



eduresourceza.com



**KING DAVID HIGH SCHOOL
VICTORY PARK**

**Preliminary Examination
August 2024
Physical Science Paper 1**

Time: 3hrs
Examiner: Ms S Nargaroo

Marks: 200
Moderator: Mrs I Govender

NAME: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 30 pages and a Data sheet of 2 pages. Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer ALL the questions on the question paper.
4. Use the data and formulae whenever necessary.
5. Show your working in all calculations.
6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
7. Answers must be expressed in decimal format, not left as proper fractions.
8. Where appropriate, express answers to TWO decimal places.
9. It is in your own interest to write legibly and to present your work neatly.
10. Two blank pages (pages 31 and 32) are included at the end of the paper. If you run out of space for a question use these pages. Clearly indicate the number of your answer should you use the extra space.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	TOTAL
20	29	21	19	24	22	20	28	17	200

Answer these questions on the multiple choice grid below. Make a clear cross (X) in the box corresponding to the letter that you consider to be correct. Every question has only one correct answer.

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

1.1 Which one of the following pairs consists of one vector quantity and one scalar quantity?

- A acceleration and velocity
- B power and distance
- C time and work
- D speed and impulse

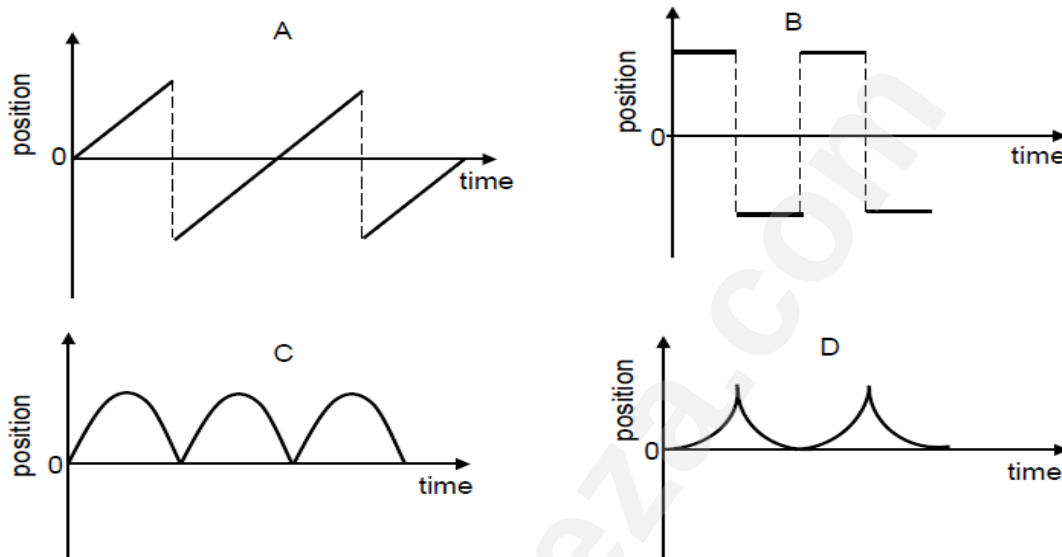
1.2 A car of mass m slides across a patch of ice at a speed v with its brakes locked. It hits a dry pavement and skids to stop in a distance d . The coefficient of kinetic friction between the tyres and the dry pavement is μ . If the car has a mass of $2m$, it would have skidded a distance of

- A $0,5 d$
- B $2 d$
- C d
- D $4 d$

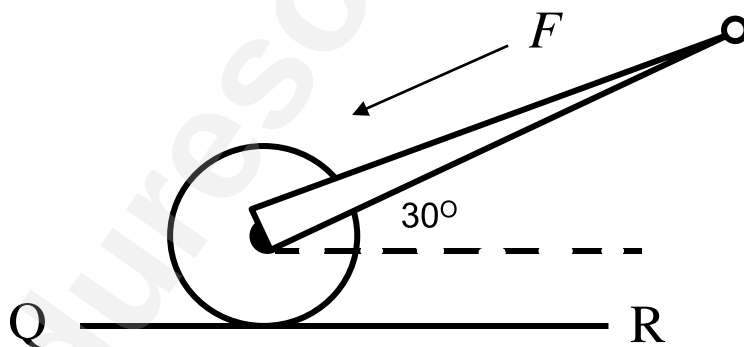
If the car's mass is doubled to $2m$, the distance it would skid to a stop does not change from d . The work done by friction (which equals the change in kinetic energy) is independent of mass since mass cancels out of the equation (Work done by friction = friction force $\times$ distance = $(\mu k mg) \times d$).

- 1.3 A ball is released from a height above the floor. The ball falls vertically and bounces off the floor a number of times. Ignore the effects of friction and assume that the collision of the ball with the floor is elastic. Take the point of release of the ball as the reference point and downward direction as positive.

Which ONE of the following is a CORRECT representation of the position-time graph for the motion of the ball?



- 1.4 A roller, of mass m , is used to roll(push) a cricket pitch. It is at rest on a rough, horizontal surface. A force of constant magnitude F is then applied on the roller at an angle of 30° to the horizontal as shown in the sketch.



If the roller has a uniform horizontal acceleration of magnitude a , the **frictional force** acting on the roller is

- A $F \cos 30^\circ - ma$, in the direction of **R**.
- B $F \sin 30^\circ - ma$, in the direction of **R**.
- C $F \cos 30^\circ - ma$, in the direction of **Q**.
- D $F \sin 30^\circ - ma$, in the direction of **Q**.

1.5 An object is suspended from a spring balance in a lift. The balance reading is 100 N when the lift is at rest. If the balance reading is 110 N, the lift is moving....

- A downwards at constant speed.
- B downwards and decreasing speed.
- C upwards at constant speed.
- D downwards and increasing speed.

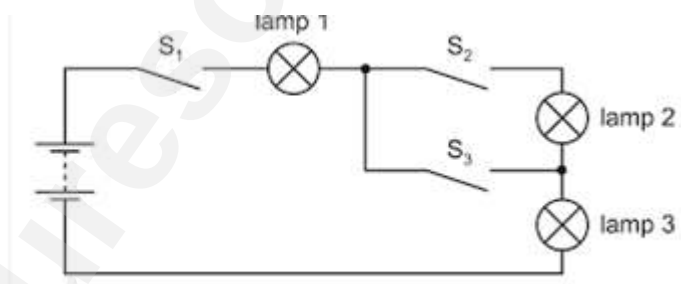
1.6 The unit for energy will be ...

- A $\text{kg.m}^2.\text{s}^{-2}$
- B kg.m.s^{-2}
- C kg.m.s^{-3}
- D $\text{kg.m}^2.\text{s}^{-3}$

1.7 When two identical metal spheres X and Y are brought into contact and then separated again, it is found that the charge on each sphere is -5nC . Which row in the table supplies the possible charges, in nC, which could have been on the spheres before they made contact?

	Sphere X	Sphere Y
A	+25	-15
B	-7	-3
C	+5	Neutral
D	-7	+2

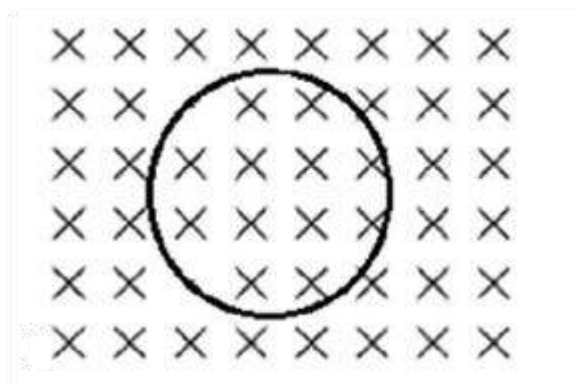
1.8 The diagram shows a circuit containing three lamps and three switches as shown below.



Lamps 1 and 3 are lit, but not lamp 2. Which switch/switches are closed?

- A S_1
- B S_1 and S_2
- C S_1 and S_3
- D S_2 and S_3

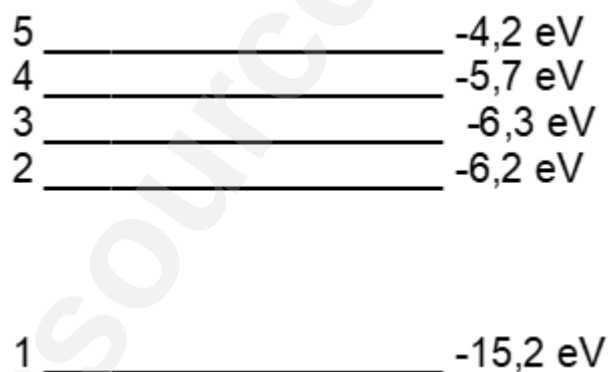
- 1.9 A conducting loop of wire is placed in an increasing magnetic field which is directed into the page as shown below:



What is the direction of the induced current in the loop?

- A clockwise
- B anti-clockwise
- C into the page
- D out of the page

- 1.10 Consider the following simulated energy level diagram:



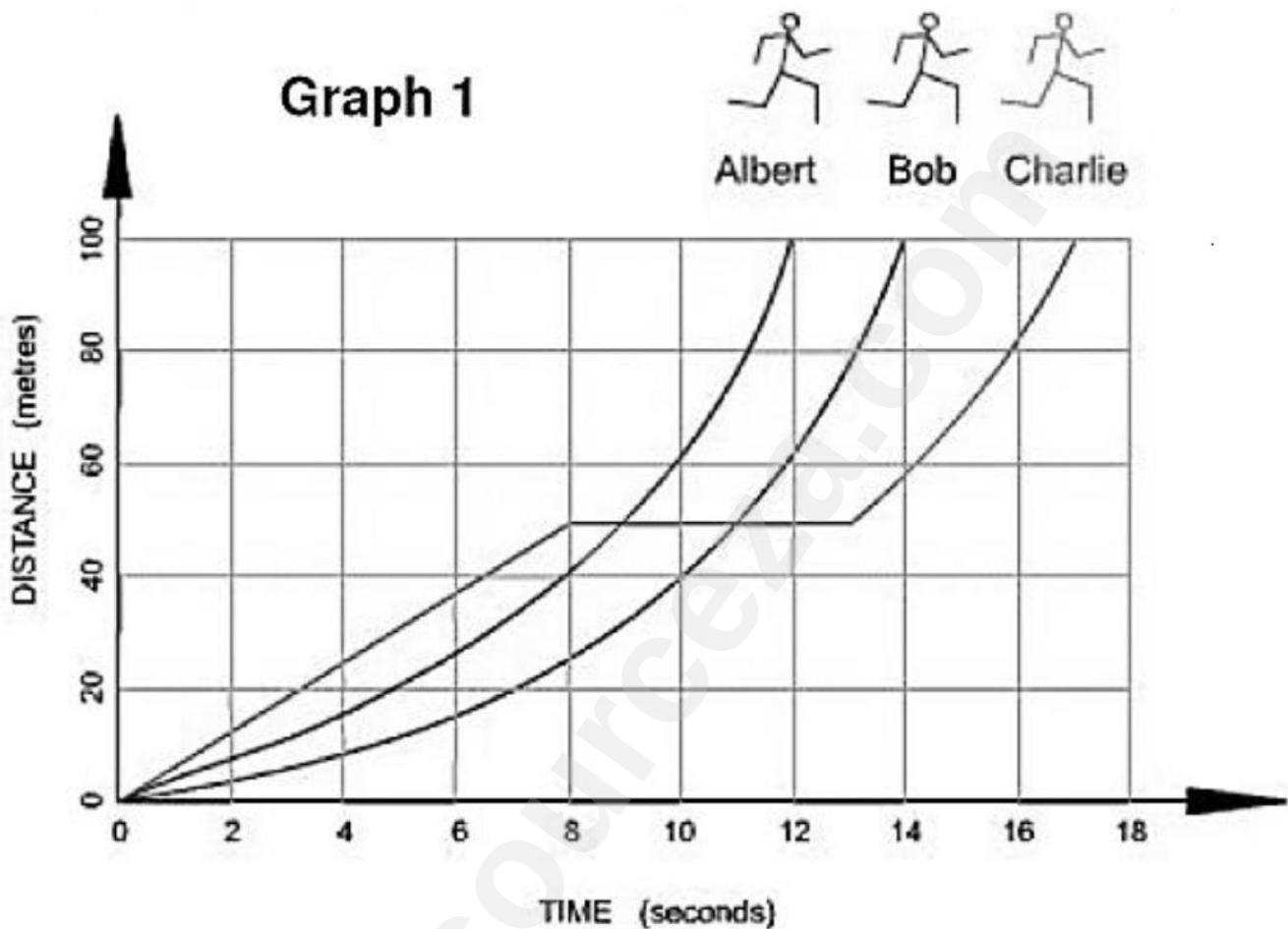
Which of the following energy level transitions will result in the emission of a photon with the highest frequency?

- A 1 to 5
- B 5 to 2
- C 1 to 2
- D 2 to 1

(20 marks)

QUESTION 2

The graph below shows the distance-time graph for how three runners ran a 100 m race.



2.1.1 Define distance. (2)

Length of path travelled. ✓✓

2.1.2 Briefly explain your answers to the following questions:

(a) Which runner won the race? (2)

Albert. He took the shortest time(12 s) to run 100 m. ✓✓

(b) Which runner stopped for a rest, and how long was his break? (2)

Charlie. He took a 5 s break(between 8 to 13 s)/no change in his distance ✓✓

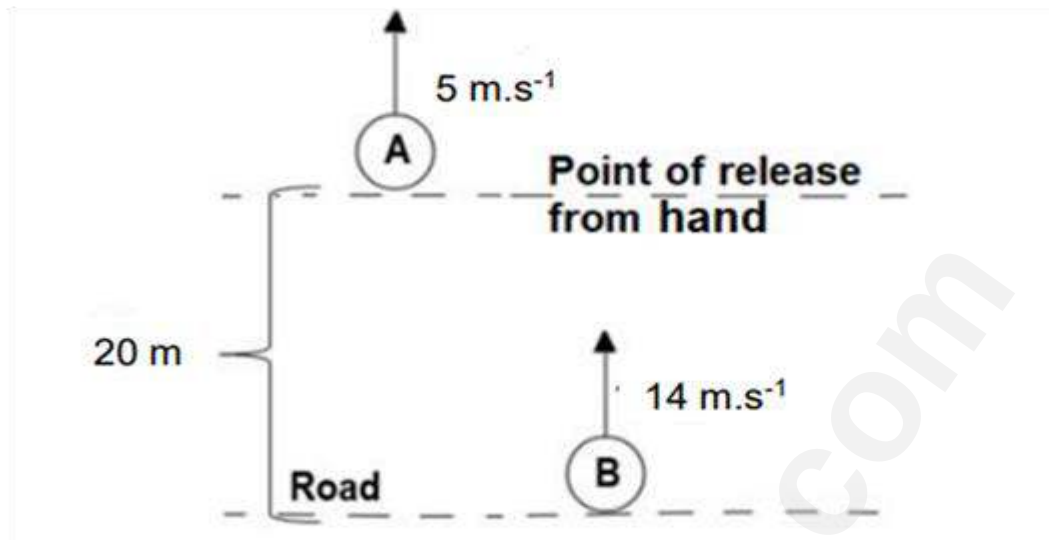
(c) How long did Bob take to complete the race? (1)

14 s ✓

2.1.3 Calculate Albert's average speed. (3)

Average Speed = $x/t = 100/12$ ✓✓ = 8,33 m.s⁻¹ ✓

- 2.2 Shiv throws a tennis ball A upwards at 5 m.s^{-1} from a bridge. At the same instant Shay projects tennis ball B vertically upwards from the surface of the road at a speed of 14 m.s^{-1} .



- 2.2.1 Calculate the time taken for ball A to reach its maximum height. (3)

$$v_f = v_i + at$$

$$0 = 5 + (-9,8)t \checkmark \checkmark$$

$$t = 0,51 \text{ s} \checkmark \checkmark$$

- 2.2.2 Calculate the magnitude of the velocity of ball B the moment that ball A is at its maximum height. (3)

$$v_f = v_i + at$$

$$= 14 + (-9,8)(0,5) \checkmark \checkmark$$

$$= -9 \text{ m.s}^{-1} (= 9 \text{ m.s}^{-1} \text{ down}) \checkmark \checkmark$$

- 2.2.3 Calculate how far apart ball A and ball B will be after 1,2 s. (5)

$$\text{A: } x = v_i + \frac{1}{2} at^2 = 5(1,2) + \frac{1}{2} (-9,8)(1,2)^2 = -1,06 \text{ m}$$

$$1,06 \text{ m below the bridge} \checkmark \checkmark$$

$$\text{B: } x = v_i + \frac{1}{2} at^2 = 14(1,2) + \frac{1}{2} (-9,8)(1,2)^2 = 9,74 \text{ m (upwards from the ground)} \checkmark \checkmark$$

$$\text{Distance apart: } 20 - 1,06 - 9,74 = 9,2 \text{ m} \checkmark$$

OR

$$\text{A: } x = v_i + \frac{1}{2} at^2 = 5(1,2) + \frac{1}{2} (-9,8)(1,2)^2 = -1,06 \text{ m}$$

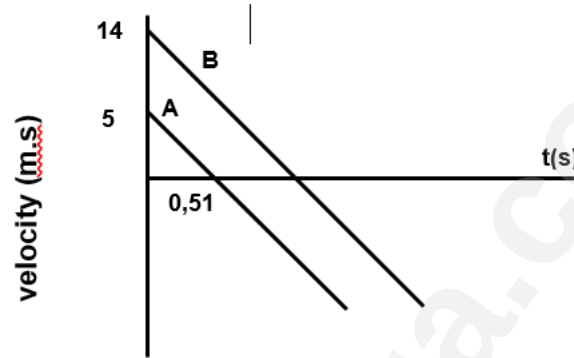
$$\text{therefore } 18,964 \text{ m above the road}$$

$$\text{B: } x = v_i + \frac{1}{2} at^2 = 14(1,2) + \frac{1}{2} (-9,8)(1,2)^2 = 9,74 \text{ m (upwards from the ground)} \square \square$$

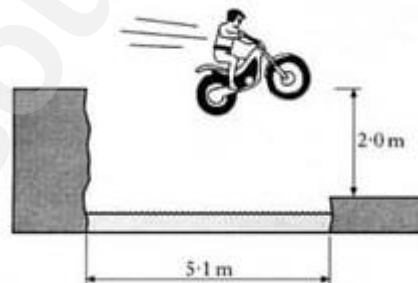
$$\text{Ball A is } 18,964 - 9,74 = 9,2 \text{ m above Ball B}$$

- 2.2.4 Sketch the velocity-time graph for the complete motions of the two balls on the same set of axes. Label the respective graphs for ball A and ball B clearly. Show the following on the graphs:
- Initial velocity of ball A
 - Time taken for ball A to reach its maximum height.
 - Initial velocity of ball B.

(4)



- 2.3 A stunt motorcyclist attempts to jump a river which is 5.1m wide. The bank from which he will take-off is 2m higher than the bank on which he will land, as shown below.



Calculate the minimum constant horizontal speed he must achieve before take-off to avoid landing in the river. (hint: first calculate the time taken for the vertical drop of 2 m).

(4)

$$x = v_i t + \frac{1}{2} a t^2$$

$$2 = 0 + \frac{1}{2} 9,8 t^2$$

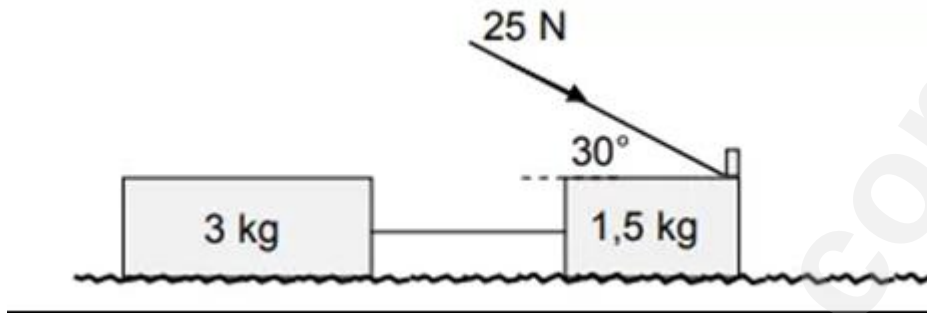
$$t = 0,64 \text{ s} \checkmark \checkmark$$

$$v = x/t = 5,1/0,64 = 7.98 \text{ m.s}^{-1} \checkmark \checkmark$$

(29 marks)

QUESTION 3

- 3.1 A learner constructs a push toy by using two blocks with masses 1,5 kg and 3 kg respectively. The blocks are connected by a massless, frictionless, inextensible cord. The learner then applies a force of 25 N (at an angle as shown below) to the 1,5 kg block by means of a light, rigid rod, causing the toy to move across a flat, rough, horizontal surface.



The coefficient of kinetic friction between the surface and each block is 0,15.

- 3.1.1 State Newtons Second Law of Motion. (2)

When a net force, F_{net} is applied on an object of mass m , it accelerates in the direction of the net force. The acceleration is directly proportional to the net force ✓ and inversely proportional to the mass. ✓

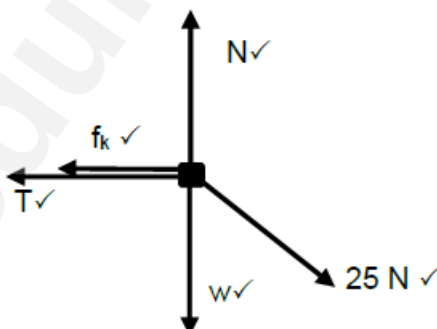
OR: The net force acting on an object is ✓ equal to the rate of change of momentum. ✓

- 3.1.2 Calculate the magnitude of the kinetic frictional force acting on the 3 kg block. (3)

$$F_k = \mu F_N \checkmark \\ = 0,15(3 \times 9,8) = 4,41 \text{ N} \checkmark \checkmark$$

- 3.1.3 Draw a fully labelled free body diagram showing all the forces acting on the 1,5 kg block. (4)

F_N bigger than F_G ✓✓✓✓



- 3.1.4 Calculate the magnitude of the:

- 3.1.4.1 kinetic frictional force acting on the 1,5 kg block. (3)

$$F_k = \mu F_N = (0,15 \cdot 25 \sin 30) \checkmark + (1,5 \times 9,8) \checkmark = 4,08 \text{ N} \checkmark \\ (F_N = F_g + F_y)$$

3.1.4.2

tension in the cord connecting the two blocks.

(5)

$$1,5 \text{ kg: } F_{\text{net}} = ma$$

$$25 \cos 30 - F_T - 4,08 = 1,5a$$

$$17,57 - F_T = 1,5a \quad (F_T = 17,57 - 1,5a)$$

$$3 \text{ kg: } F_{\text{net}} = ma$$

$$F_T - 4,41 = 3a \quad (F_T = 3a + 4,41) \quad \checkmark$$

$$3a + 4,41 = 17,57 - 1,5a$$

$$4,5a = 13,34$$

$$a = 2,96 \text{ m.s}^{-2} \checkmark$$

$$T = 3(2,96) + 4,41 = 13,30 \text{ N} \checkmark$$

- 3.2 Two students are experimenting with an object of mass m sliding down a frictionless inclined plane from rest. They use a data logger to record the velocity v of the mass m when it travels a distance S_1 to the end of the plane when it is inclined to an angle as shown in diagram A.

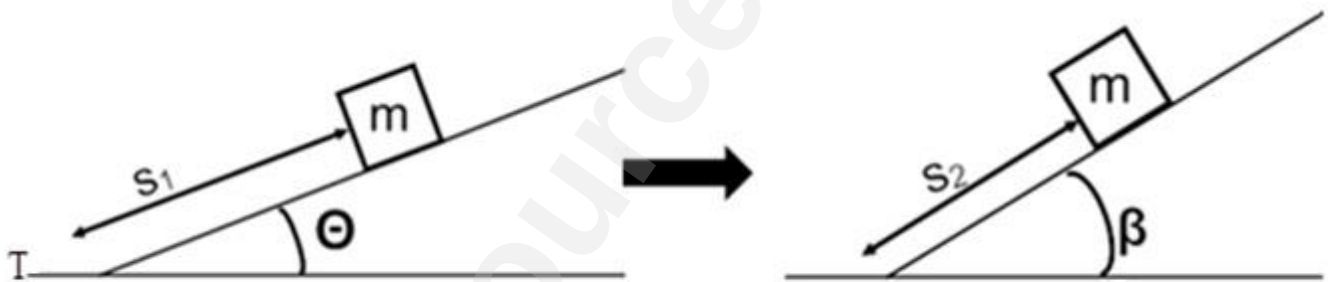


Diagram A

Diagram B

They wonder: "If we change the angle of the plane as shown in diagram A to that shown in diagram B, at what distance S_2 up the plane we will need to put the block so that it reaches the bottom of the plane with the same velocity v as before".

Derive a relationship for the distance S_2 in terms of S_1 and the angles shown in the two diagrams above. (Hint: use conservation of mechanical energy principles)

(4)

They have the same velocity at the bottom of the slope, then also the same E_K , therefore they must be at the same height (have the same E_P). $\checkmark$

$$\sin \theta = h/s_1 \quad \text{and} \quad \sin \beta = h/s_2 \checkmark$$

$$h = s_1 \sin \theta \quad h = s_2 \sin \beta \checkmark$$

$$s_1 \sin \theta = s_2 \sin \beta$$

$$s_2 = s_1 \sin \theta / \sin \beta \checkmark$$

(21 marks)

QUESTION 4

- 4.1 After an ice hockey game some people are skating on the rink. A girl (mass 50 kg) travelling at a constant speed of $7,2 \text{ m.s}^{-1}$ collides with a stationary boy of mass 60 kg. They move off together after the collision.

- 4.1.1 State the law of Conservation of linear Momentum. (2)

The total linear momentum of an isolated system remains constant (is conserved). ✓✓

- 4.1.2 Calculate their maximum speed immediately after the collision. (4)

$p_{\text{before}} = p_{\text{after}}$ ✓
 $(50 \times 7,2) + 0 = (50 + 60)v_f$ ✓✓
 $v_f = 3,27 \text{ m.s}^{-1}$ ✓

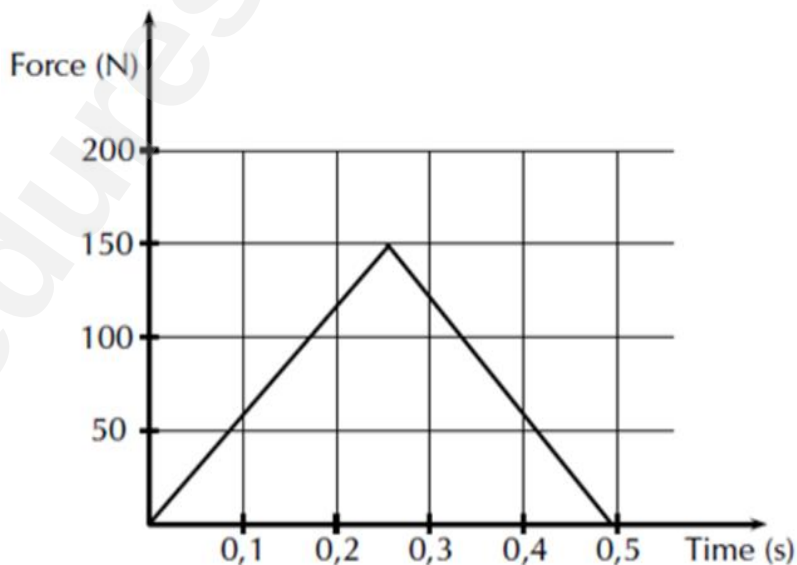
- 4.1.3 How would you expect the kinetic energy of the girl and boy moving together to compare with the kinetic energy of the girl just before she collided with the boy? Explain briefly. (3)

$E_k(\text{girl})$ is greater than the $E_k(\text{boy} + \text{girl})$ ✓
 E_k is directly proportional to mass and also velocity squared, ✓ so although of mass of the boy and girl system is greater than that of just the girl, the velocity is squared and thus the E_k of the girl is greater. ✓ (OR its an inelastic collision and some of the energy would be transferred to heat and sound hence the E_k of the girl and the boy would be less than that of the girl) ✓

- 4.1.4 Is the force with which the girl collides with the boy GREATER THAN, LESS THAN or EQUAL to the force of the boy on the girl. Explain your answer fully. (3)

Equal. ✓ **According to Newtons third law, the girl ✓ exerts a force on the boy and he simultaneously exerts a force of equal magnitude (but in the opposite direction) on the girl.** ✓

- 4.2 During a hockey game, a player strikes a stationary 150 g ball. The graph below shows how the force of the ball varies with time.



- 4.2.1 What does the area under the graph represent? (1)

Impulse ✓

- 4.2.2 Calculate the speed at which the hockey ball leaves the stick. (3)

$$J = p$$

$$\frac{1}{2} 0,5 \times 150 \checkmark = m(v_f - v_i) \checkmark$$

$$37,5 = 0,1 \cdot v_f$$

$$v_f = 250 \text{ m} \cdot \text{s}^{-1} \checkmark$$

- 4.2.3 The same player hits a practice ball of the same mass, but which is made from a softer material. The hit is such that the ball moves off with the same speed as before. How will the area, the height and the base of the triangle that forms the graph, compare with that of the original ball. (3)

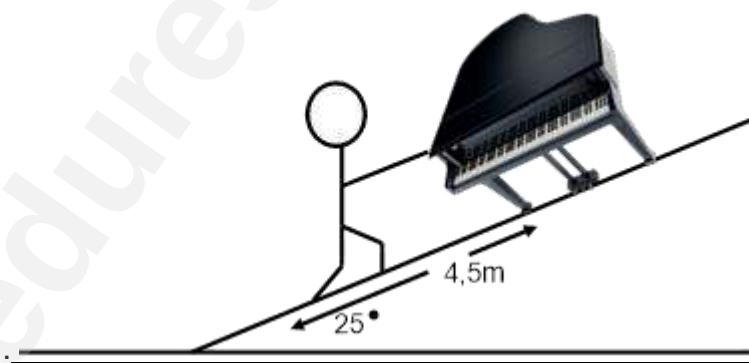
The net force is directly proportional to the rate of change of momentum...a softer material increases the time, hence base of triangle increases✓. Since the speed is the same, the net force increases, hence the height of the triangle increases,✓ thus area remains the same.✓

OR: **The change in momentum of the ball is constant and since the net force is directly proportional to the rate of change of momentum, then the net force is inversely proportional to the time. The softer material increases the contact time, hence a bigger base of the triangle, the net force decreases, hence a bigger height and the area which represents impulse which is equivalent to change in momentum remains constant.**

(19 marks)

QUESTION 5

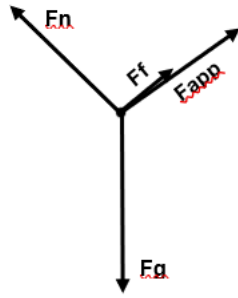
- 5.1 A 300 kg piano slides 4,5 m down (as shown in the diagram below) and the piano is kept from accelerating by a man pushing back on it parallel to the incline. The coefficient of static friction is 0,4



- 5.1.1 Define frictional force. (2)

Force that opposes the motion of an object. ✓✓

5.1.2 Draw a free body diagram showing all the forces acting on the piano. (3)



Calculate the:

5.1.3 force exerted by the man. (5)

$$F_{g//} - F_{app} - F_f = 0 \checkmark$$

$$F_{app} = 300 \cdot 9,8 \cdot \sin 25 \checkmark - 0,4 \cdot 300 \cdot 9,8 \cdot \cos 25 \checkmark = 1242,49 - 1065,82 \checkmark = 176,67 \text{ N} \checkmark$$

5.1.4 potential energy of the piano at the top of the incline. (3)

$$E_p = mgh = 300 \times 9,8 \checkmark \times 4 \sin 25 \checkmark = 5591,24 \text{ J} \checkmark$$

5.1.5 work done by the frictional force. (3)

$$W_F = F_f \cdot x \checkmark = 1065,82 \times 4,5 \checkmark = 4796,19 \text{ J} \checkmark$$

(Coe from 5.1.3)

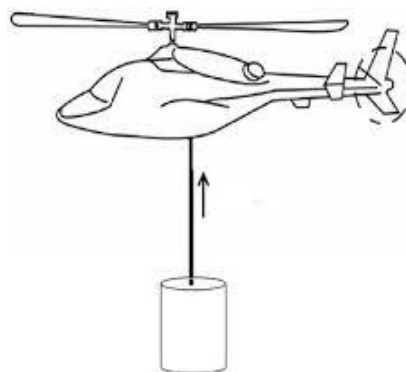
5.1.6 speed at which the piano reaches the ground if it was released from the top of the incline. (3)

$$E_K = \frac{1}{2} mv^2$$

$$5591,24 - 4796,19 \checkmark = \frac{1}{2} 300 v^2 \checkmark$$

$$v = 2,3 \text{ m} \cdot \text{s}^{-1} \checkmark$$

- 5.2 During a fire extinguishing operation, a helicopter remains stationary(hovers) above a dam while filling a bucket with water. The bucket, with a mass of 80 kg. is filled with 1600 kg of water, is lifted vertically upwards through a height of 20 m by a cable, at a constant speed of $2 \text{ m} \cdot \text{s}^{-1}$. The tension in the cable is 17 000 N. Assume that there is no sideways motion during the lift; Air friction is not ignored.



Use the work-energy theorem to calculate the work done by air friction on the bucket of water after moving through the height of 20 m. (5)

$$W_T = F \cdot x = 17000 \times 20 = 340\,000 \text{ N} \checkmark$$

$$E_P = mgh = 1600 \times 9,8 \times 20 = 329\,280 \text{ J} \checkmark$$

$$W_{\text{net}} = E_{KF} - E_{KI}$$

$$340\,000 - W_F = 329\,280 \checkmark$$

$$W_F = 10\,720 \text{ J} \checkmark$$

OR

$$W_{\text{net}} = E_K \checkmark$$

$$F_{\text{net}} \cdot x = 0$$

$$T_{20} + F_{F20} + F_{g20} = 0 \checkmark$$

$$F_{F20} = -17000 + 16454 = -536 \text{ N} \checkmark$$

$$W_F = -536 \times 20 = -10720 \text{ J} \checkmark \checkmark$$

(24 marks)

QUESTION 6

6.1.1 Define gravitational field.

(2)

Force acting per unit mass. $\checkmark \checkmark$

6.1.2 The gravitational field on the surface of the Earth is $9,81 \text{ N.kg}^{-1}$. A satellite in a geostationary orbit around the Earth experiences a gravitational field of $0,225 \text{ N.kg}^{-1}$.

Determine the orbital radius r of the satellite from the centre of the Earth in terms of radius of the Earth, r_e

(4)

$$g = GM/r^2$$

$$\text{earth: } 9,81 = GM/r^2 \quad (9,81r^2 = GM) \quad \checkmark$$

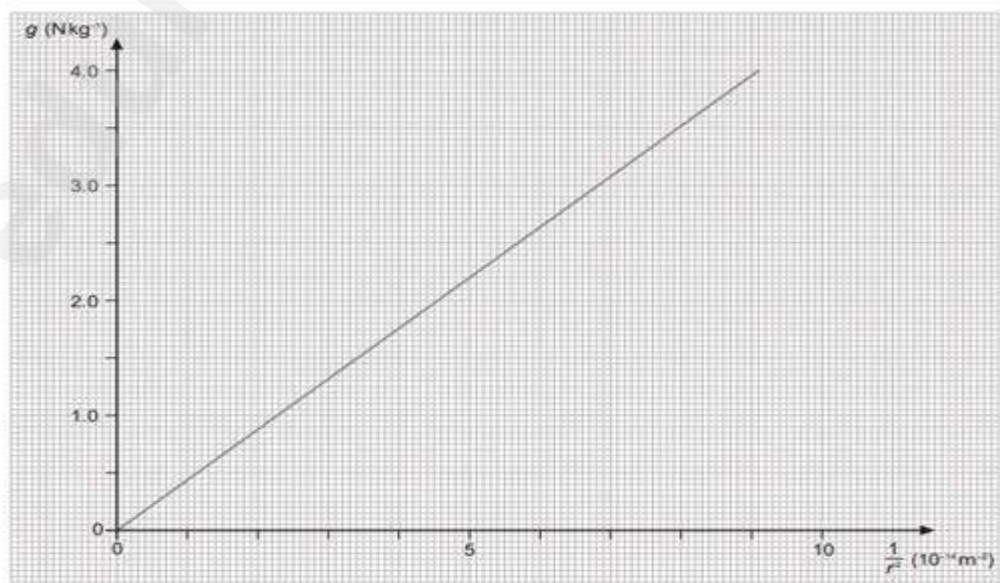
$$\text{satellite: } 0,225 = GM/r^2 \quad (0,225r^2 = GM) \quad \checkmark$$

$$9,81r_{\text{earth}}^2 = 0,225r_{\text{satellite}}^2$$

$$3,13r_e = 0,46r_s$$

$$6,67r_e = r_s \checkmark \checkmark$$

6.2 The variation of the gravitational field strength g of a planet with the distance r from the centre is shown below:

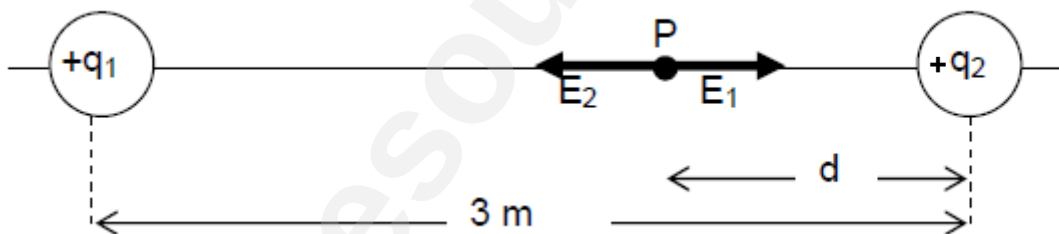


- 6.2.1 Explain why the gradient of the graph is equal to GM , where M is the mass of the planet. (hint: use the equation $y = mx + c$) (1)
- $g = GM/r^2$ and $y = mx + c$ and $m = GM$ ✓

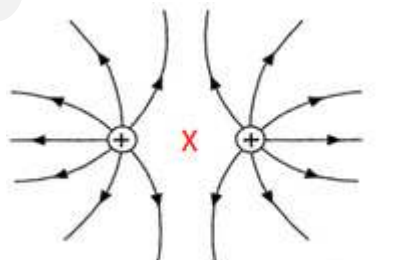
- 6.2.2 Use the information given in the above question and the graph to determine the mass of the planet. (2)
- $m = 3,5 / 8 \times 10^{-14} = 4,38 \times 10^{13} \text{ Nm}^2 \text{ kg}^{-1}$
- $GM = 4,38 \times 10^{13}$
- $M = \frac{4,38 \times 10^{13}}{6,7 \times 10^{-11}} = 6,6 \times 10^{23} \text{ kg}$ ✓

- 6.3 The distance between the electron and the proton ($m = 1,67 \times 10^{-27} \text{ kg}$) in a hydrogen atom is $5,3 \times 10^{-11} \text{ m}$. Calculate the ratio of the electrostatic force, F_E to the gravitational force, F_G , if the mass of the proton is $1,67 \times 10^{-27} \text{ kg}$. (5)
- $F_G = \frac{6,7 \times 10^{-11} \times 9,1 \times 10^{-31} \times 1,67 \times 10^{-27}}{(5,3 \times 10^{-9})^2} = 3,62 \times 10^{-49} \text{ N}$ ✓✓
- $F_E = \frac{9 \times 10^9 \times (1,6 \times 10^{-9})^2}{(5,3 \times 10^{-11})^2} = 8,2 \times 10^{-6} \text{ N}$ ✓✓
- $F_E : F_G = \frac{8,2 \times 10^{-6}}{3,62 \times 10^{-47}} = 2,26 \times 10^{39}$ ✓

- 6.4 Two positive point charges, $q_1 = +16 \times 10^{-6} \text{ C}$ and $q_2 = +4 \times 10^{-6} \text{ C}$, are separated by a distance 3 m.



- 6.4.1 Draw the electric field pattern between the charges q_1 and q_2 . (3)



- 6.4.2 Calculate the distance d between the charge q_2 and point P where the net electric field is zero. (5)
- $E = KQ/r^2$
- $E_1 + E_2 = 0$
- $\frac{k \cdot 16 \times 10^{-6}}{(3-d)^2} = \frac{k \cdot 4 \times 10^{-6}}{d^2}$ ✓✓

$$16 \times 10^{-6} \cdot d^2 = 4 \times 10^{-6} (3-d)^2$$

$$9 - 6d + d^2 - 4d^2 = 0 \checkmark$$

$$(3 + d)(1-d) = 0 \checkmark$$

$$d = 1 \text{ m} \checkmark$$

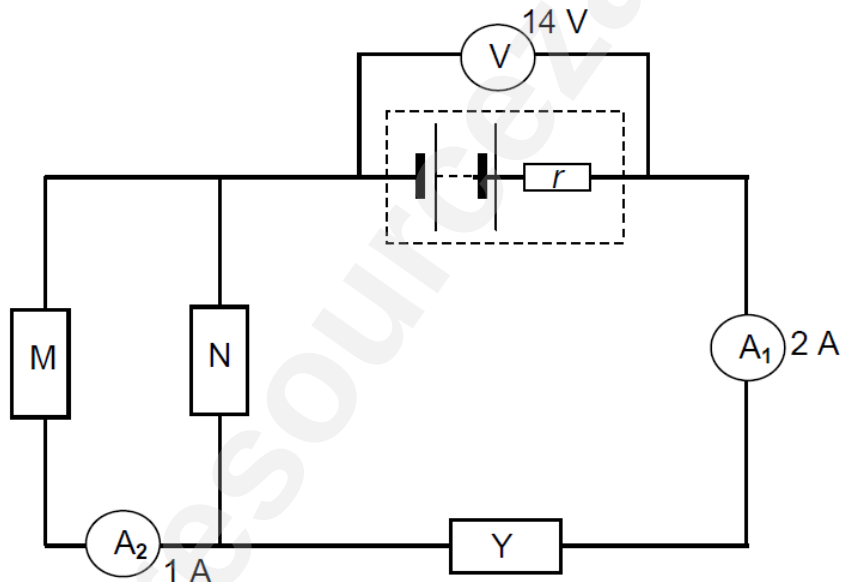
6.4.3 If the distance between q_1 and q_2 is doubled, what is the new force between q_1 and q_2 ? (1)

$$F/4 \checkmark$$

(22marks)

QUESTION 7

7.1 The circuit diagram below shows a battery, with an internal resistance r , connected to three resistors, M, N, and Y. The resistance of N is 2Ω and the reading on voltmeter V is 14 V . The reading on ammeter A_1 is 2 A and the reading on ammeter A_2 is 1 A . (The resistance of the ammeters and the connecting wires may be ignored)



7.1.1 What is resistance? (2)

A materials opposition to the flow of charge. $\checkmark \checkmark$

7.1.2 Briefly explain how the resistance of M compares with that of N? (2)

Equal $\checkmark$... **1 A flows through M and the same 1 A flows through N and since V across both M and N is the same, the resistance of M and N will be the same.** $\checkmark$

7.1.3 If the emf of the battery is 17 V , calculate the internal resistance of the battery. (3)

$$E = I(R + r)$$

$$17 = 14 + 2r \checkmark \checkmark$$

$$r = 1,5 \Omega \checkmark$$

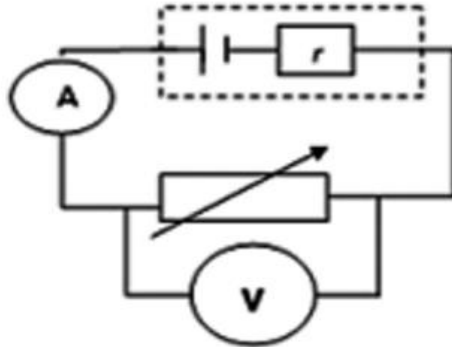
7.1.4 Calculate the potential difference across resistor N. (3)

$$V = IR = 1 \times 2 = 2 \text{ V}$$

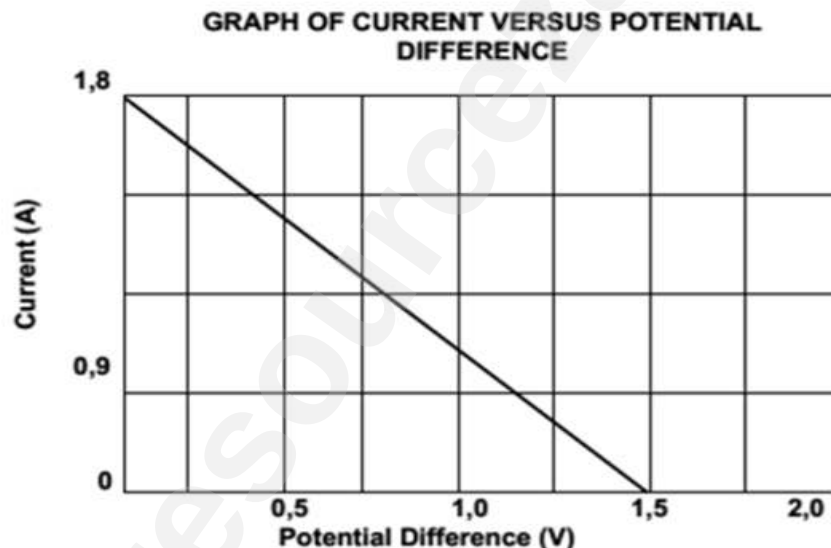
7.1.5 Calculate the resistance of Y. (3)

$$R = V/I = 12/2 = 6 \Omega$$

7.2 Learners conduct an experiment as shown in the diagram below:



The results obtained are shown in the graph below:



7.2.1 Use the graph to answer the questions below:

(a) What is the emf of the battery? (1)

$$1.5 \text{ V}$$

(b) Calculate the internal resistance of the battery (3)

$$m = 0 - 1.8/1.5 - 0 = -1.2$$

$$V/I = 1/1.2 = 0.83 \Omega$$

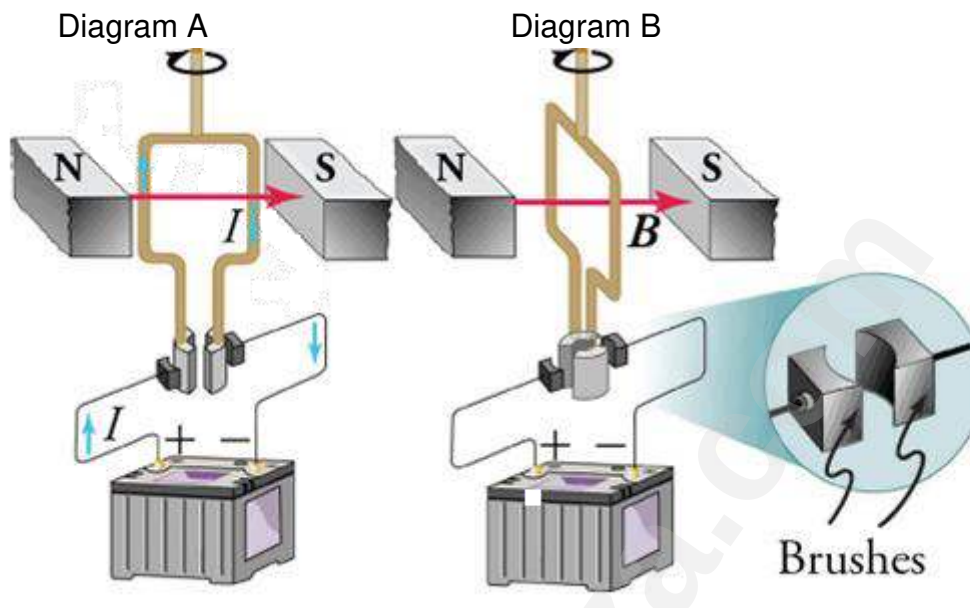
(c) The resistance of the rheostat is now increased:
How will this change the voltmeter reading? Write down INCREASE, DECREASE or REMAIN THE SAME and explain your answer. (3)

Increase ...when the resistance of the rheostat increases and the emf of the battery remains the same, the total current decreases, therefore $V = IR$ (across the rheostat) increases.

(20 marks)

QUESTION 8

8.1 Consider the diagrams below and answer the questions that follow



8.1.1 What is the energy conversion in an electric motor? (2)

Electrical to mechanical✓✓

8.1.2 How is the coil carried through the vertical position? (1)

Momentum/inertia✓

8.1.3 Label on diagram A the component that allows the coil to move continuously. (1)
✓

8.1.4 State the direction in which the coil moves. (2)

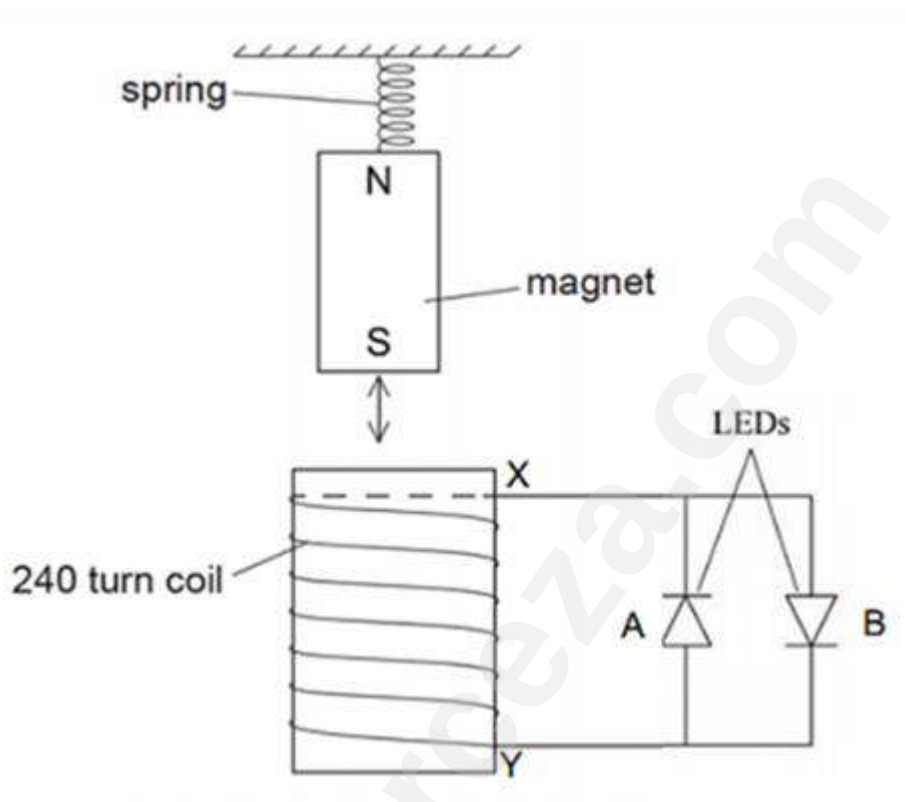
anticlockwise✓

8.1.5 How would the functioning of the motor be affected if there was no Carbon brushes present? (1)

The wires will get entangled as the carbon brushes are fixed and is the contact between the current in the battery to the current in the coil.

OR **Reduces wear on commutator/transfers electricity from outside motor**

- 8.2 The apparatus below can be used to demonstrate the principle of electromagnetic induction. When the magnet is released, it falls thus increasing the tension in the spring. As a result, the magnet will oscillate up and down, moving into and out of the coil. The coil is connected to two LEDs (light emitting diodes).



- 8.2.1 State Lenz's law. (2)
The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. ✓✓
- 8.2.2 What is the direction of the induced current in the coil when the S pole of the magnet moves into the coil. Does the current flow from X to Y or Y to X? (1)
Y to X✓
- 8.2.3 Briefly explain which LED A or B will light up when the S pole of the magnet moves into the coil? (2)
B✓ **...outside the coil, the current flows from X to Y and B will conduct since it is forward biased.** (coe from 8.2.2) ✓
- 8.2.4 What is observed when the LEDs when the magnet oscillates, moving into and out of the coil? (1)
LEDs A and B switch on and off. ✓

- 8.3 Consider the diagrams below which illustrate how electromagnetic induction is applied in the devices shown:

Diagram A:

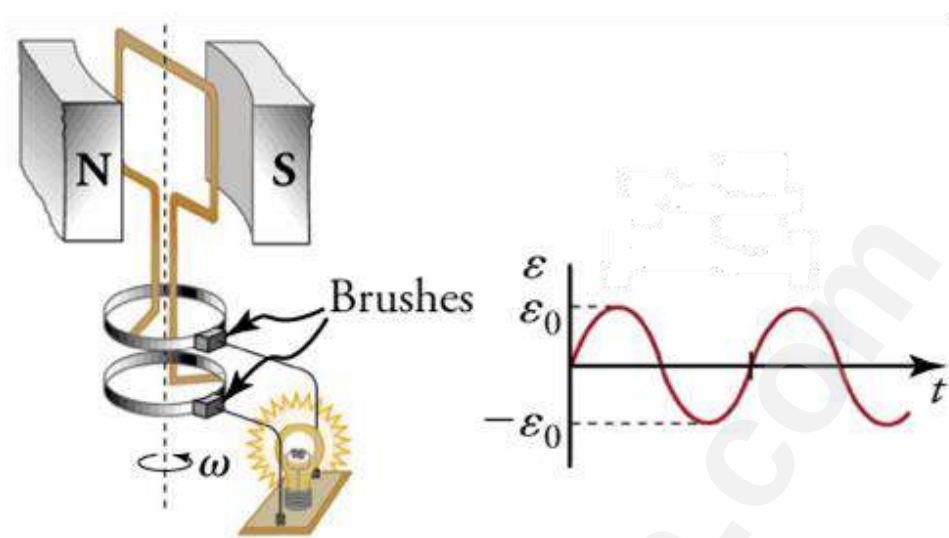
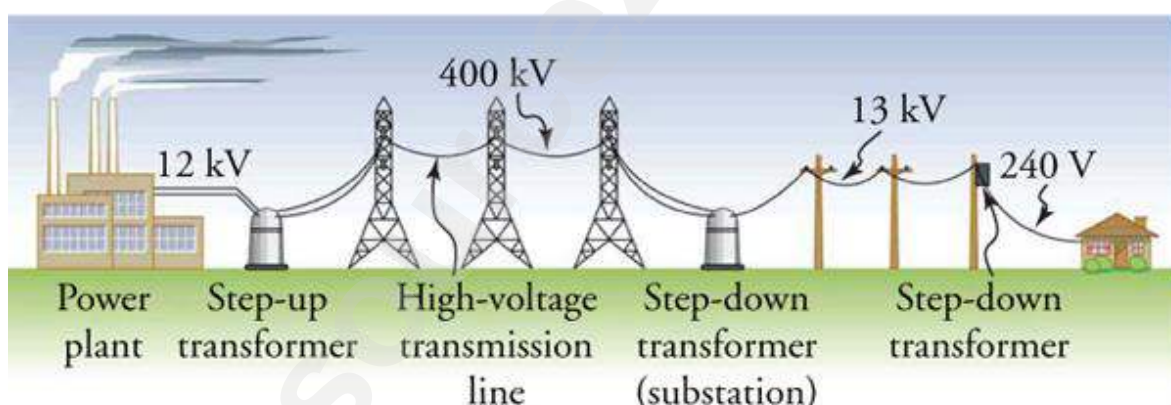


Diagram B:

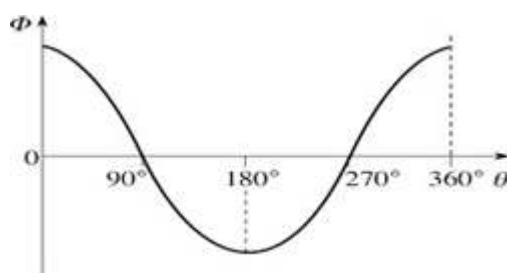


Consider diagram A:

- 8.3.1 What is the function of the slip rings? (2)

Ensures direction of the current in the external circuit is the same as the direction of the current in the coil. ✓✓

- 8.3.2 Draw the corresponding magnetic flux-time graph that represents how the induced emf varies per unit time as the coil rotates in the magnetic field. (3)



Consider Diagram B:

8.3.3 A transformer having the efficiency of 90% is working on 200 V and 3 KW power supply. The current in the secondary coil is 6 A. Calculate the:

(a) voltage that occurs in the secondary coil. (3)

$$P_{out}/P_{in} = V_S I_S / V_P I_P$$

$$90/100 = 6V_S/3000 \checkmark \checkmark$$

$$V_S = 450 \text{ V} \checkmark$$

(b) current in the primary coil. (3)

$$P = VI$$

$$2000 = 200I \checkmark \checkmark$$

$$I = 15 \text{ A} \checkmark$$

(c) Use a suitable equation/s to explain the need for a high voltage transmission line and a step down transformer at the sub-station in the distribution of power. (4)

High voltage transmission provides energy for electricity to be transported long distances and also steps down the current... $P = I^2 R$, hence if current(squared) is decreased, power loss is decreased even though resistance is also greater. $\checkmark \checkmark$

Step-down at substations steps down the voltage (for safety) and steps up the current to provide sufficient electrical energy. $\checkmark$

(28 marks)

QUESTION 9

Diagram A shows an experimental arrangement used to demonstrate aspects of the photoelectric effect. A photo electric cell is coupled in series with a voltage source and an ammeter. When photoelectrons from the photo electric cell are emitted (Diagram B), the ammeter registers a current.

Diagram A:

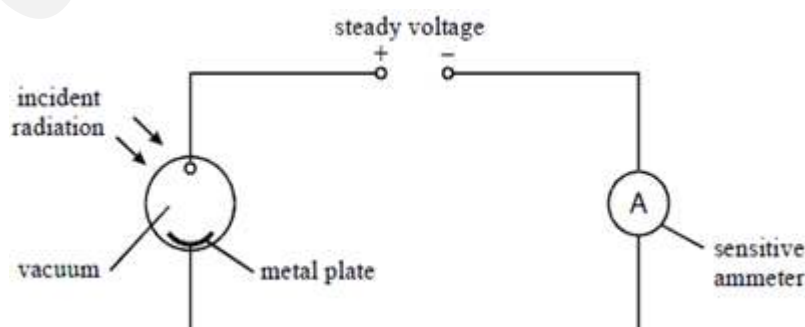
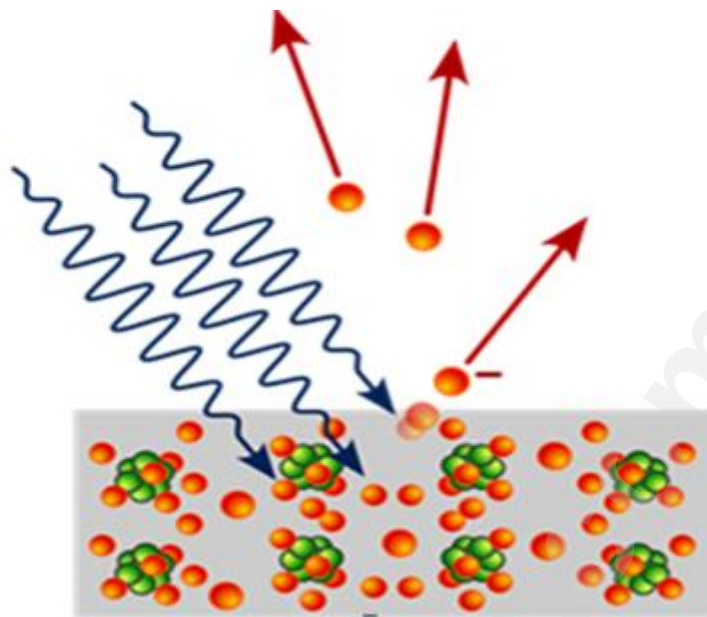
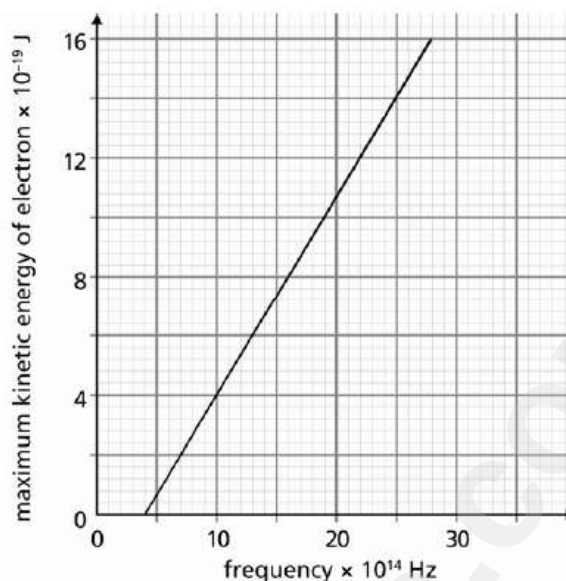


Diagram B:



- 9.1 The metal plate is illuminated with radiation of a particular frequency, but **does not emit photoelectrons**. If the intensity of the radiation is increased, state and explain what effect this increase will have on the observed current. (2)
No effect ✓ **...frequency of incident radiation must be above the threshold frequency.** ✓
- 9.2 The metal plate is illuminated with radiation such that **photoelectrons are emitted**. The intensity of the radiation is now increased. State and explain what effect this increase in intensity has on the observed current. (2)
Increased intensity increases the number of photons incident on the metal thus more photo-electrons are emitted per second ✓ **and the current increases (as long as the frequency is $\geq$ threshold frequency).** ✓
- 9.3 What is the significance of the phenomenon illustrated in Diagram B. (2)
Establishes the quantum theory ✓ **and illustrates the particle nature of light.** ✓
- 9.4 The metal plate is illuminated with radiation such that photoelectrons are emitted. Air is allowed to enter the photo electric cell and the vacuum is destroyed. State and explain what effect the air will have on the observed current. (2)
Electrons collide with the air particles and slows down/stops the movement of the electrons (resistance increases) ✓ **and the current decreases.** ✓

- 9.5 The diagram below shows how the maximum kinetic energy of electrons emitted from the cathode of a photoelectric cell varies with the frequency of the incident radiation.



- 9.5.1 Define threshold frequency. (2)

Minimum frequency of incident radiation at which electrons will be emitted from a particular metal. ✓✓

- 9.5.2 What is the value of the threshold frequency of the incident radiation? (1)

4×10^{14} Hz (from the graph) ✓

- 9.5.3 Calculate the speed of the electrons emitted with maximum kinetic energy. (3)

$$E_K = \frac{1}{2} mv^2$$

$$16 \times 10^{-19} = \frac{1}{2} 9,1 \times 10^{-31} v^2 \quad \checkmark \checkmark$$

$$v = 1,88 \times 10^6 \text{ m.s}^{-1} \quad \checkmark$$

- 9.5.4 Use the graph to calculate the maximum wavelength of electromagnetic radiation that can release photoelectrons from the cathode surface. (3)

$$c = f \lambda$$

$$3 \times 10^8 = 4 \times 10^{14} \lambda \quad \checkmark \checkmark$$

$$\lambda = 7,5 \times 10^{-7} \text{ m} \quad \checkmark$$

(17 marks)

TOTAL: 200 MARKS

BLANK PAGE

eduresourceza.com

BLANK PAGE

eduresourceza.com

eduresourceza.com