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DAINFERN College

Preliminary Examination

7 September 2023

PHYSICAL SCIENCES

GRADE 12: PAPER 1 PHYSICS

Time: 3 Hours **Total:** 200 marks

Examiner: J Orsmond

Moderator: A Hewitt

NAME: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. This question paper contains a total of 36 pages. Please ensure you have all pages.
2. An **information sheet** has been provided on pages 35 and 36. Detach from the back of this question paper.
3. Extra space is provided on pages 32 - 34.
4. Answer on this question paper.
5. You may use a scientific non-programmable calculator.
6. If answers need to be rounded off, then round them off to **2 decimal places unless** instructed otherwise.
7. Read through the paper carefully before you begin answering the questions.
8. Look at the mark allocation to know how much detail is required and how much time you should spend on each question.
9. It is in your best interests to show all your working neatly.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total
/20	/20	/21	/22	/35	/21	/29	/20	/12	/200

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QUESTION 1 Multiple Choice

Circle the letter of the correct answer in each question.

1.1 The unit and direction of conventional current is

A Ampere ; North to south

B Ohm ; positive to negative

C Ampere ; positive to negative

D Volt ; negative to positive

1.2 When electrical energy must be transported over long distances, the energy loss can be minimised if:

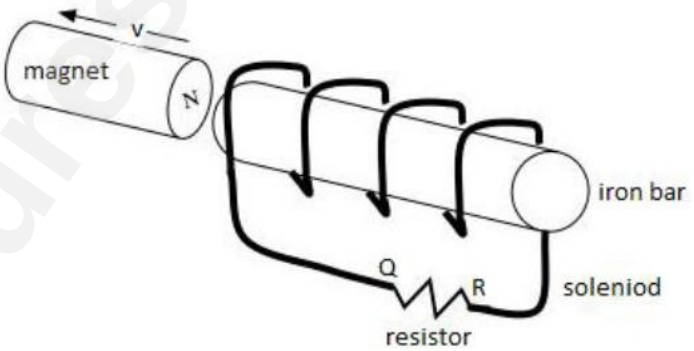
A the current is high and the voltage is low

B the voltage is high and the current is low

C both current and voltage is high

D both current and voltage is high

1.3 The magnet in the following diagram is moving away from the solenoid. The induced current flows through the resistor in a direction from



A Q to R

B R to Q

C Q to R then R to Q

D R to Q then Q to R

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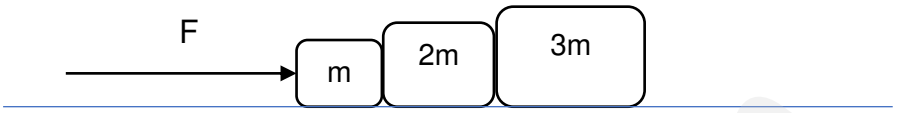
1.4 Three blocks of mass m, 2m and 3m are placed adjacent to each other on a frictionless surface as shown in the diagram. A horizontal force F accelerates the system to the right.



Which one of the following statements is true?

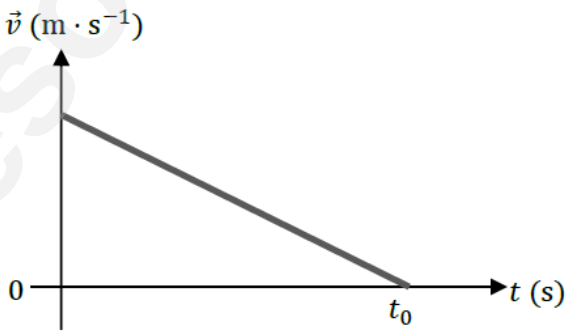
A The acceleration of the boxes vary according to their mass.

B The net force acting on 3m is three times greater than the net force acting on m.

C The net force on each block is the same.

D Box 2m exerts a Normal force on 3m, but not on m.

1.5 The following velocity-time graph represents the motion of an object moving vertically through the air near the earth's surface.



Use the graph to determine the positive direction as well as the significance of time t_0.

	Positive direction	At time t_0 the box…
A	up	….reaches maximum height
B	down	…..hits the ground
C	up	…..hits the ground
D	down	….reaches maximum height

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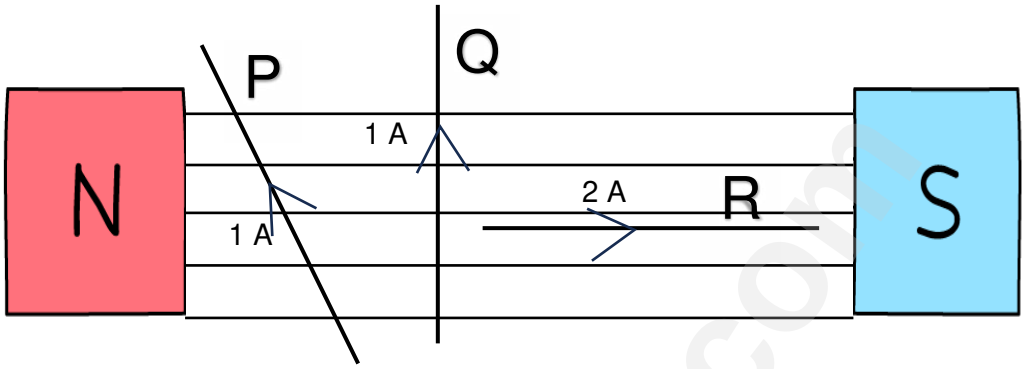
1.6 Three identical current carrying conductors of equal length are placed in the same magnetic field as shown in the diagram below. The current in each conductor is shown in the diagram.



The conductor which experiences the greatest force is:

A Conductor P

B Conductor Q

C Conductor R

D All three experience the same magnitude force

1.7 A constant net force, F, is applied to a crate which moves along a frictionless horizontal surface. Which ONE of the following quantities remains constant while force F acts on the crate?

A the rate of change of momentum

B the work done on the crate

C the velocity of the crate

D the change in momentum

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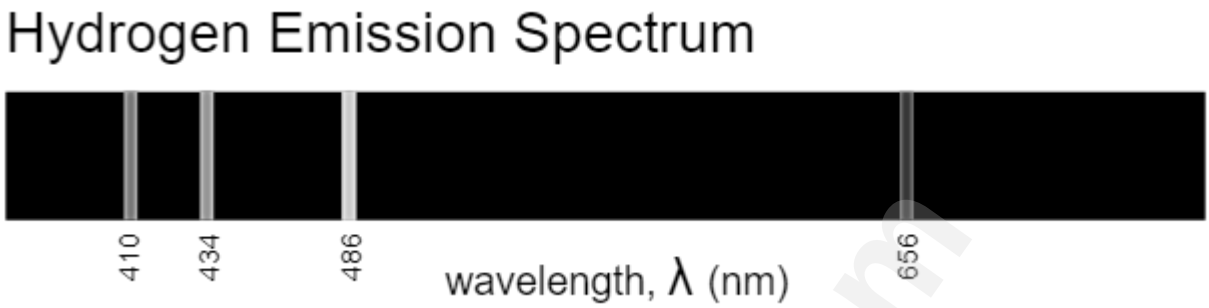
1.8 The visible emission spectrum for hydrogen (in grayscale) is shown below.



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The emission spectrum arises as a result of

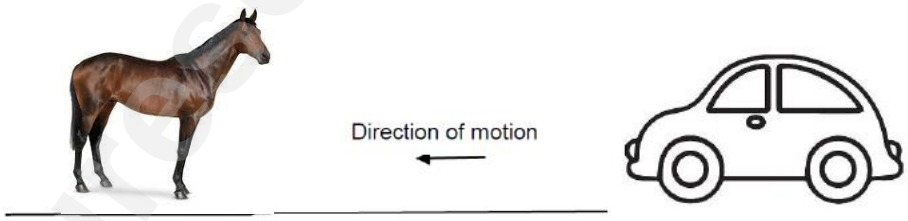
A energy given out when electrons move from lower to higher energy levels in the hydrogen atom.

B light energy emitted when electrons move out of a hydrogen atom.

C energy given out when electrons move from higher to lower energy levels in the hydrogen atom.

D energy given out as hydrogen molecules break apart to form atoms.

1.9 Ashley is driving along Cedar road when she sees a horse standing in the road. She slams on brakes.



Ashley is wearing a seatbelt which exerts a force on her. The reaction to this force is the force of

A Ashley on the seatbelt

B The seatbelt on the seat.

C The car's frame on the seatbelt.

D Ashley on the seat

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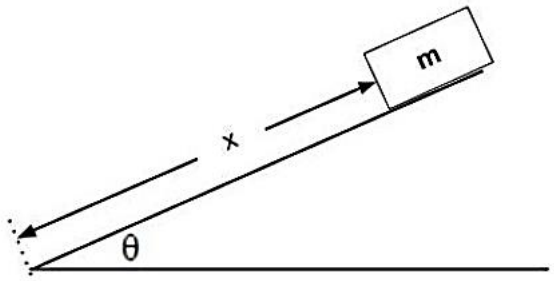
1.10 A block. With mass m, is sliding down a rough surface that makes and angle θ with the horizontal, through a distance x as indicated in the sketch below.

The work done on the block by the net force will INCREASE if…



A a greater frictional force acts on the block.

B the mass of the block is decreased.

C the distance x is decreased.

D the angle θ is increased

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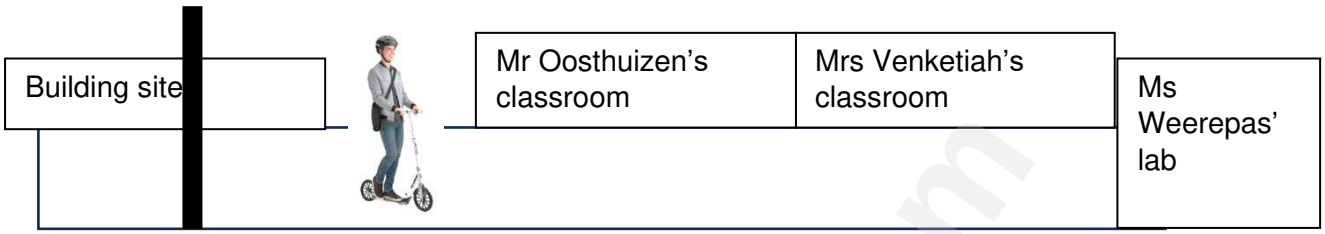
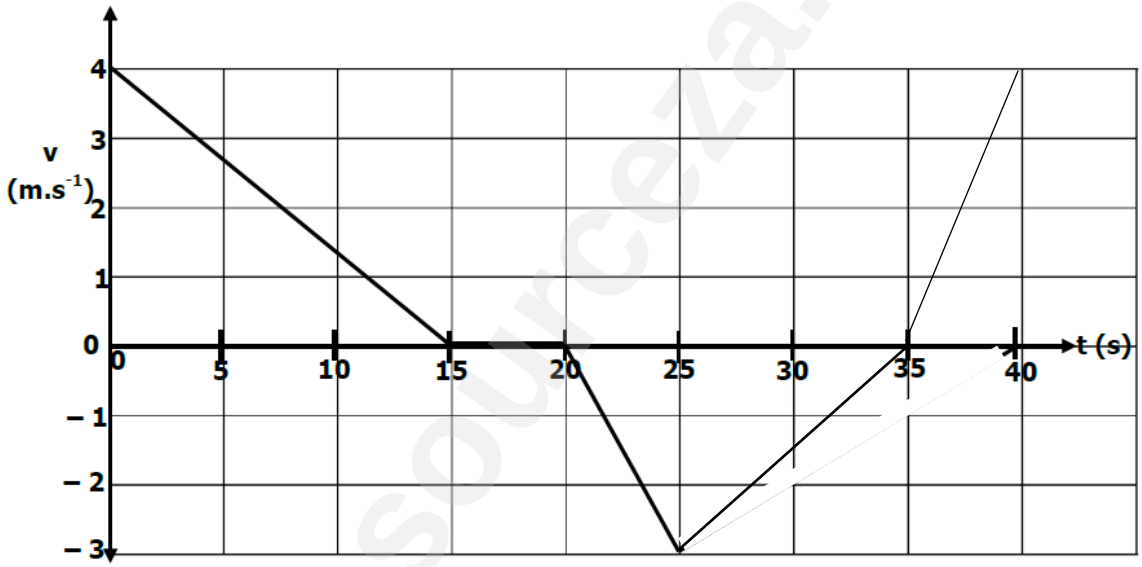
QUESTION 2

Mr Oosthuizen is riding his scooter up and down the corridor outside his classroom.



The graph below shows how the velocity of scooter changes during a **part** of his journey. Mr Oosthuizen is initially traveling **south** (towards Ms Weerepas' Lab)



Kearsney 2016

2.1. Define *accleleration*. (1)

2.2. Use a graphical method to determine the Mr O's acceleration between 20 and 25 s. (3)

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2.3 Use a graphical method to determine the displacement of the scooter between t = 0 s and t = 40 s. Show your working. (4)

2.4 Describe the velocity of the scooter in the following intervals. Write only EAST/WEST and SPEEDING UP/SLOWING DOWN/CONSTANT.

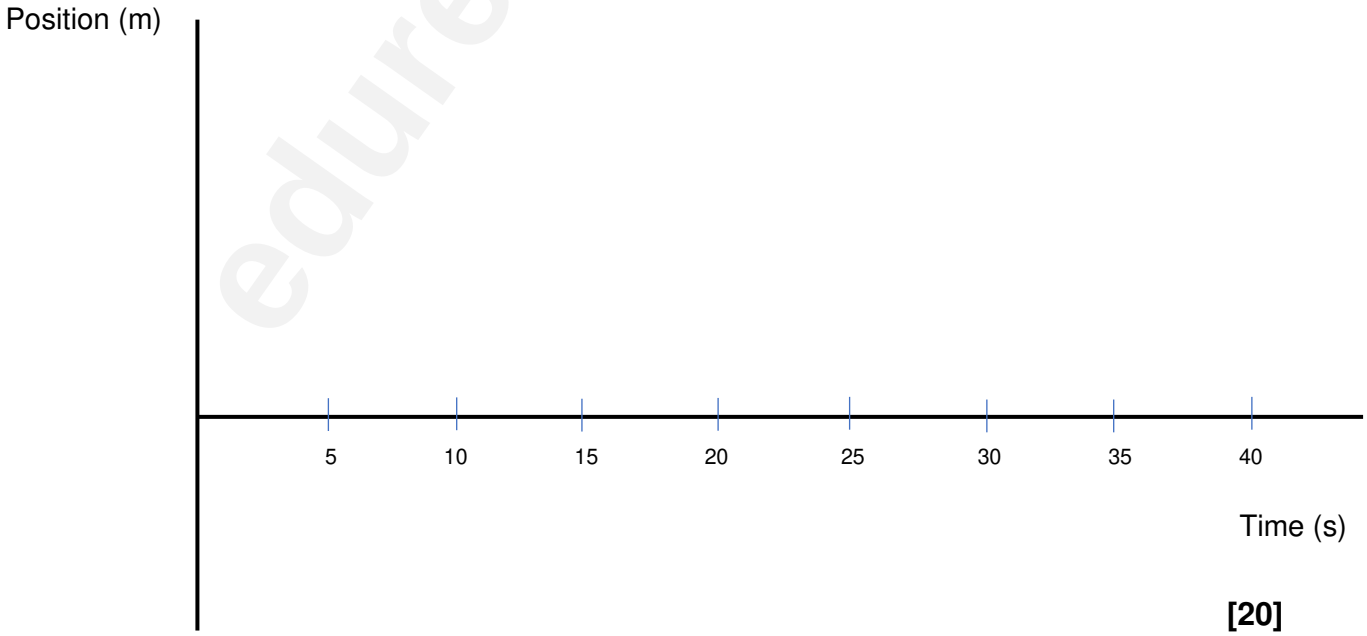
2.4.1 t = 0 – 15 s (2)

2.4.2 t = 25 – 35 s (2)

2.5 Did the scooter change direction? If so, at what time(s)? (2)

2.6 Calculate the average speed of the scooter between 0 and 40 s. (2)

2.7 Draw a corresponding sketch graph of the position vs time of the scooter from t = 0 s to t = 40 s. Values are not required on the y-axis and will not be marked, but they may be placed there to assist you. (5)



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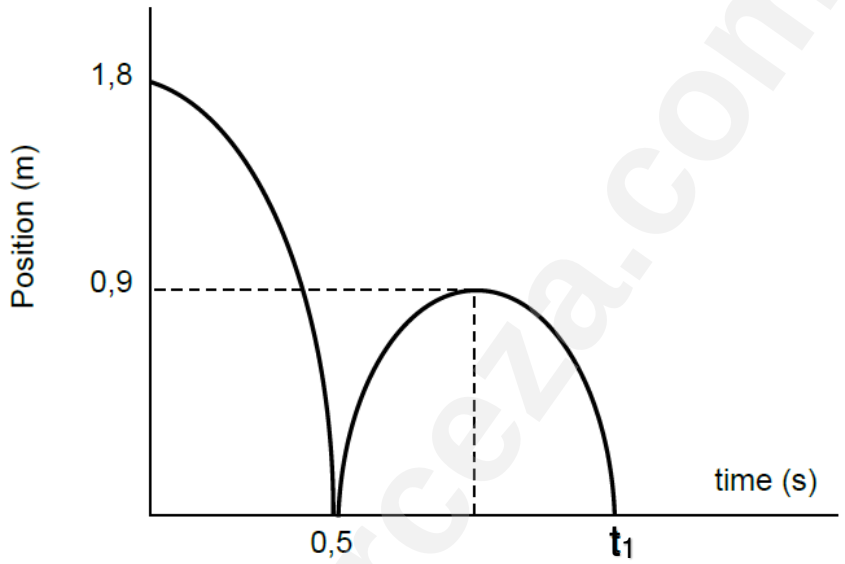
QUESTION 3

The position – time graph is given for **ball A** which is **thrown** straight downwards from a vertical height of **1,8 m,** with an initial speed of **1,15 m.s^{-1},** and bounces once on reaching the ground. The contact time between ball A and the floor can be ignored.



WC south 2015

3.1 Define *velocity*. (1)

3.2 Calculate the speed at which ball A strikes the ground? (3)

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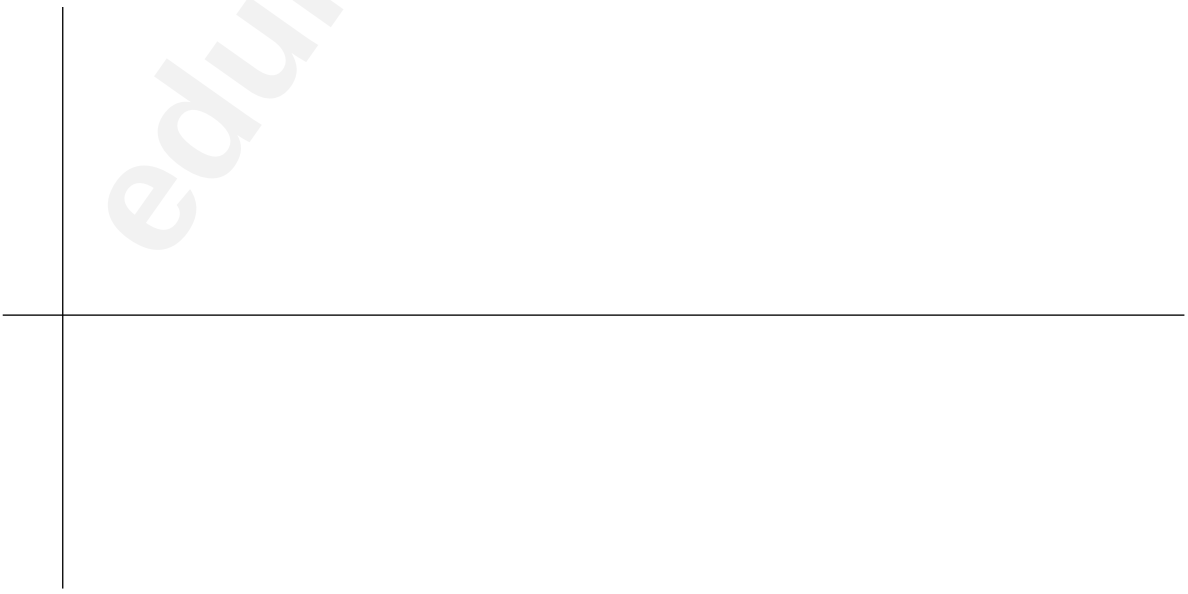
3.3 Determine the velocity at which ball A leaves the ground after bouncing. (3)

3.4 Calculate the value of time t_1. (3)

3.5 Sketch a velocity-time graph on the axes below to represent the motion of ball A. Show only relevant time values on the axes. No values are required on the Y-axis. Take down as positive.

(5)



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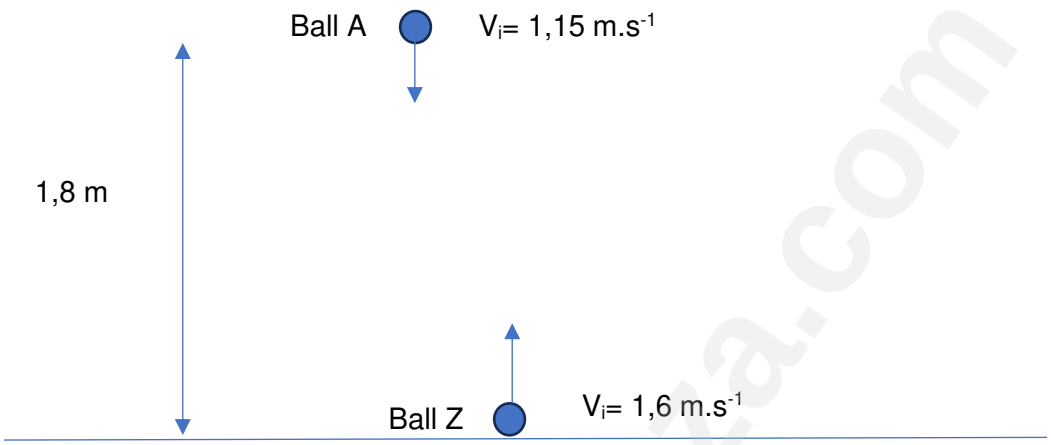
3.6 A second ball, **ball Z**, was projected directly upward from ground level at the same moment that ball A was thrown directly down.
The initial speed of the ball Z was **1.6 m.s^{-1}**.
Will ball A pass ball Z before it strikes the ground? And if it does, after how many seconds will this occur? Your working MUST be shown clearly. (6)



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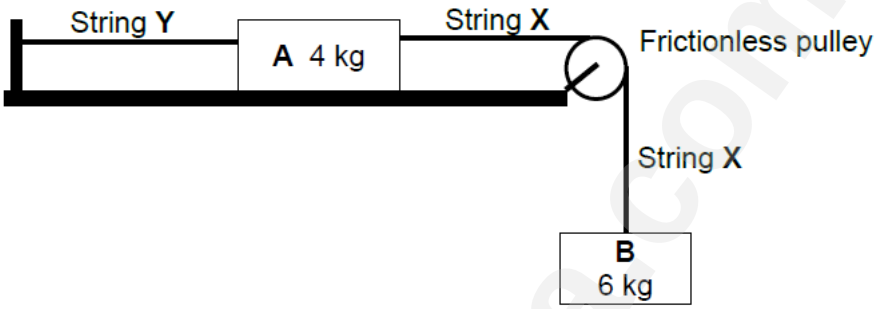
QUESTION 4

4.1 Block A (mass 4 kg) and Block B (mass 6 kg) are connected via a light, inextensible string, **X**, over a frictionless pulley.
Block A, which is at rest on a rough horizontal surface, is tied via a light inextensible string, **Y**, to a fixed post as shown in the diagram.



Kearsney 2017

String **Y** is cut and the system starts accelerating. The tension in string **X** is 40,2 N.

4.1.1 Calculate the acceleration of block B. (4)

4.1.2 Calculate the magnitude of the frictional force acting on Block **A** while it is accelerating. (3)

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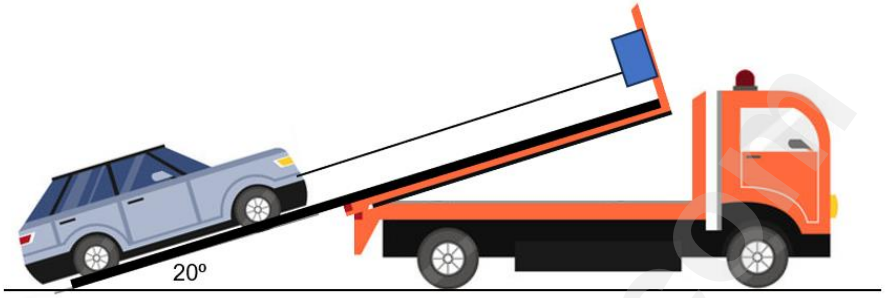
4.2 A Dainfern Matric student's new Land Rover, of mass **2500 kg**, developed an oil leak on William Nicol drive last Tuesday and had to stop at the side of the road. The towing company sent a flatbed trailer to transport the car to the Land Rover garage.



4.2.1 A winch was used to pull the Land Rover up the ramp at a constant speed of 0,5 $m.s^{-1}$. The ramp was inclined at an angle of 20º to the horizontal. If the coefficient of kinetic friction between the car tyres and the ramp is 0,8, determine the tension in the winch cable. (4)

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The Land Rover's handbrake was applied once it was in position on the horizontal flat bed. The Land Rover was not secured to the truck by any other means.

The truck travelled south along William Nicol at 80 $km.h^{-1}$ until the truck driver saw a red traffic light up ahead. He braked and brought the truck to a stop over a distance of 150 m. The Land Rover remained in place on the back of the truck as the truck slowed to a stop.

4.2.2 Determine the acceleration of the truck (in $m.s^{-2}$). (4)

4.2.3 Determine the minimum coefficient of static friction between the wheels of the Land Rover and the floor of the flat bed. (4)

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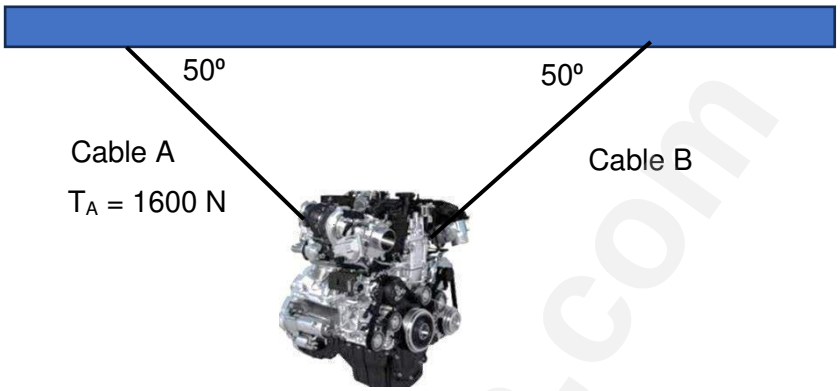
4.3 At the garage, the Land Rover engine was taken out of the car and suspended from a beam by 2 cables as shown in the diagram below



Use the information given in the diagram to calculate the mass of the Land Rover engine.

(3)

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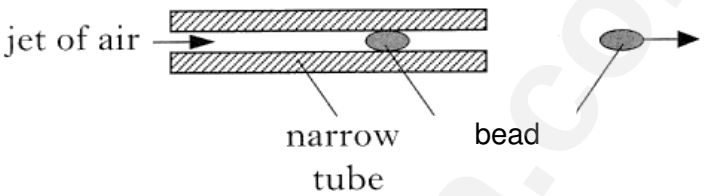
QUESTION 5

5.1 A machine is designed to shoot beads out of a narrow frictionless tube. The beads are accelerated along the tube by a stream of air.

The machine was designed to provide a force of **0,5 N** to accelerate the bead from rest for a time of **3 ms**. Each bead has a mass of **2 x 10^{-5} kg**.

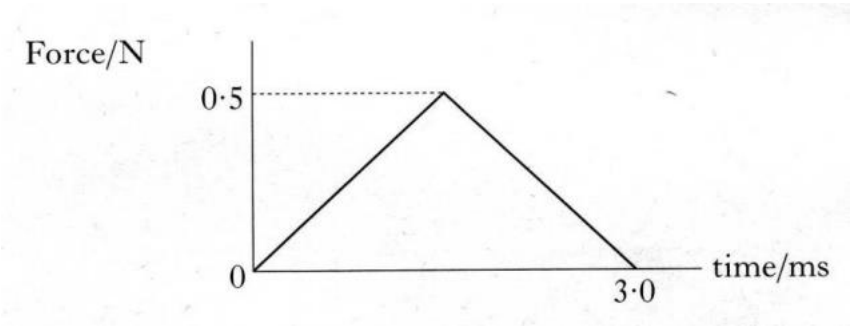


Laberthigh.com

5.1.1 Calculate the impulse on the bead. (3)

5.1.2 Hence calculate the speed of the bead as if emerges from the tube. (3)

In practice, the force on the bead varies. The graph below shows how the force on the bead varies between 0 and 3 ms.



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5.1.3 Use the graph to show that the speed of the bead as it emerges will be half of that calculated in 5.1.2. (3)

5.1.4 The action of a rifle on a bullet is similar to the action of the above machine on a bead. The bullet is accelerated by expanding gases from the exploded fuel at the back of the bullet.

Use momentum principles and a suitable formula to explain why hunting rifles are made with long barrels. (3)

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5.2 The diagram below shows a car of mass m travelling at a velocity of 20 m·s^{-1} east on a straight level road and a truck of mass $2m$ travelling at 20 m·s^{-1} west on the same road. Ignore the effects of friction.

The vehicles collide head-on and stick together during the collision.

5.2.1 State the *principle of conservation of linear momentum* in words. (2)

5.2.2 Calculate the velocity of the truck-car system immediately after the collision. (5)

On impact the truck exerts an average force $+F$ on the car and the car experiences an acceleration of magnitude a

5.2.3 Determine, in terms of F, the force that the car exerts on the truck on impact. Name the law you used to form your answer. (2)

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5.2.4 Determine, in terms of *a*, the magnitude of the acceleration that the truck experiences on impact. Give a reason for the answer. (3)

5.2.5 Both drivers have the same mass and are wearing identical seat belts. Which driver is likely to be more severely injured by the seatbelt on impact? Explain the answer by referring to acceleration. (3)

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Please turn over…

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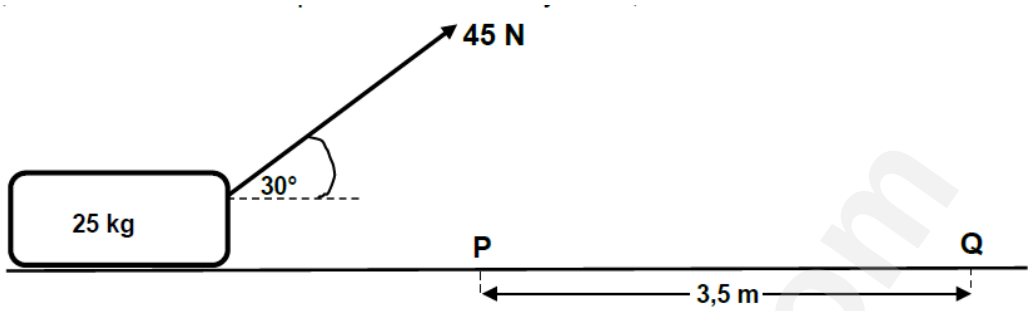
5.3 A worker applies a constant force of 45 N on a crate of mass 25kg, at an angle of 30º to the horizontal. When the crate reaches point P, its velocity is 12 m.s^{-1}, and 3,5 m further, at point Q, it has a velocity of 10,8 m.s^{-1}.



5.3.1 State the Work-Energy theorem in words. (2)

5.3.2 Use the Work-Energy theorem to calculate the magnitude of the frictional force between the crate and the floor between points P and Q. (6)

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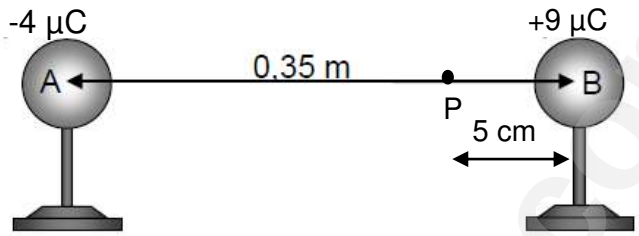
QUESTION 6

6.1 The diagram below shows two identical metal spheres, A and B, on insulated stands. The distance between the centres of the two spheres is 0,35 m.

A has a charge of **-4 µC** and the charge on B is **+9 µC**.



6.1.1 Calculate the magnitude and direction of the net field due to charges A and B at point P. Point P is 5 cm left of sphere B. (5)

6.1.2 Hence calculate the net electrostatic force on a -10 C point charge when it is placed at point P. (3)

6.1.3 Calculate the number of excess electrons on sphere A. (2)

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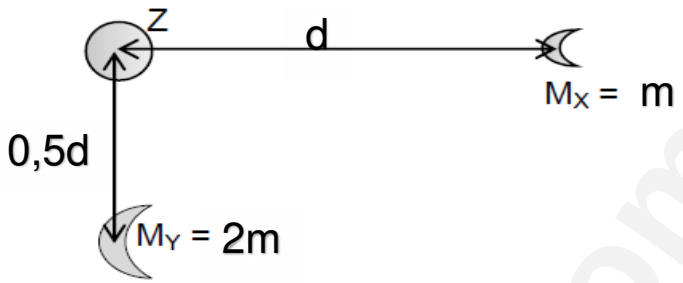
6.2 The diagram below shows a planet Z and its two moons X and Y. At one moment in time, lines drawn between planet Z and the two moons form a right angle as shown in the diagram below.



The distance between centre of planet Z and the centre of moon X is **d**. The distance between centre of planet Z and the centre of moon Y is **0,5d**. The mass of X is **m**. The mass of Y is **2m**.

6.2.1 If the gravitational force between **moon X** and **planet Z** is **$1,5 \times 10^{16}$ N.** Determine the magnitude of the gravitational force that **moon Y** exerts on **planet Z**. Show your working. (4)

6.2.2 **On the diagram above**, draw a neat arrow to represent the net gravitational force of the two moons on planet Z. Show any construction lines you use. (2)

6.2.3 Calculate the <u>magnitude</u> of the net gravitational force of the two moons on planet Z. (3)

6.2.4 Suggest a reason why planet Z does not accelerate in the direction of the net force calculated in 6.2.3. (2)

[21]

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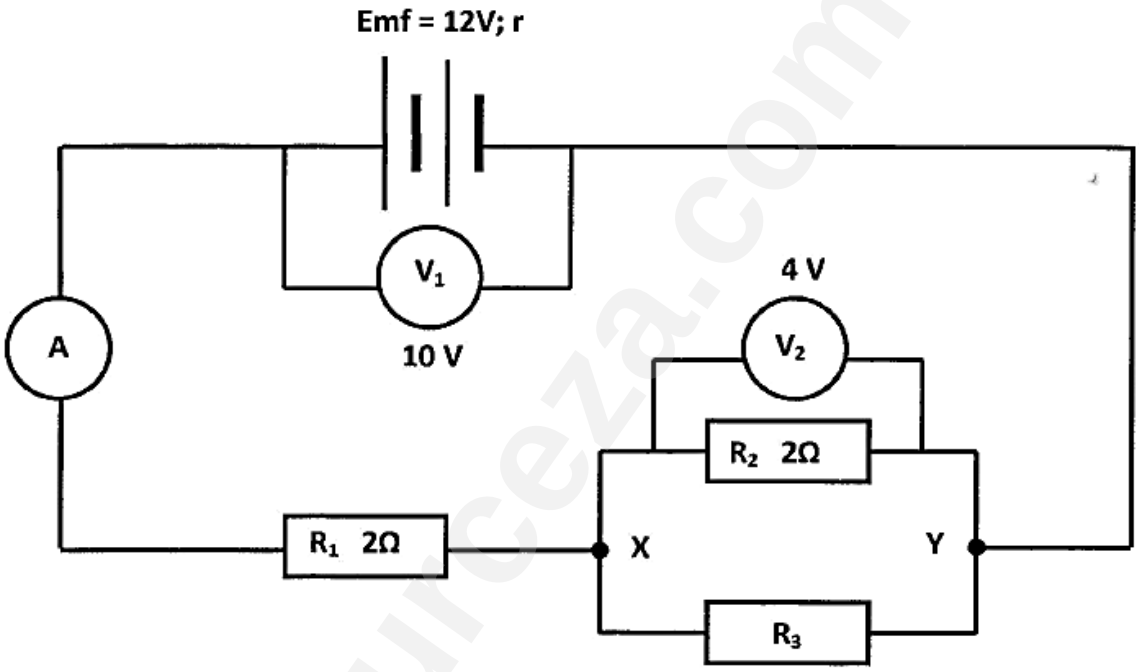
QUESTION 7

7.1 In the circuit represented below, the battery has an unknown internal resistance and an emf of 12 V. When current flows through the circuit, the voltmeter across the battery reads 10 V and a voltmeter across R_2 reads 4 V.



7.1.1 Define *current*. (1)

7.1.2 Calculate the current through R_1. (3)

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7.1.3 Determine the internal resistance of the battery. (3)

7.1.4 Determine the resistance of R_3. (4)

7.1.5 Resistor R_3 is removed from the circuit and **replaced** with a wire of negligible resistance. State what will happen to each of the following. Write only INCREASE, DECREASE or REMAIN THE SAME.

(i) The total current in the circuit. _____ (1)

(ii) The resistance between X and Y. _____ (1)

(iii) The reading on V_1. _____ (1)

7.1.6 Explain your answer to 7.1.5 (iii) with reference to a suitable formula. (3)

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7.2 Mulanga bought a new electric blanket at the beginning of winter. It is rated **240V; 120W.**

7.2.1 Why does the power rating list power and voltage together? (1)

7.2.2 Calculate the resistance of the electric blanket. (2)

7.2.3 Mulanga connects her electric blanket to a 240 V source. She used her electric blanket for 6 hours daily for a total of 90 days this winter.

Calculate the cost of the electrical power consumed by Mulanga's blanket if electricity costs R1,83 per kWh.
(Assume there is no loadshedding in this time period.) (3)

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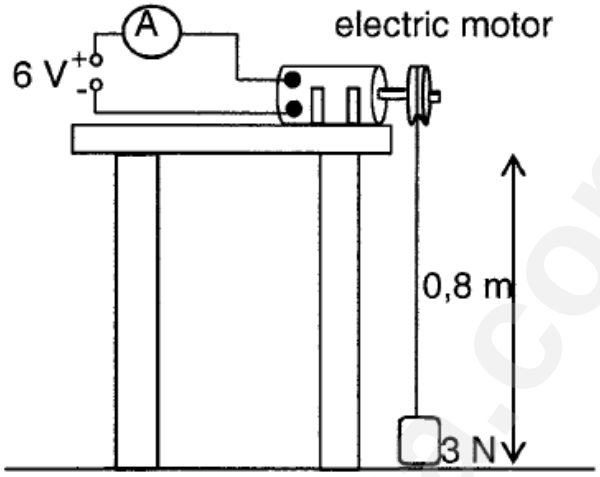
7.3 The electric motor in the diagram below is connected to a power supply of emf 6 V, and negligible internal resistance. The motor lifts an object of weight 3 N through a height of 0,8 m in a time of 2 s.



7.3.1 State the energy conversion which takes place in a motor. (1)

7.3.2 Determine the reading on the ammeter if the motor is 80% efficient. (5)

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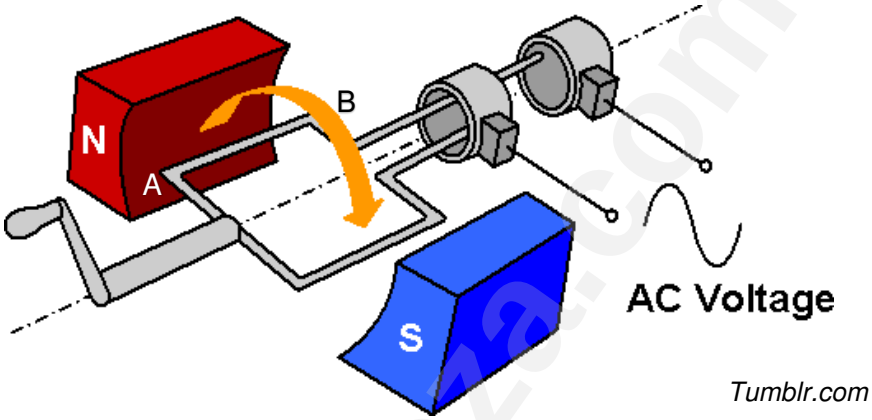
QUESTION 8

8.1 In a simple generator a coil is rotated clockwise at a constant speed in a uniform magnetic field. The diagram below shows the generator at the instant the coil lies parallel to the magnetic field.



8.1.1 Name the principle on which the generator operates. (1)

_____

8.1.2 State Faraday's Law of magnetic induction in words. (2)

The loop is rotated through 90º from the horizontal to the vertical position in the direction shown on the diagram.

8.1.3 Does the flux through the coil increase or decrease? (1)

_____

8.1.4 Does the induced emf in the coil increase or decrease? (1)

_____

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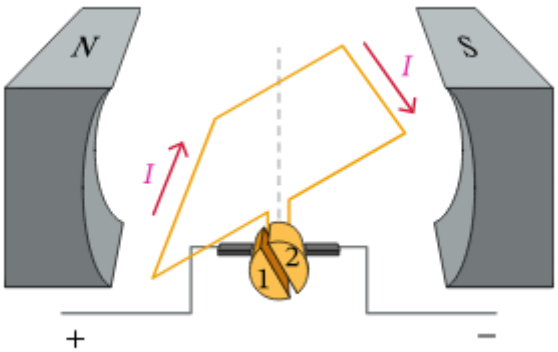
8.1.5 Explain your answer to 8.1.3 with reference to a suitable formula. (3)

8.1.6 State the direction of the induced current in the coil. Write only A to B, or B to A. (1)

_____

8.1.7 On the axes below, draw a sketch graph of the emf induced in the coil in one full rotation, starting from the position shown in the diagram above. (2)

8.2 The diagram below is of a DC motor which is rotating.



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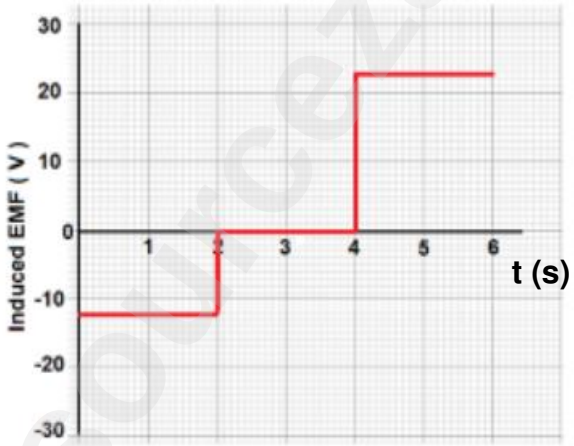
8.2.1 Give the name AND function of the component marked with numbers 1 and 2. (3)

8.2.2 In which direction is the coil rotating. Write only CLOCKWISE or ANTICLOCKWISE. (1)

8.3 The graph below shows the EMF induced in a closed metal loop due to a changing flux through the loop.



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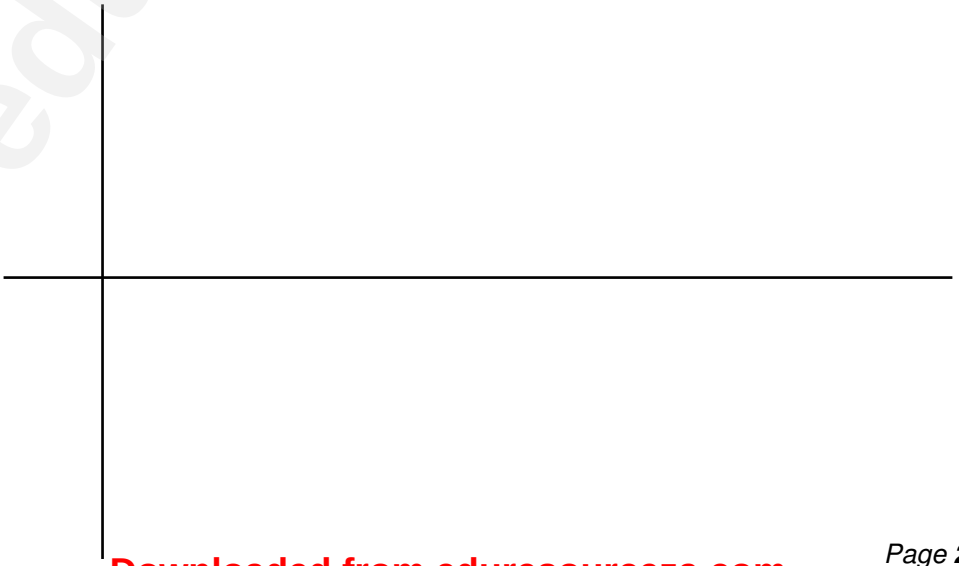
On the axes below, draw the corresponding graph representing the flux through the coil vs time. NO values are required on the y – axis. (5)



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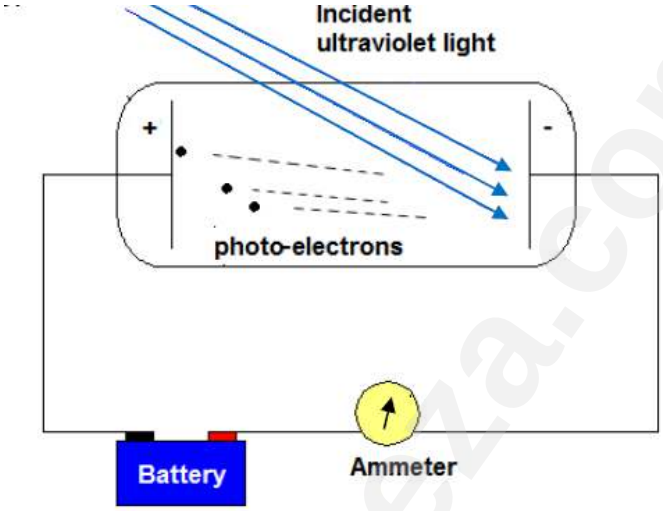
QUESTION 9

In the diagram below, ultraviolet light with energy 5,6 x 10^{-19}J is incident on the cathode of the photocell and photoelectrons are emitted from the metal surface.



The threshold frequency of the cathode of the photocell is 7,2 x 10^{14}Hz.

9.1 Which property of light is illustrated by the photo-electric effect? (1)

_____

9.2 Define the term *threshold frequency* in words. (2)

9.3 Calculate the kinetic energy of the photoelectrons. (3)

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9.4 The brightness of the ultraviolet light is now increased. How will this change affect each of the following. Write only INCREASES, DECREASES or REMAINS THE SAME.

9.4.1 The kinetic energy of the photoelectrons. (1)

_____

9.4.2 The reading on the ammeter. (1)

_____

9.5 The ultraviolet source is now replaced with a light source of wavelength 622 nm. Will this light source be able to eject photoelectrons from the photocell? Support your answer with a calculation. (4)

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Physics Data Sheet

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m\cdot s^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m\cdot s^{-1}$
Universal gravitational constant	G	$6{,}7 \times 10^{-11}\ N\cdot m^{2}\cdot kg^{-2}$
Coulomb's constant	k	$9{,}0 \times 10^{9}\ N\cdot m^{2}\cdot C^{-2}$
Magnitude of charge on electron	e	$1{,}6 \times 10^{-19}\ C$
Mass of an electron	m_e	$9{,}1 \times 10^{-31}\ kg$
Planck's constant	h	$6{,}6 \times 10^{-34}\ J\cdot s$
1 electron volt	eV	$1{,}6 \times 10^{-19}\ J$

TABLE 2 PHYSICS FORMULAE

MOTION

$v = u + at$ **or** $v_f = v_i + a\Delta t$	$s = \left(\frac{v+u}{2}\right)t$ **or** $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$v^2 = u^2 + 2as$ **or** $v_f^2 = v_i^2 + 2a\Delta x$	$s = ut + \frac{1}{2}at^2$ **or** $\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$

FORCE AND MOMENTUM

$F_{net} = ma$	$F_{net} = \frac{\Delta p}{\Delta t}$ **or** $F_{net}\Delta t = m\Delta v$	$J = \Delta p = mv - mu$ **or** $J = \Delta p = mv_f - mv_i$
$p = mv$	$F_g = mg$	$F_{fs}^{max} = \mu_s F_N$ $F_{fk} = \mu_k F_N$

WORK, ENERGY AND POWER

$W = Fs$ **or** $W = F\Delta x$ **or** $W = F\Delta x \cos\theta$		$P = \frac{W}{t}$	$P = Fv$
$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta E_K$	efficiency $= \frac{\text{power}_{out}}{\text{power}_{in}} \times 100$

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GRAVITATIONAL AND ELECTRIC FIELDS

$F = G\frac{m_1 m_2}{r^2}$	$g = \frac{F}{m}$	$g = G\frac{M}{r^2}$
$F = k\frac{q_1 q_2}{r^2}$	$E = \frac{F}{q}$	$E = \frac{kQ}{r^2}$

ELECTRIC CIRCUITS

$I = \frac{q}{t}$	$V = \frac{W}{q}$
$R = \frac{V}{I}$	$emf = I(R_{ext} + r)$ **or** $emf = V_{load} + V_{internal\ resistance}$
$R_S = R_1 + R_2 + ...$	$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$P = \frac{W}{t}$ **or** $W = Pt$	
$W = VIt$ **or** $W = I^2Rt$ **or** $W = \frac{V^2}{R}t$	
$P = VI$ **or** $P = I^2R$ **or** $P = \frac{V^2}{R}$	

ELECTRODYNAMICS

$\Phi = BA\cos\theta$	$\text{emf} = -\frac{N\Delta\Phi}{\Delta t}$	$F = IB\ell\sin\theta$
$V_p I_p = V_s I_s$	$\frac{N_s}{N_p} = \frac{V_s}{V_p}$	

PHOTONS AND ELECTRONS

$c = f\lambda$	$E = hf$ **or** $E = \frac{hc}{\lambda}$	
$E = W_0 + E_{K(max)}$	$W_0 = hf_0$	$E_{K(max)} = \frac{1}{2}mv_{max}^2$

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