ALEXANDER ROAD HIGH SCHOOL

JUNE 2018 3 HOUR

PHYSICAL SCIENCES MID-YEAR EXAMINATION PAPER 1

CO, JA, MH TOTAL = 150

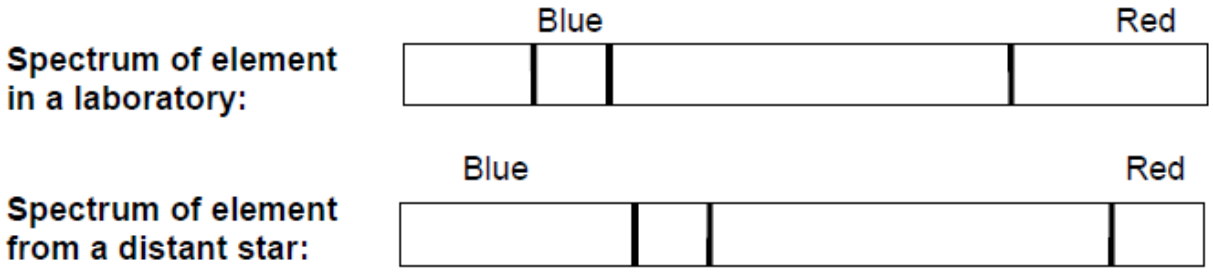
GRADE 12

Instructions

- The question paper consists of 9 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided 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 and a periodic table on the back of the answer sheet.

QUESTION 1

1.1 Astronomers obtained the following spectral lines of an element:



The observation confirms that the…

A …temperature of earth is increasing.

B …earth is moving towards the star.

C …star is moving away from earth.

D …star is moving towards earth.

1.2 You are given 2 metal balls with masses m kg and 2m kg, with a force of 0,005N between them, and a distance r apart. If the mass of one of the balls is doubled and the distance between their centres is tripled, the new force measured between them will be …. N.

A 0,0011

B 0,0022

C 0,0033

D 0,0044

1.3 Given: spheres with charges q_1 and q_2, a distance d apart. A graph of electrostatic force between the charged spheres vs. the charge on ONE of the spheres will be a …

A hyperbolic graph with the Force axis as asymptote.

B straight line with gradient equal to $9x10^9$

C straight line with gradient equal to $9x10^9 x q_1 x q_2$

D straight line with gradient equal to $9x10^9 x q_1 \div d^2$

1.4 The front of a modern car is designed to crumple in case of a head-on collision. The chance of serious injuries to the passenger is reduced because the…

A …net force acting on the passenger is reduced, since the rate of change in momentum decreases.

B …net force acting on the passenger is reduced, since the rate of change in momentum is increases.

C …net force acting on the passenger is reduced, since the change in the momentum is reduced.

D …net force acting on the passenger is reduced, since the contact time for the car to stop decreases.

1.5 Which one of the following physical quantities is a measure of the inertia of an object?

A Momentum.

B Mass.

C Acceleration.

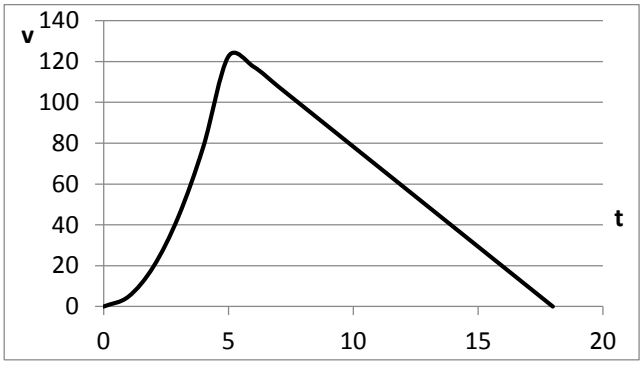
D Energy.

1.6 Two bodies undergo an ELASTIC collision. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

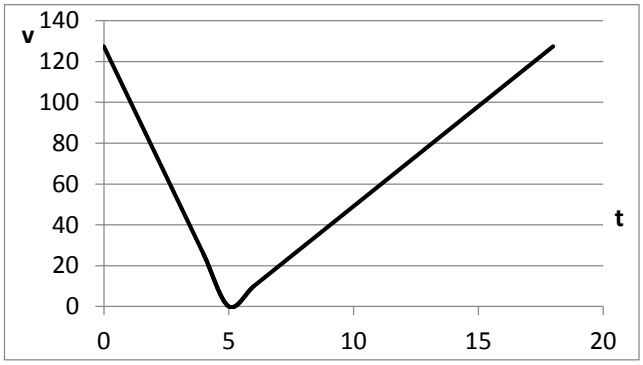
	Momentum	**Kinetic Energy**
A.	Not conserved	Not conserved
B.	Not conserved	Conserved
C.	Conserved	Not conserved
D.	Conserved	Conserved

1.7 A spaceship accelerates with a constant acceleration vertically upwards from rest, 5 s after launching it runs out of fuel, 13 s after running out of fuel, it reaches its maximum height. If upwards is taken as the positive direction, which ONE of the following velocity-time graphs accurately represents this scenario?

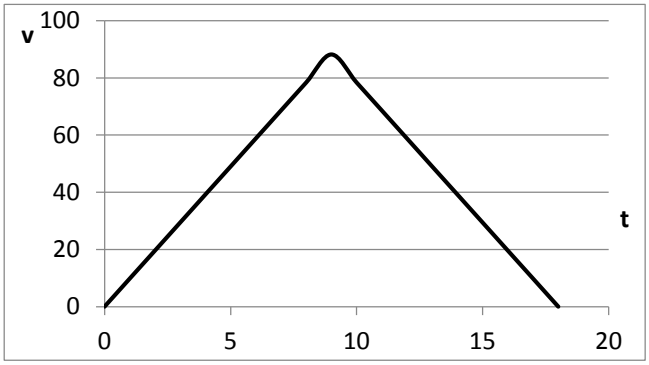
A.



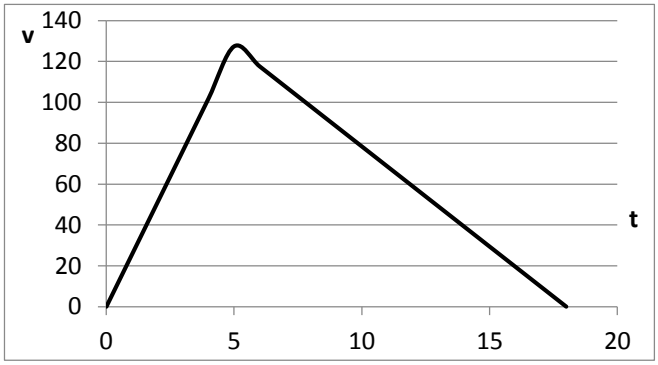
B.



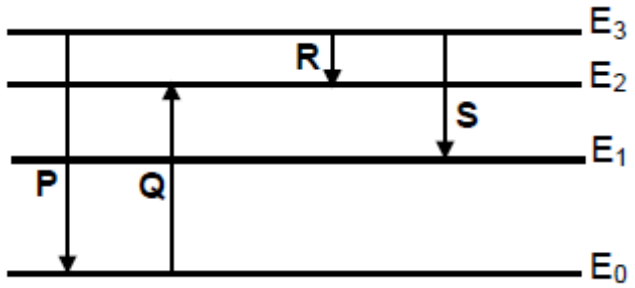
C.



D.



1.8 The diagram below shows the electron transitions **P**, **Q**, **R** and **S** between different energy levels in an atom.



Which ONE of the transitions will result in an emission of radiation with the largest frequency?

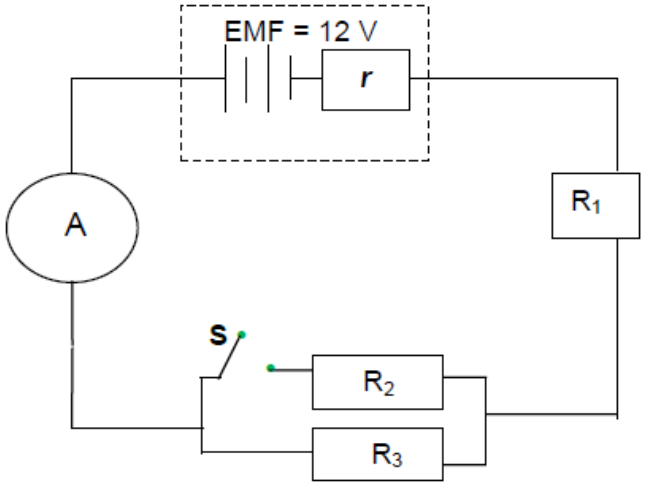
A **P**

B **Q**

C **R**

D **S**

1.9 The circuit diagram below contains a combination of resistors R_1, R_2 and R_3. The battery has an EMF of 12 V and an unknown resistance, **r**.



Switch S is now CLOSED. The external resistance will…

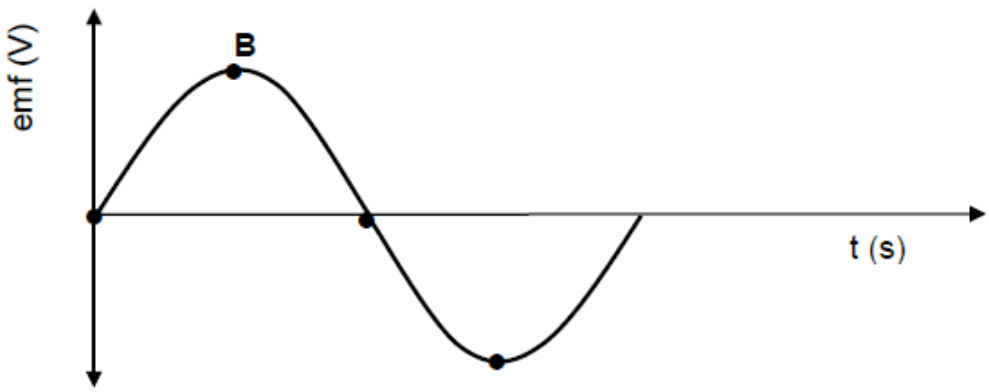
A …remain the same.

B …increase.

C …decrease.

D ...be unknown as there is insufficient information on the diagram.

1.10 The coils of an AC generator make one complete rotation. The resulting graph for the output emf is shown below.



The position **B** on the graph is obtained when the plane of the coil is at an angle of … to the magnetic field.

A 0°

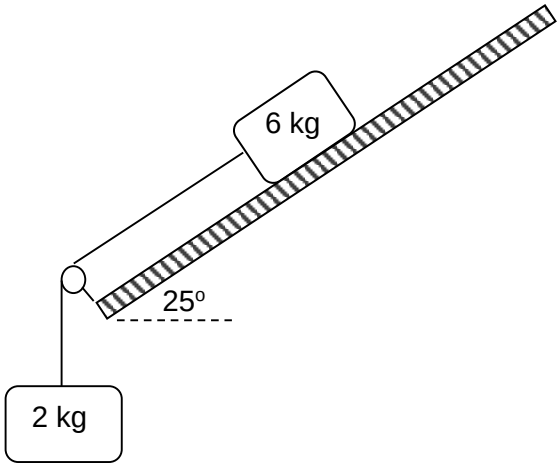
B 60°

C 90°

D 120°

QUESTION 2

2.1 A block of mass 6 kg, on an inclined ramp, is connected to another block of mass 2 kg by means of a light inextensible string that is hanging over a frictionless pulley. The system accelerates down the ramp. The ramp is inclined at an angle 25° with the horizontal as shown in the diagram below.



The coefficient of kinetic friction between the 6 kg block and the surface of the ramp is 0,5. Ignore the effects of air friction.

2.1.1 Write down the NAME of the forces which is responsible for the acceleration of the 6 kg block down the incline. (2)

2.1.2 State Newton's second law of motion in words. (2)

2.1.3 Draw a labelled free-body diagram indicating ALL the forces acting on the 6 kg block. (4)

2.1.4 Calculate the tension in the connecting string. (6)

2.2 Thandi and Sue are wearing ice skates on an ice rink. Thandi has a mass of 50kg.
They push of from each other and Thandi accelerates at a rate of 4,5 $m.s^{-2}$ to the right, but Sue only accelerates at a rate of 3,2 $m.s^{-2}$ to the left. Ignore friction.

2.2.1 Calculate Sue's mass. (3)

2.2.2 Identify two force pairs from the scenario. (2)

2.2.3 State Newton's third law of motion in words. (2)

2.2.4 If there is some friction on the ice. Would Thandi or Sue be most likely move the furthest? (1)

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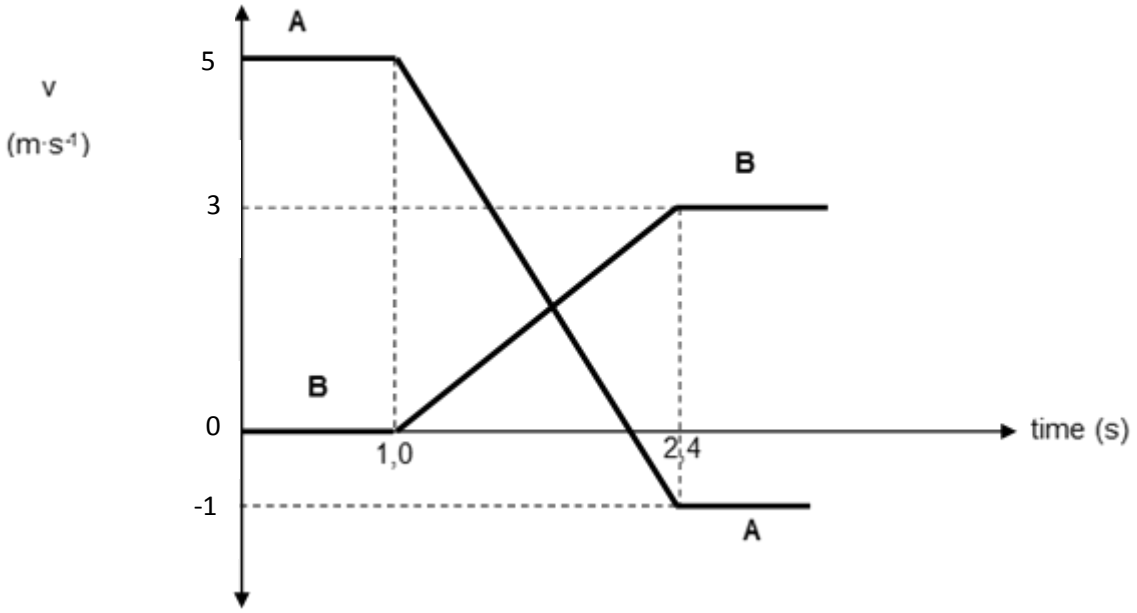
QUESTION 3

A railway carriage A of mass 500 kg is moving horizontally in an easterly direction at 5 m·s^{-1}. It collides with another railway carriage B of unknown mass which is initially at rest on a straight level track.
The graph below shows the variation of the velocities with time of the two railway carriages before, during and after the collision.



Ignore frictional forces between the railway carriages and the track before, during and after the collision.

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

3.2 Calculate the change in momentum of railway carriage A between 1,0 s and 2,4 s: (4)

3.3 Calculate the magnitude of the net force experienced by railway carriage A between 1,0 s and 2,4 s. (3)

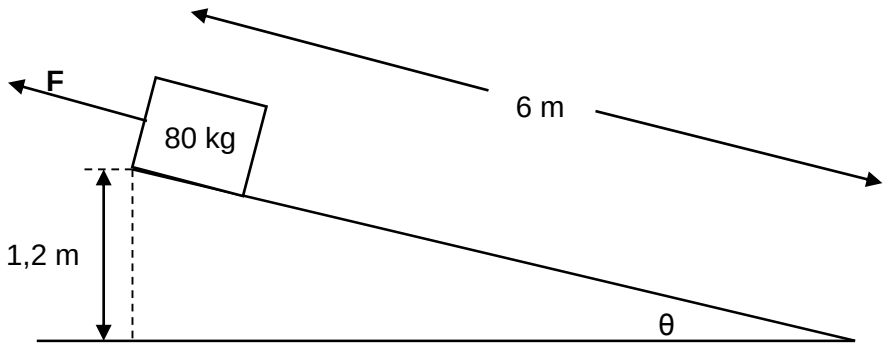
3.4 Calculate the distance travelled by carriage B between 1,0 s and 2,4 s. (3)

3.5 Calculate the mass of train carriage B. (4)

[16]

QUESTION 4

An object of mass 80 kg slides down a rough inclined plane at constant velocity while a constant force F is applied to the object as shown in the diagram below. The plane is inclined at an angle θ to the ground. The coefficient of kinetic friction μ_k between the block and the inclined surface is 0,25.



4.1 Draw a labelled free body diagram indicating ALL the forces acting on the object as it slides down the incline. (4)

4.2 Write down the work-energy theorem IN WORDS. (2)

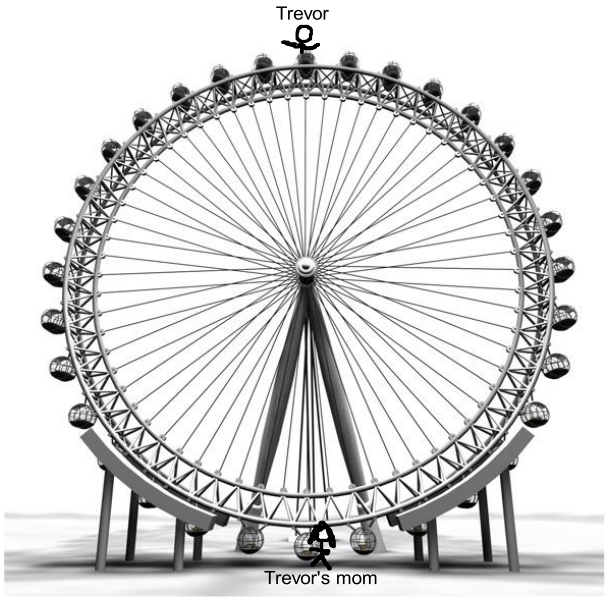
4.3 Calculate the work done by the applied force F as the block slides along the rough horizontal surface. (6)

[12]

QUESTION 5

5.1 Define the term *free fall*. (2)

5.2 The High Roller in Los Angeles, USA, is the world's tallest Ferris wheel. Trevor, a tourist from South Africa, decides to take a ride on the High Roller Ferris wheel. When Trevor reaches the top of the Ferris wheel, he is so amazed by the view that he drops his ice cream cone. The ice cream cone falls vertically downwards, striking Trevor's mother, who is standing directly beneath the Ferris wheel, 5,7 seconds later. The effects of air resistance can be ignored for all calculations.



Adapted from http://getdrawings.com/ferris-wheel-drawing#ferris-wheel-drawing-7.jpg

5.2.1 Calculate the velocity with which the ice cream cone strikes Trevor's mother. (3)

5.2.2 Sketch the velocity-time graph for the motion of the ice cream cone. Indicate the following on your graph:

- Initial velocity of the ice cream cone.
- Final velocity of the ice cream cone.
- Time at which the ice cream cone strikes Trevor's mother. (4)

5.2.3 Calculate the height of the High Roller Ferris wheel. (4)

5.2.4 In real life, the High Roller Ferris wheel is 158,5m tall. Why is there a difference between the actual height and your answer in 5.2.2? (Note: there are <u>no</u> rounding errors). (1)

5.2.5 Trevor's brother Vuyo is standing next to Trevor's mother. Vuyo throws a ball vertically upwards with an initial speed of $25 m.s^{-1}$. Will the ball reach the top of the High Roller Ferris wheel? Explain your answer. (2)

[16]

QUESTION 6

6.1 Dolphins use ultrasound to scan their environment. When a dolphin is 100 m from a rock, it emits ultrasound waves of frequency 250 kHz whilst swimming at 20 $m.s^{-1}$ towards the rock. Assume that the speed of sound in water is 1 500 $m.s^{-1}$.

6.1.1 Write down the name of the above phenomenon. (1)

6.1.2 Calculate the frequency of the sound waves detected by a detector on the rock. (4)

6.1.3 When the dolphin is 50 m from the rock, another ultrasound wave with frequency 250 kHz is emitted. How will the frequency of the detected sound wave compare with the answer calculated in QUESTION 6.1.2? Write down only HIGHER, LOWER or REMAINS THE SAME. Explain your answer. (2)

6.2.1 The phenomenon/effect mentioned in 6.1.1 is used in astronomy. State the name of the phenomenon that is referred to. (1)

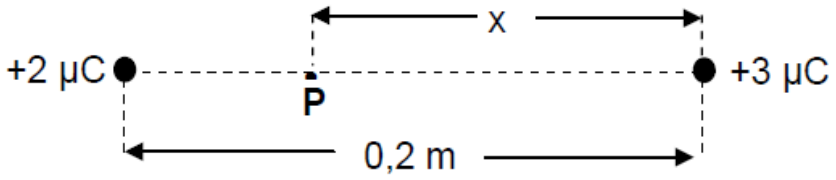
6.2.2 Explain this effect with regard to the colour of stars observed from earth. (2)

6.2.3 Name one medical instrument where this effect is widely used. (1)

[11]

QUESTION 7

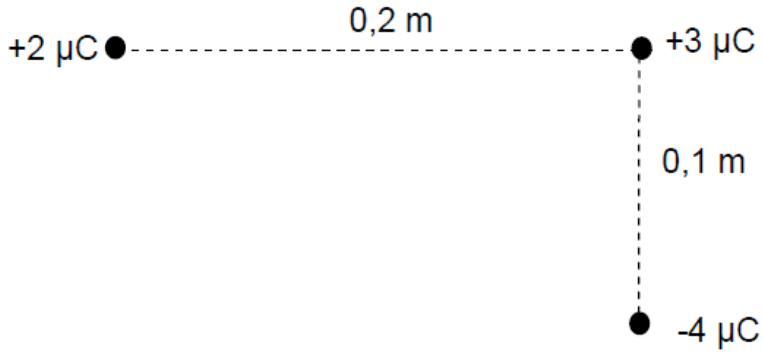
Two point charges of +2 μC and +3 μC are placed a distance of 0,2 m apart. P is a point on the line joining the two charges, a distance of **X** m from the 3 μC charge such that the net electric field at point P is zero.



7.1 Define the term electric field at a point in words. (2)

7.2 Calculate the distance **x**. (7)

A -4 μC charge is now placed a distance of 0,1 m from the +3 μC charge as shown in the sketch below.



7.3 Calculate the magnitude of the electrostatic force experienced by the +3 μC charge due to the presence of the other two charges. (5)

7.4 If it is assumed that the +2 μC and +3 μC charges are small polystyrene spheres, and they were brought together to touch and then separated again.

7.4.1 Calculate the new charge on each sphere after separation. (3)

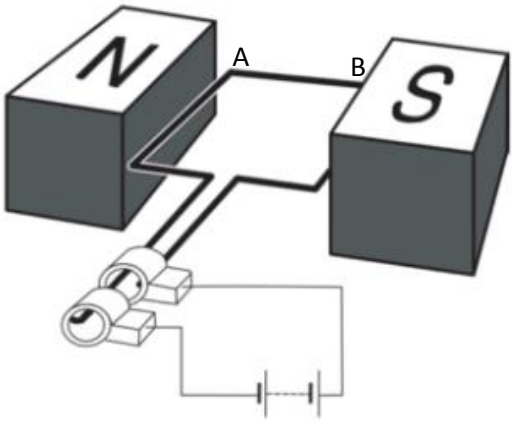
7.4.2 Calculate the amount of electrons that moved from the one sphere to the next. (3)

7.4.3 In which direction did the electrons move? (1)

[21]

QUESTION 8

8.1.1 The electrodynamic device shown below has a structural design error. Name the error if this should be a **DC device**. (1)



8.1.2 If this DC device is working (switched on) the loop will move. In what direction will it move? Only state UP or DOWN or CLOCKWISE or ANTI-CLOCKWISE. (1)

8.2 The battery (in the original device in sketch) is now replaced with a bulb, and a rotational axis and handle are installed.

8.2.1 What is the energy conversion that will be applicable when the handle is turned? (1)

8.2.2 The handle (which was installed) is turned anti-clockwise, what will be the current direction (only state **A to B** or **B to A**)? (1)

8.2.3 By which principle does the device work? (2)

8.2.4 The device has carbon brushes. What is their function? (2)

8.2.5 If the device produces a maximum power of 20 Watt, and a maximum potential difference of 5,6 V, calculate the I_{rms} produced by the device. (4)

8.2.6 Define power. (2)

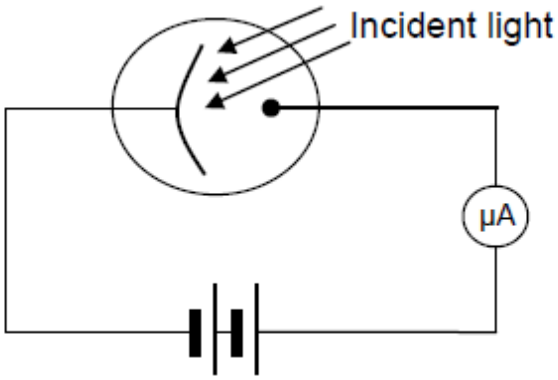
8.2.7 Name one change that could be made to the device to produce a higher voltage. (1)

8.3 State one structural difference between a DC motor and an AC generator. (2)

[17]

QUESTION 9

An investigation is conducted to determine the maximum kinetic energy of ejected photoelectrons. In the first experiment a caesium cathode is used. In the second experiment a sodium cathode is used. In both experiments, the photocell is radiated by ultraviolet light from the same source. The apparatus used as well as the incomplete results of the experiment are shown below.



Metal	Work Function (in J)	Maximum Kinetic Energy of Photoelectrons (in J)
Caesium	$3,36 \times 10^{-19}$	$2,23 \times 10^{-19}$
Sodium	$3,65 \times 10^{-19}$	E_k

9.1 Define the term *work function of a metal*. (2)

9.2 WITHOUT doing any calculations, state which metal's photoelectrons would have the LARGEST maximum kinetic energy. (1)

9.3 Use the information in the table to calculate the wavelength of ultraviolet light used in the investigation. (4)

9.4 Assuming that the ultraviolet light used in the investigation had a wavelength of $3,50 \times 10^{-7}$m, calculate the maximum kinetic energy, E_k, of an electron ejected from the sodium metal. (4)

9.5 How will an INCREASE in the INTENSITY of the UV light affect the following? Write down only INCREASES, DECREASES or REMAINS THE SAME.

9.5.1 The maximum kinetic energy of the photoelectrons. (1)

9.5.2 The reading on the ammeter. (1)

9.6 Explain your answer to QUESTION 9.5.1. (2)

[15]