of a 10m deep borehole. What is the minimum power of the electric motor required to pump water at a rate of 150 litres per minute?

A 245W

B 25W

C 98W

D 275W

SECTION B

QUESTION 2

Two boys, each of mass 50kg, are standing at the back of a flatbed trolley of mass 200kg. The trolley is at rest on a frictionless horizontal surface.

One of the boys jumps off at one end of the trolley with a horizontal velocity of 2 $m.s^{-1}$. The trolley, with the other boy, moves in the opposite direction.

2.1 Write down the principle of conservation of linear momentum in words (2)

2.2 Calculate the velocity of the trolley and boy after the first boy jumped off. (4)

The other boy now jumps off at the same end of the trolley also with a horizontal velocity of 2 $m.s^{1}$. The trolley moves in the opposite direction.

2.3 Calculate the final velocity of the trolley (4)

2.4 How would the final velocity of the trolley have changed if both the two boys jump off the trolley at the same time. How will the velocity of the trolley compare to that calculated in QUESTION 2.3? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

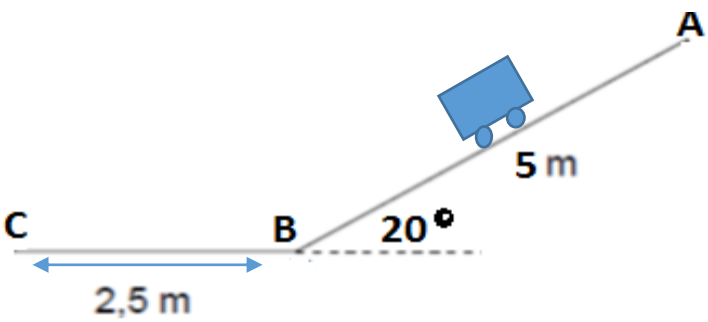
2.5 A squash ball of mass 0,1kg is served to start a match. The average accelerating force exerted by the squash racquet is 1000N, and the ball moves away from the racquet at 30 $m.s^{-1}$. For how long was the racquet in contact with the ball? (3)

[14]

QUESTION 3

A 2 kg trolley is at rest on a plane inclined at 20° to the horizontal. When the trolley is released at A, the trolley free wheels down the 5 m long slope and experiences a constant frictional force of 3 N.

When the trolley reaches point B the trolley now moves along a horizontal surface experiencing a constant frictional force of 2 N until it reaches point C which is 2,5 m from point B.



3.1 Draw a labelled free-body diagram showing all the forces acting on the trolley as it moves down the inclined plane. (3)

3.2 Write down the name of one non-conservative and one conservative force acting on the trolley as it moves down the incline. (2)

3.3 Determine the net work done on the trolley as it moves down the incline. (4)

3.4 State the WORK-ENERGY THEOREM in words. (2)

3.5 Use the work-energy theorem to calculate the speed of the trolley when it reaches point B. (4)

3.6 Use the answer obtained in 3.5, and the work-energy theorem, to calculate the speed of the trolley at point C. (4)

3.7 Determine how far the trolley would need to travel in order to come to rest. (4)

3.8 Calculate the power output of the trolley as it moves down the slope if the trolley takes 3,5 s to move from point A to B. (3)

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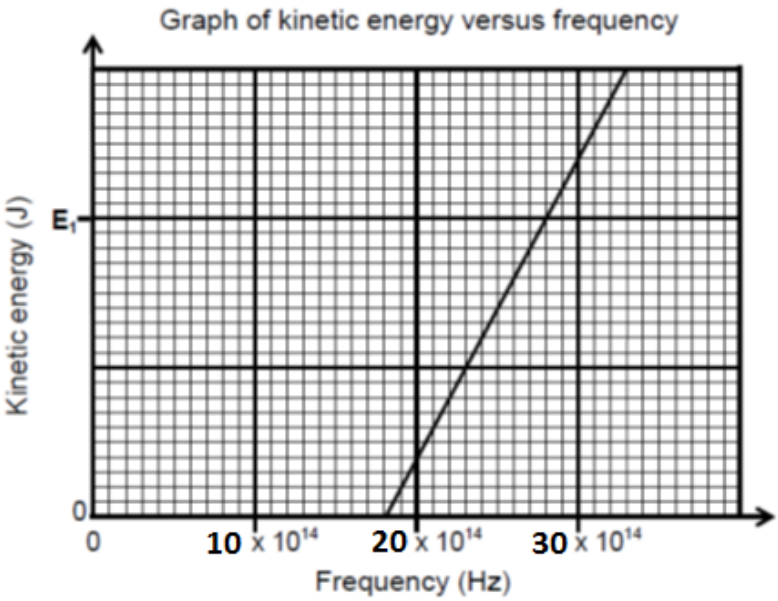
QUESTION 4

During an investigation, light of different frequencies is shone onto a metal cathode of a photocell. The kinetic energy is measured for the emitted photocells. The graph below shows the results obtained from the experiment.



4.1 Define the term threshold frequency. (2)

4.2 Use the graph to obtain the threshold frequency of the metal used as the cathode in the photocell. (1)

4.3 Calculate the work function of the metal used as the cathode in the photcell (3)

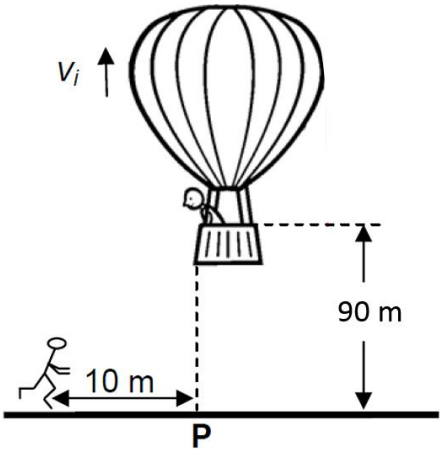
4.4 Calculate the kinetic energy at E_1 shown in the graph (4)

4.5 How would the kinetic energy calculated in 4.4 be affected if light of higher intensity was used? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[11]

QUESTION 5

A hot-air balloon is moving vertically upwards at a constant speed. A camera is accidentally dropped from the balloon at a height of 90 m as shown in the diagram below. The camera strikes the ground after 5 s. Ignore the effects of friction.



5.1 At the instant the camera is dropped, it moves upwards. Give a reason for this observation. (1)

5.2 Calculate the speed v_i at which the balloon is rising when the camera is dropped. (4)

5.3 Draw a sketch graph of velocity versus time for the entire motion of the camera.
Indicate the following on the graph:

- Initial velocity
- Time at which it reaches the ground (4)

5.4 If a jogger, 10 m away from point **P,** as shown in the above diagram, running at a constant speed of 2 $m \cdot s^{-1}$, sees the camera at the same instant it starts falling from the balloon, will he be able to catch the camera before it strikes the ground?
Use a calculation to show how you arrived at the answer. (5)

[14]

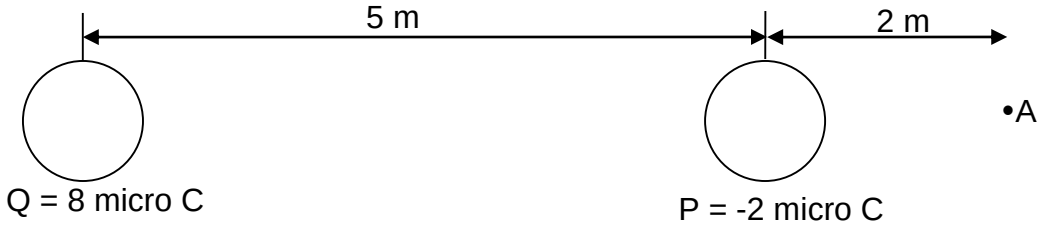
QUESTION 6

6.1.1 Define the electric field strength at a point in an E-field. (3)

6.1.2 Give the mathematical term for the relationship between the E-field strength and the distance from a charge. (1)

6.1.3 Now show the relationship on a labeled graph. (2)

6.2 Two charged polystyrene balls (P and Q) are positioned as shown in the diagram below.



6.2.1 Calculate the net electric field at point A (with no charge) as a result of P and Q. (6)

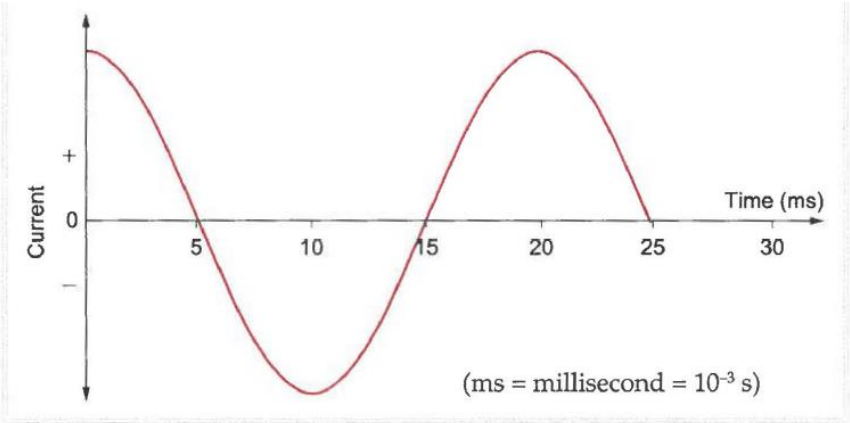
6.2.2 A charge is now placed at A and it experiences a force of 3×10^{-3} N towards the left. What are the magnitude and polarity of this charge? (4)

6.2.3 Draw the resultant electric field that will be present between charges P and Q **after they were brought together to touch**, and then separated to their original positions (now there is no charge at A). (3)

[19]

QUESTION 7

The graph below shows the induced (maximum) current produced by an AC generator over time.



7.1.1 Redraw the graph and draw a new line/curve (use dotted line or different colour) showing how the induced current changes with time when the coil is rotated at **half its original speed**. (3)

7.1.2 Explain why the new graph differs from the original given curve by referring to Faraday's law. (2)

7.1.3 The AC generator works on a specific principle. Name this principle. (1)

7.1.4 Now explain this principle. (2)

7.1.5 What is the energy conversion in this generator? (1)

7.1.6 What is name of the component(s) that keep(s) the armature in place and ensures smooth rotation around the axis of rotation? (1)

7.1.7 What is the function of carbon brushes? (1)

7.1.8 If the maximum (peak) current produced by this generator is 1,2A, calculate the average power of a 3,8V light bulb that works from this current. (3)

7.1.9 Calculate the resistance of the bulb in the previous question. (2)

7.1.10 How would this generator differ from a DC generator? (1)

7.1.11 What is the frequency of electrical energy delivered to South African wall plugs? (1)

7.1.12 Explain the meaning of the term AC, in terms of the answer in the previous question. (3)

7.2 Complete the sentence (only write the four answers): The use of an electric motor is indispensable for modern life, as we know it. Motors are electrodynamic devises that work on the principle of the __7.2.1 __ . The flow of current in the __7.2.2__ is changing direction after every 180º, at vertical position. This ensures that the __7.2.3__ energy is converted to __7.2.4__ energy in order for the __7.2.2 ___ to perform a smooth rotating action. (4)

7.3 Which type of motor (DC or AC) will be present in the following appliances? Also state, in terms of power, why this type of motor is your choice.

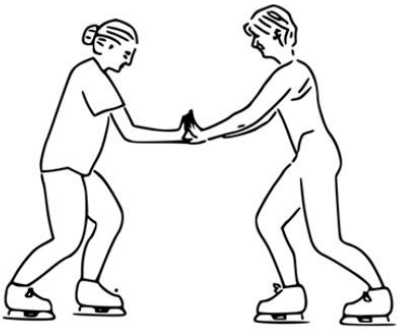
7.3.1 electric toy car

7.3.2 industrial (heavy duty) drill machine (4)

[29]

QUESTION 8

Mary and Sue, with masses 50 kg and 60 kg respectively, are standing on ice skates facing each other. Initially they are at rest. They push against each other and both move in opposite directions (ignore friction).



8.1 How does the force exerted on Sue compare to the force exerted on Mary? Write GREATER, SMALLER or EQUAL. (1)

8.2 **Name and state** the Newton's Law of Motion you used to answer 8.1. (3)

8.3 Will Sue or Mary have the greatest acceleration? Give a reason for your answer in terms of Newton's Laws of Motion. (3)

8.4 If the movement of the skaters over the ice is considered frictionless. What is the value of the coefficient of friction? (1)

[8]

QUESTION 9

The data below was obtained during an investigation into the relationship between the different velocities of a moving sound source and the frequencies detected by a stationary observer for each velocity. The effect of the wind was ignored.

Experiment number	1	2	3	4
Velocity of the sound source ($m.s^{-1}$)	0	10	20	30
Frequency (Hz) of the sound detected by the observer	500	486	472	460

9.1 What is the dependant variable for the investigation? (1)

9.2 What is the independent variable for the investigation? (1)

9.3 Is the sound source moving TOWARDS or AWAY FROM the observer? Give a reason for your answer. (2)

9.4 Use the information in the table to calculate the speed of sound in the medium. (5)

[9]