ALEXANDER ROAD HIGH SCHOOL

JUNE 2019 3 HOUR

PHYSICAL SCIENCE PAPER 1

EXAMINER: CO, MH, JA TOTAL = 150

GRADE 12

Instructions

- The question paper consists of 11 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided AND section B on folio sheets.
- Rule off after each question in Section B.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- Round off to two (2) decimal places where necessary.
- Formulas have been included at the end of the question paper

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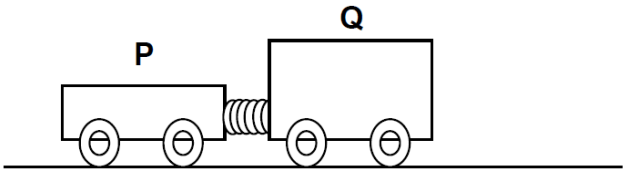
SECTION A

- Answer on the answer sheet -

QUESTION 1: Multiple choice

Four possible options are provided as answers to the following questions. Each question has only 1 correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.10) on the answer sheet.

1.1 Two trolleys, P and Q, of mass *m* and *2m* respectively are connected by a compressed spring. Both trolleys are at rest until the spring is released. The trolleys then move in opposite directions across a frictionless horizontal surface. Which ONE of the following statements is TRUE about the trolleys?



A. The speed of trolley P after the spring is released is less than the speed of trolley Q after the spring is released.

B. The kinetic energy of trolley P after the spring is released is equal to the kinetic energy of trolley Q after the spring is released.

C. The sum of the kinetic energies of trolley P and Q after the spring is released is zero.

D. The sum of the momentum of trolley P and Q after the spring is released is zero.

1.2 The function of an airbag in a car during a collision is too…

A. …bring the passenger to rest in a shorter period of time.

B. …reduce the net force acting on the passenger.

C. …reduce the passenger's change in momentum.

D. …increase the passenger's change in momentum.

1.3 Two charges, Q_1 and Q_2, are a distance ***r*** apart. If the distance is decreased by a third and the size of the first charge is quadrupled, the new force in terms of the original force ***F*** is…

A. … 0,44 ***F***

B. … 12 ***F***

C. … 36 ***F***

D. … 324 ***F***

1.4 A block of weight ***W*** sildes at a constant speed down a plane inclined at an angle of θ to the horizontal. The normal force acting on the block is ***N*** and the frictional force between the block and the plane is ***F***. What is the magnitude of ***N***?

A ***F*** cos θ

B ***W***

C ***W*** cos θ

D ***W*** sin θ

1.5 A block is suspended by a single, vertical string from the ceiling. Which force froms a Newton's Third Law force pair with the weight of the block?

A The normal force exerted by the block on the Earth.

B The force from the ceiling acting on the block.

C The weight of the block has no Newton's Third Law force pair as the block is in the air and at equilibrium.

D The force of tension in the string acting on the block.

1.6 A ball is thrown vertically upwards. Which ONE of the following physical quantities has a non-zero value at the instant the ball changes direction?

A Acceleration

B Kinetic energy

C Momentum

D None of the above

1.7 A man stands on the side of a road listening to passing vehicles. When a truck was a certain distance away from the man, the truck driver honks the horn as he approached the man, until he was in line with the man. The sound heard by the man has a frequency of 10% higher than the actual frequency of the horn. If the speed of sound is taken as 330 $m.s^{-1}$, the constant speed of the truck was … $m.s^{-1}$.

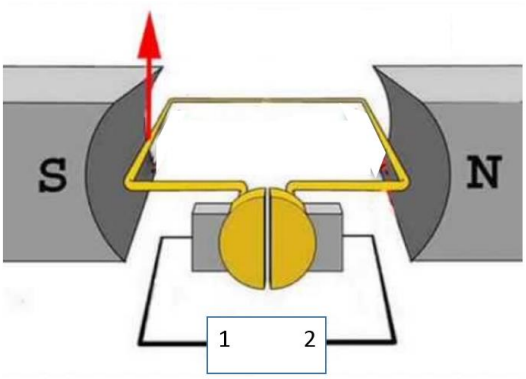
A 20

B 25

C 30

D 35

1.8 The diagram shows a DC motor. What is the polarity of the battery if the coil is rotating clockwise?



[Image from: https://www.youtube.com/watch?v=fWyzPdyCAzU]

	1	2
A	south	north
B	north	south
C	positive	negative
D	negative	positive

1.9 A line in a hydrogen spectrum has a frequency of 7,55 x 10^{14} Hz when measured in a laboratory. The same line in the light of a star has a frequency of 7,23 x 10^{14} Hz.
What is the relative motion between the star and the earth?

A Towards
B Away
C Standing still
D Not enough information to say

1.10 If a diesel generator has a maximum power output of x Watt, and an efficiency of 80%, calculate x if V_{rms} = 230 V and I_{rms} = 2 A are delivered by this generator.

A 920 W
B 1150 W
C 460 W
D 368 W

[2 x 10 = 20]

SECTION B

QUESTION 2

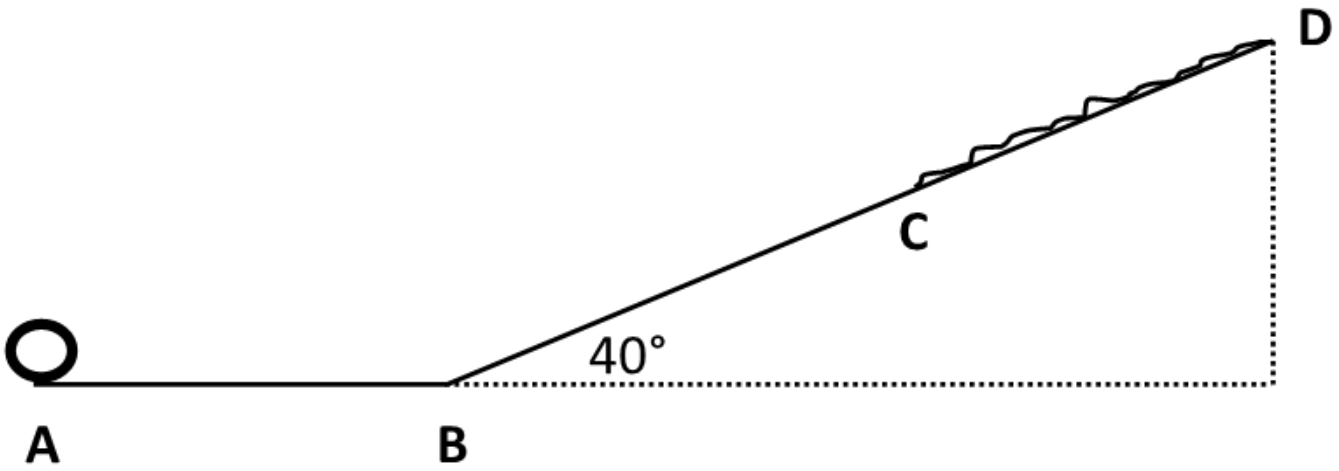
A 1 500 kg ambulance rushes down a road at 25 m.s^{-1} due east. It collides with a stationary 750 kg car. After the collision both the ambulance and the car move off separately in an easterly direction. The car decelerates at a constant rate of 2 m.s^{-2} due to friction between the car's tyres and the road surface coming to a rest in 7,5 seconds.

2.1 Define the term *momentum*. (1)
2.2 Calculate the momentum of the ambulance BEFORE the collision. (3)
2.3 State the *principle of conservation of linear momentum*. (1)
2.4 Calculate the speed of the ambulance AFTER the collision. (5)
2.5 During the collision the ambulance is in contact with the car for 0,2 seconds. Calculate the magnitude of the average force exerted by the ambulance on the car whilst the two are in contact. (3)
2.6 How will increasing the time the ambulance is in contact with car affect the average force calculated in 2.5? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

[14]

QUESTION 3

Johnny loves playing with marbles. His dad builds him a ramp as shown in the diagram below. The dad sands the ramp from point A to point C making the surface smooth but then gets tired and leaves the surface from point C to point D rough. Incline BD is setup at an angle of 40° to the horizontal and is 2 m long. C is the midpoint of BD. Johnny flicks a 10 g marble from point A at a velocity of 4 $m.s^{-1}$.



3.1 State the *principle of conservation of mechanical energy*. (1)

3.2 What is the velocity of the ball at point B? (1)

3.3 Calculate the gravitational potential energy of the marble at point C. (3)

3.4 Calculate the velocity of the marble at point C. (4)

3.5 The marble experiences a constant frictional force of 0,05 N from point C to point D. If the velocity of the marble at point C is 2 $m.s^{-1}$, will the marble reach point D? Justify your answer with an appropriate calculation. **Note:** no marks will be awarded if only the answer is given. (6)

3.6 What is the total distance travelled by the marble from point B up the ramp? (1)

3.7 How would your answer in 3.6 be affected if Johnny flicked the marble with a greater initial velocity? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

3.8 How would your answer in 3.6 be affected if Johnny's dad decreases the incline of the ramp to 30°? Write down only INCREASES, DECREASES or REMAINS THE SAME then give a reason for your answer. (2)

[19]

QUESTION 4

4.1 Define the term *power*. (2)

4.2 A diesel engine pumps 100 kg of water at an average rate of 4 $m.s^{-1}$. Calculate the average power produced by the engine. (3)

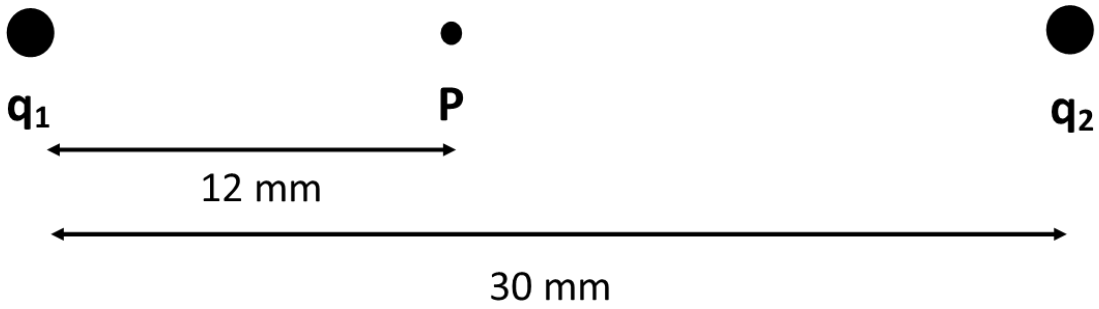
4.3 Calculate the work done to move a box 10 m across a frictionless, horizontal surface if a constant force of 300 N is applied to the box at an angle of $43°$ to the horizontal. (3)

[8]

QUESTION 5

5.1 State *Coulomb's law of electrostatics*. (2)

5.2 Two charges, q_1 and q_2, are placed 30 mm apart. The charges of q_1 and q_2 are -37 nC and 54 nC respectively.



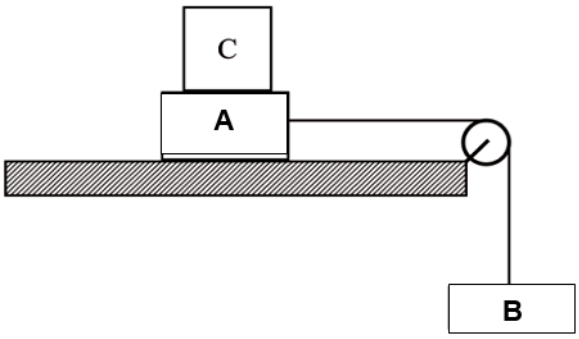
5.2.1. Calculate the net electric field at point P which is 12 mm to the right of q_1. (5)

5.2.2. Calculate the electrostatic force experienced by a -40 nC charge placed at P. (3)

[10]

QUESTION 6

6.1 Block A has a mass of 4 kg and Block B has a mass of 2 kg. Block A is placed on a rough table that has a coefficient of static friction of 0,2. Block A and Block B are connected via a light, inextensible rope over a frictionless pulley and Block C is placed on top of Block A as shown in the diagram below.



The system, as shown on the diagram, is only just at rest and on the limit of sliding.

6.1 Draw a free-body diagram of all the forces acting on Block A. (5)

6.2 Calculate the minimum weight needed for Block C, to stop Block A from sliding. (7)

Block C is now removed and the system starts accelerating.

6.3 State *Newton's Second Law* in words. (2)

6.4 The magnitude of the acceleration of the system is 2,3 $m.s^{-1}$. Calculate the tension in the rope joining the blocks. (3)

6.5 Calculate the kinetic friction between the table and Block A while it is accelerating. (3)

[20]

QUESTION 7

A man drops ball A from the edge of a window, 45 m above a dam of water. One second later he throws a second ball, ball B, downwards and observes that both balls strike the surface of the water at the same time. Ignore air friction.

7.1 Calculate the:

7.1.1 Speed with which ball A hits the surface of the water. (3)

7.1.2 Time it takes for ball B to hit the surface of the water. (3)

7.1.3 Initial velocity of ball B. (5)

7.2 On the same set of axes, sketch a velocity versus time graph for the motion of balls A and B. Clearly indicate the following on your graph:

- Initial velocity of both balls A and B
- The time of release of ball B
- The time taken by both balls to hit the surface of the water (4)

[15]

QUESTION 8

8.1 An ambulance approaches a stationary observer at a constant speed of 10,6 $m \cdot s^{-1}$, while its siren produces sound at a constant frequency of 954,3 Hz. The stationary observer measures the frequency of the sound as 3% higher than the produced sound.

8.1.1 State the Doppler effect. (2)

8.1.2 Calculate the velocity of sound. (5)

8.1.3 How would the **wavelength** of the sound wave produced by the siren of the ambulance change if the frequency of the wave were higher than 954,3 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

8.1.4 Give a reason for the answer to QUESTION 6.1.3. (2)

8.1.5 How would the frequency that the driver hears, compare to the 954,3Hz? Only write down HIGHER, LOWER or THE SAME. (1)

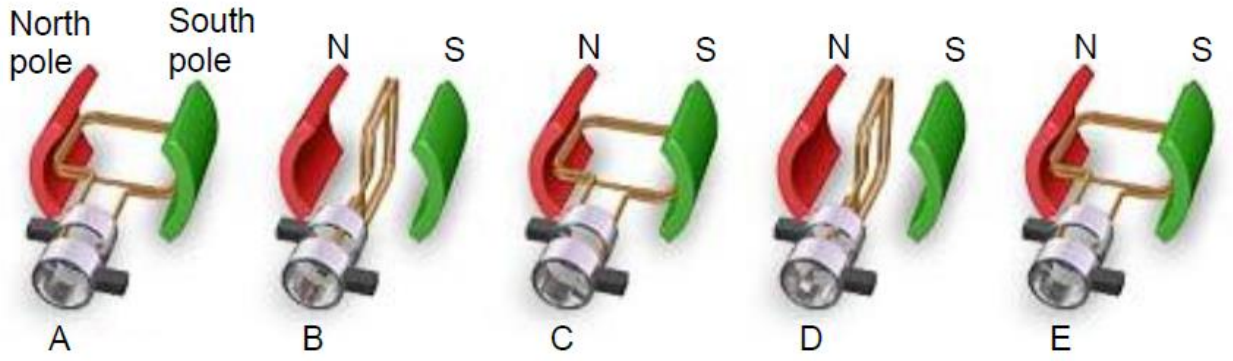
8.2.1 Name a medical instrument that makes use of the Doppler effect. (1)

8.2.2 The colour of a distant star is observed from earth as more red than it actually is. What is this phenomenon called? (1)

[13]

QUESTION 9

The diagrams illustrate an electrical generator with a rotating coil shown in a number of different positions labelled A–E between magnetic poles.



[Images from: <http://micro.magnet.fsu.edu/electromag/electricity/generators/index.html>]

9.2.1 State the energy conversion that takes place during the operation of the generator. (2)

9.2.2 A student states that the diagrams illustrate an AC generator. Is this statement correct? Give a reason for your answer. (2)

9.2.3 State *Faraday's Law that the functioning of this device is based on.* (2)

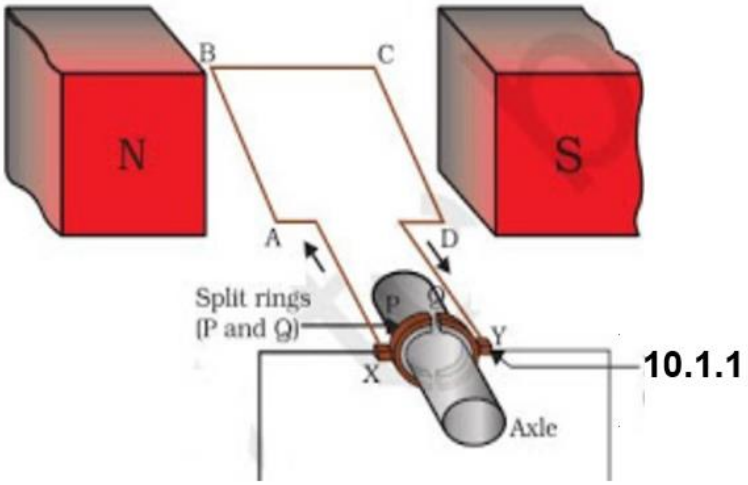
9.2.4 Draw a sketch graph of the emf output from this generator as a function of time. Draw the graph ONLY for Position A – D. Position A occurs at 0 s. Label points A–D to correspond to the diagrams. (3)

9.2.5 Briefly explain why you labelled point C in the position shown in your answer to Question 9.2.4. (2)

[11]

QUESTION 10

The motor shown below has an **electron current** (indicated with the two arrows) flowing as indicated.



<https://www.studyrankers.com/2017/08/notes-of-ch-13-magnetic-effects-of-electric- current-class10th.html>

10.1.1 Give the label for the component numbered 10.1.1. (1)

10.1.2 What is the function of the component in 10.1.1. (2)

10.1.3 Will the coil turn clockwise or anti-clockwise? (1)

10.1.4 Is this a DC or AC motor? Give a reason for your answer. (2)

10.1.5 State one change that can be made to **this** motor to increase the strength of the motor. (1)

10.1.6 By which principle does this motor work? (1)

10.1.7 State the principle mentioned in 10.1.6. (2)

10.1.8 State the energy conversion in this device. (2)

[12]

QUESTION 11

An electrical heater which has a resistance of 50 Ω is operated by connecting the heater to an *rms* potential difference of 220 V.

11.1 Calculate the average power output of the heater. (3)

11.2 Calculate the peak current needed for this heater to function optimally. (3)

11.3 Define *rms* potential difference. (2)

[8]

TOTAL 150 MARKS