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**TRIALS EXAMINATION
16 August 2019
GRADE 12**

**PHYSICAL SCIENCE
PAPER I**



CLIFTON
Scholarship
Leadership
Sportsmanship
Community

**TIME: 3 HOURS
MARKS: 200**

**EXAMINER: T. Doyle
MODERATOR: K. Garrett**

INSTRUCTIONS TO CANDIDATES

Please read the following instructions carefully.

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 17 pages and a Data Sheet of 2 pages (18 and 19). Please make sure that your question paper is complete.
2. Answer ALL the questions.
3. Read the questions carefully.
4. Use the data and formulae whenever necessary.
5. Start each question on a new page.
6. Show your working in all calculations.
7. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
8. Answers must be expressed in decimal format, not left as proper fractions.
9. Where appropriate express answers to TWO decimal places.
10. It is in your own interest to write legibly and to present your work neatly.

QUESTION 1

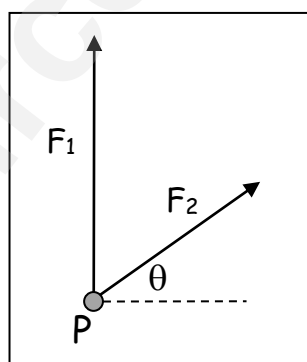
For Questions 1.1 to 1.10, choose the most correct answer from the options presented and record the answer on the answer grid provided on the *FRONT* inside cover of your answer booklet.

- 1.1 The unit for a certain physical quantity is represented in base units as kg.m.s^{-1} . The physical quantity and its nature is

	Physical quantity	Nature
A	Impulse	Vector quantity
B	Work	Vector quantity
C	Power	Scalar quantity
D	Net force	Scalar quantity

(2)

- 1.2 Two forces act on a point, **P**, as shown below.

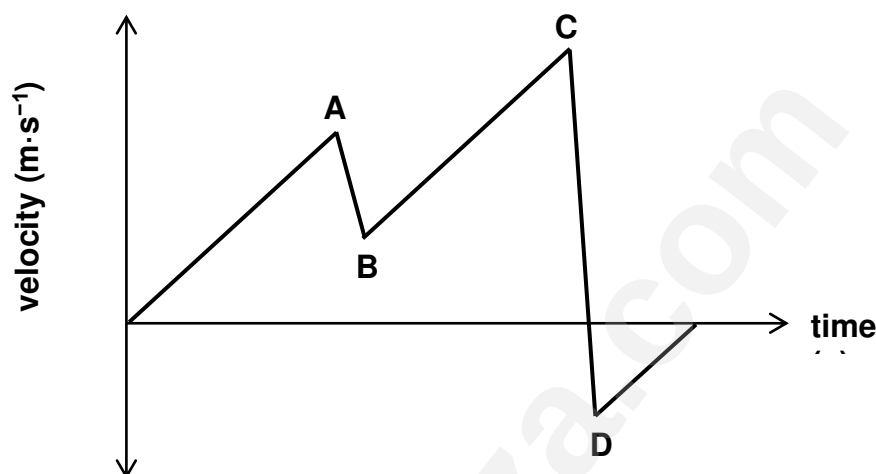


The magnitude of the net force acting on point **P** is given by...

- A $(F_2.\sin\theta)^2 + (F_2.\cos\theta)^2$
 B $\sqrt{F_1 + F_2.\cos\theta}$
 C $\sqrt{(F_2.\cos\theta)^2 + (F_1 + F_2.\sin\theta)^2}$
 D $F_1 + F_2$

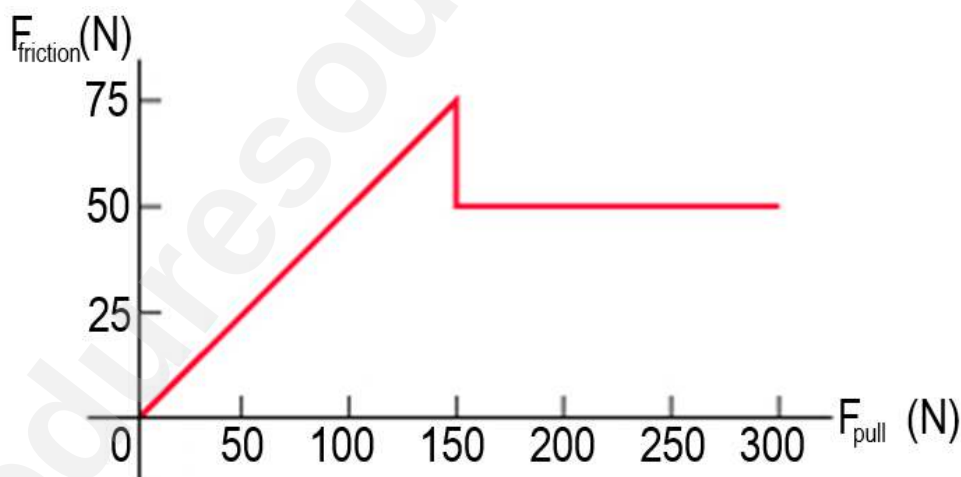
(2)

- 1.3 An avocado falls from a tree and hits a horizontal pane of thin glass after some time. It breaks through the glass and continues to free fall toward the ground, before bouncing. The following graph shows the avocado's velocity as a function of time.



At which point labelled on the graph does the ball start its free fall again after contact with the glass? (2)

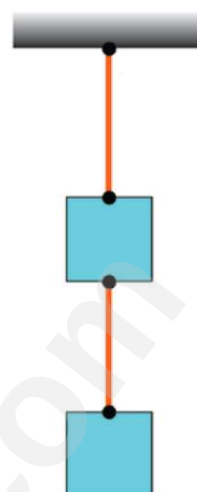
- 1.4 The graph shown below, represents the friction force on a block as a function of the pulling force.



Which statement below is incorrect?

- A The block is being pulled along a rough horizontal surface.
 - B The block is being pulled up a rough inclined surface.
 - C The maximum static friction force on the block is 75 N.
 - D The kinetic friction force on the block is 50 N.
- (2)

- 1.5 Two boxes are held together by a strong wire and attached to the ceiling by a second wire as shown in the diagram alongside.

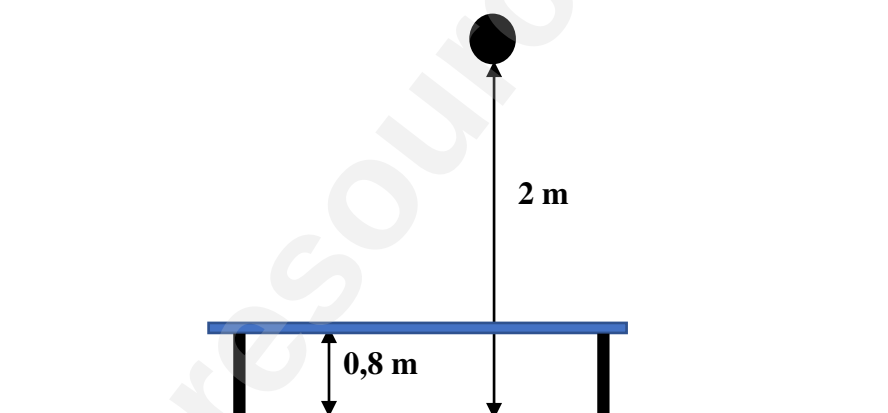


The forces the bottom box and the top box exert on each other are:

- A Unequal in magnitude and opposite in direction
- B Equal in magnitude and direction
- C Unequal in magnitude but in the same direction
- D Equal in magnitude and opposite in direction

(2)

- 1.6 A steel ball is dropped from a height of 2 m onto a glass table of height 0,8 m. The steel ball breaks the glass tabletop and continues to fall to the ground.



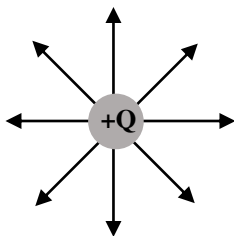
Which expression below can best be used to calculate the work done by the ball in breaking the glass (W_{ball})?

- A $W_{\text{ball}} = E_{\text{k at 0,8m}}$
- B $W_{\text{ball}} = E_{\text{p at 0,8 m}} + E_{\text{k at 0,8 m}}$
- C $W_{\text{ball}} = E_{\text{p at 2m}} - E_{\text{k at ground level}}$
- D $W_{\text{ball}} = E_{\text{p at 2 m}} - E_{\text{p at 0,8 m}}$

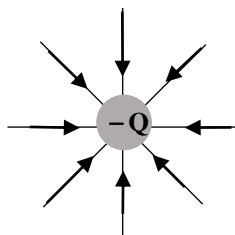
(2)

- 1.7 Which one of the following diagrams does not show the correct electric field pattern?

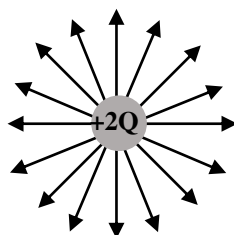
A



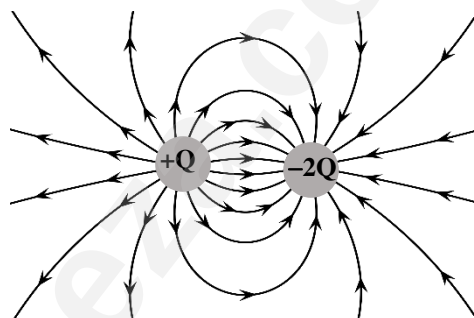
B



C

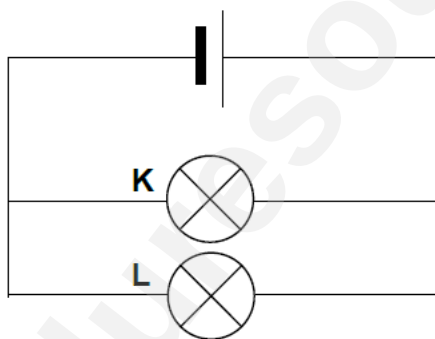


D

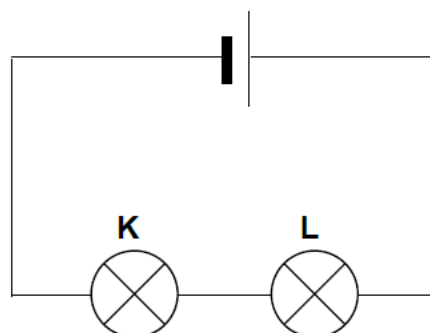


(2)

- 1.8 The same cell is connected in turn into each of the two circuits shown below. Bulbs **K** and **L** have **equal resistance**. The cell has negligible internal resistance.



Circuit 1



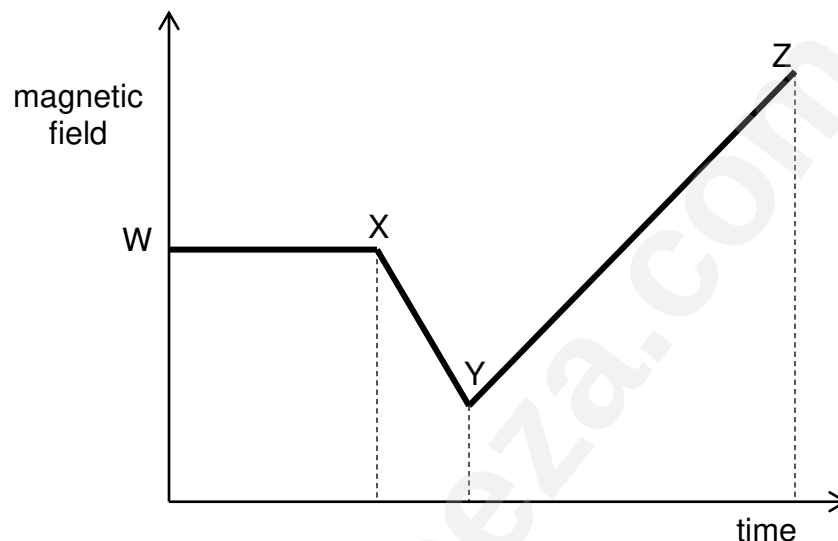
Circuit 2

If the power in bulb **L** of Circuit 1 is **P**, what is the **total** power in Circuit 1 and Circuit 2 in terms of **P**?

	Circuit 1	Circuit 2
A	2P	$\frac{1}{2}P$
B	2P	$\frac{1}{4}P$
C	$\frac{1}{2}P$	P
D	$\frac{1}{2}P$	2P

(2)

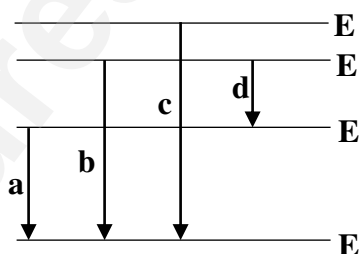
- 1.9 A square loop of area A is placed on top of a variable magnet whose field strength vs time is plotted on the graph below:
http://dev.physicslab.org/Document.aspx?doctype=3&filename=Induction_Faraday.xml



When would the loop experience an induced voltage?

- | | | | |
|---|-----------|---|---------|
| A | XY and YZ | B | WX only |
| C | XY only | D | YZ only |
- (2)

- 1.10 The diagram below shows the possible transitions of electrons between energy levels in an atom of a specific element.



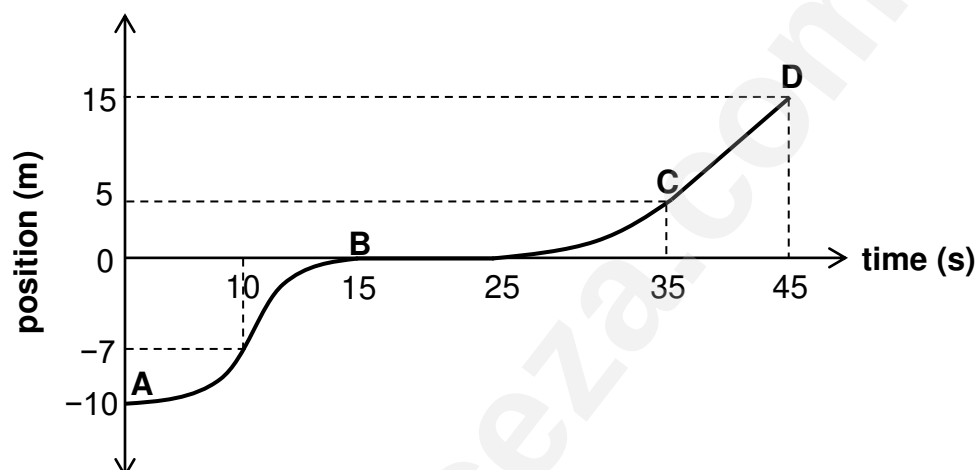
Which transition will produce the line of longest wavelength of the emission spectra of the element.

- | | | | |
|---|--------------|---|--------------|
| A | Transition a | B | Transition b |
| C | Transition c | D | Transition d |
- (2)

[20]

QUESTION 2

A cat runs from rest along a horizontal lawn in an **easterly** direction. She begins at the house (point **A**), runs toward a lawn chair (point **B**), and then proceeds to the other end of the lawn through points **C** and **D**. The cat's position-time graph (NOT TO SCALE) is shown below. During the time period $t = 10$ s and $t = 15$ s, the cat has a constant acceleration of magnitude $0,12 \text{ m}\cdot\text{s}^{-2}$.



- 2.1 What reference point was chosen for the cat's motion? (1)
- 2.2 Define *displacement*. (2)
- 2.3 Write down the cat's total displacement. (2)
- 2.4 Distinguish between *average* and *instantaneous velocity*. (3)
- 2.5 Determine the cat's average velocity between $t = 0$ s (Point **A**) and $t = 15$ s (Point **B**). (4)
- 2.6 What particular part of the graph could one use to determine the instantaneous velocity of the cat at 30 s? (1)
- 2.7 What is the direction of the cat's acceleration during the time period $t = 10$ s and $t = 15$ s? (1)
- 2.8 Calculate the velocity of the cat at $t = 10$ s. (4)
- 2.9 Draw the corresponding velocity-time sketch graph for the cat's entire motion. Consider any period of acceleration as constant. Show points **A** to **D** on your graph. (6)

[24]

QUESTION 3

At the recent Cricket World Cup, every match began with a coin toss by the match referee to determine who decides to bat or field first.



<https://www.youtube.com/watch?v=58UEI th 1A>

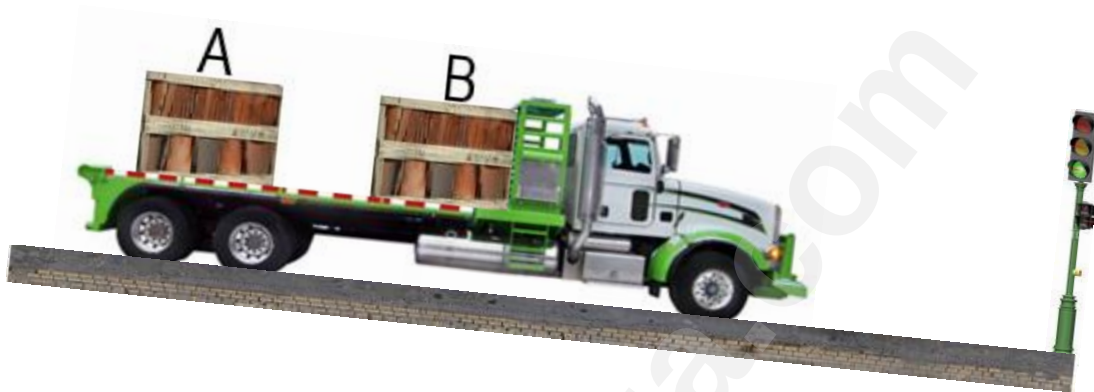
At one such coin toss, the match referee tosses the coin directly upwards, from a height of 1,6 m above the ground. From the moment the coin leaves the hand of the referee, it is in free fall until it reaches the ground. It reaches the ground in 1,45 s.

- 3.1 Explain what is meant by the term 'free fall'? (2)
- 3.2 Show that the speed at which the coin leaves the referee's hand is $6 \text{ m} \cdot \text{s}^{-1}$. (4)
- 3.3 How long does it take the coin to reach its maximum height? (4)
- 3.4 What is the coin's acceleration at the moment it reaches its maximum height? (2)
- 3.5 On the way back to his hotel room, the referee rides in a lift that accelerates upward at $1,8 \text{ m} \cdot \text{s}^{-2}$. The moment the lift begins to move, he accidentally drops his coin from a height of 1,2 m above the lift floor. You may assume that the velocities of both the lift and the coin are zero at the moment the coin is dropped.
Determine how long it takes the coin to reach the lift floor. (6)

[18]

QUESTION 4

- 4.1 Crates of French Terracotta roof tiles are being transported to a construction site. The truck driver, travelling too fast downhill, slams on breaks as he approaches a red traffic light in order to come to rest.



As he does so, crate A slides along the flat-bed towards crate B and collides with crate B.

Explain this phenomenon by referring to a specific Law of Motion.

(4)

- 4.2 The last stretch of road to the construction site is a hill of inclination 6° .



- 4.2.1 Draw a free-body diagram of all the forces acting on the truck as it moves up the hill.

(4)

- 4.2.2 Define *Newton's 2nd Law of motion*.

(2)

- 4.2.3 The truck, with its load, has a total mass of 18 410 kg. It decelerates from 16 m.s^{-1} to 11 m.s^{-1} in the first 3 minutes of travelling up the hill. Calculate the net force acting on the truck.

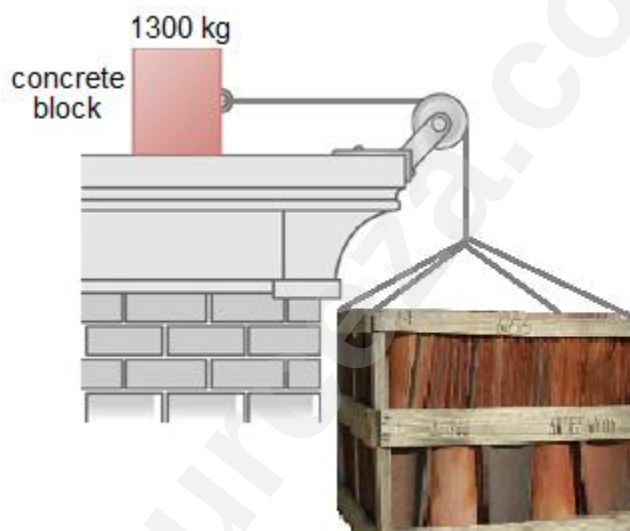
(6)

- 4.2.4 Calculate the component of the weight of the truck parallel to the road surface.

(3)

- 4.2.5 The magnitude of the friction force exerted by the road surface on the truck tyres as it decelerates up the hill is 127 000 N. Calculate the magnitude of the driving force of the truck's engine as it decelerates up the hill. (5)

- 4.3 At the construction site, a crate of French Terracotta roof tiles is to be suspended by attaching a rope to it and connecting the other end to a heavy concrete block on the roof of a building, as shown in the figure alongside.



The rope pulls horizontally on the concrete block, and the coefficient of static friction between the concrete block and the roof is 0,44.

What is the weight of the heaviest crate of roof tiles that can be supported this way, while being suspended at rest? Ignore any friction between the rope and the pulley and ignore the mass of the rope. (6)

[30]

QUESTION 5

A container forklift lifts a container with a force of 36750 N at a constant velocity of $1,2 \text{ m.s}^{-1}$ to a height of 8 m. The energy transfer is 90 % efficient.

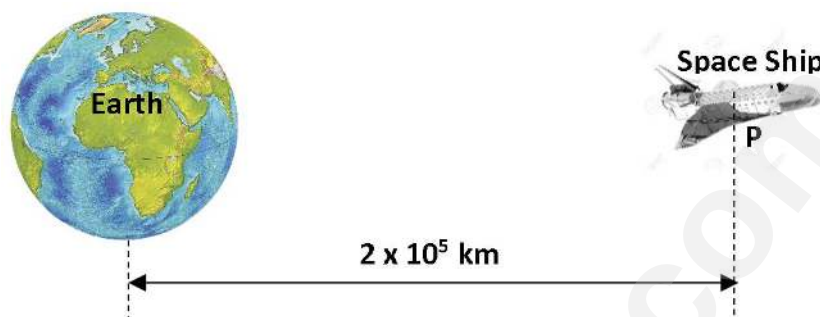


- 5.1 State what happens to the kinetic energy, gravitational potential energy and total mechanical energy of the ball as it is raised by the crane. Use only the words, **INCREASES**, **DECREASES**, or **REMAINS CONSTANT**. (3)
- 5.2 Define *gravitational potential energy*. (2)
- 5.3 Calculate the amount of useful work done by the forklift's engine to raise the container. (3)
- 5.4 Calculate the power output of the engine. (3)
- 5.5 Calculate the power input of the engine. (3)
- 5.6 When the container reaches a height of 8 m, the forklift driver accidentally presses the release button instead of the stop button. Calculate the velocity of the container as it strikes the ground. Ignore the effects of air resistance. (3)
- 5.7 Use the equation for the work-energy theorem, to calculate the work done by the container on the ground as it collides with the ground and comes to rest. (5)
- 5.8 State *Newton's second law in terms of momentum*. (2)
- 5.9 Calculate the magnitude of the force exerted by the ground on the container as the container collides with the ground and comes to rest in a time of 0,05 s. (4)
- 5.10 Other containers are loaded onto train cars ready for transportation. The train cars are coupled together by being bumped into one another. Two loaded train cars are moving toward one another, the first having a mass of 150 000 kg and a velocity of $0,3 \text{ m.s}^{-1}$, and the second having a mass of 110 000 kg and a velocity of $0,12 \text{ m.s}^{-1}$. Calculate the magnitude of their final velocity after coupling. (5)

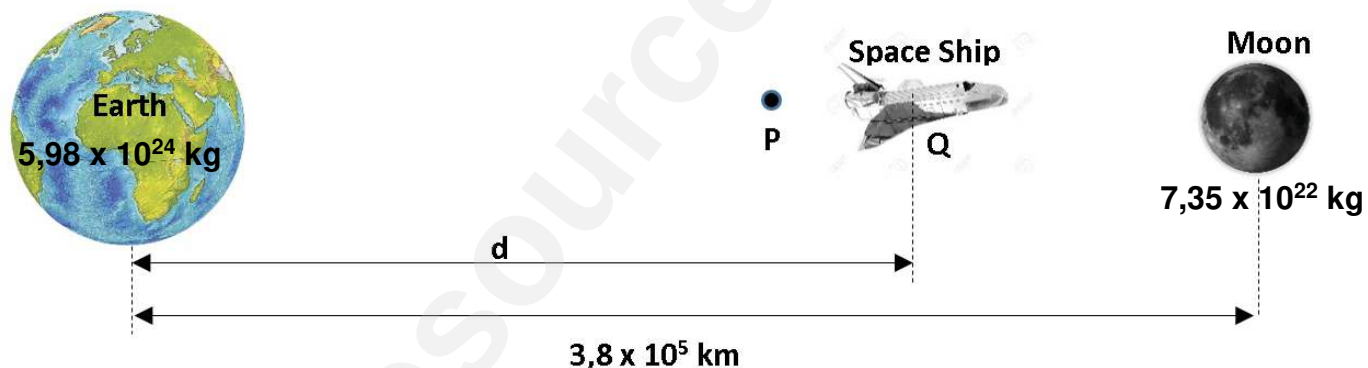
[33]

QUESTION 6

- 6.1 A space ship, mass 3 500 kg, is at rest at point **P**, 2×10^5 km from the centre on the Earth.

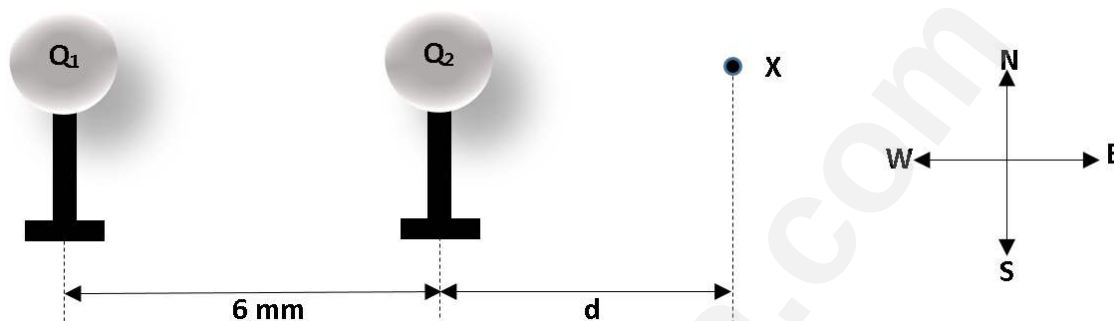


Point **Q** is a point on a straight line between the moon and the Earth. Point **Q** is a distance **d** from the centre of the Earth. The space ship experiences a ZERO net force when it is at rest at point **Q**.



- 6.1.1 State *Newton's Law of Universal Gravitation*. (2)
- 6.1.2 Calculate the distance between points **P** and **Q**. (6)

- 6.2 Two very small identical spheres, Q_1 and Q_2 , with the same negative charge placed on insulating stands with their centres 6 mm apart. The magnitude of the electrostatic force that Q_1 exerts on Q_2 is 4×10^{-3} N. Point X is a distance d East of Q_2 shown below.

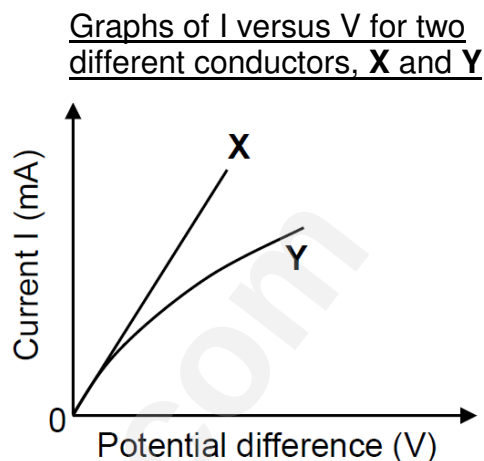


- 6.2.1 State *Coulomb's Law*. (2)
- 6.2.2 Calculate the magnitude of the charge on each sphere, Q_1 and Q_2 . (4)
- 6.2.3 The electric field at point X due to Q_1 only is $4,44 \times 10^5$ N.C $^{-1}$ West. Calculate the magnitude of distance d . (5)

[19]

QUESTION 7

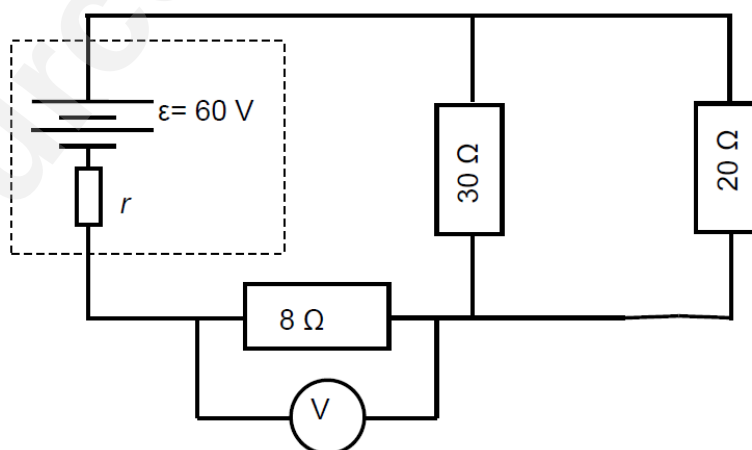
- 7.1 The graph alongside shows the relationship between current and potential difference for two different conductors, **X** and **Y**.



- 7.1.1 State *Ohm's Law* in words. (2)
- 7.1.2 Which **ONE** of the two conductors, **X** and **Y**, is ohmic? Refer to the graph and give a reason for the answer. (2)

- 7.2 The circuit diagram below shows a battery with an emf (ε) of 60 V and an unknown internal resistance r , connected to three resistors.

A voltmeter connected across the $8\ \Omega$ resistor reads 21,84 V.

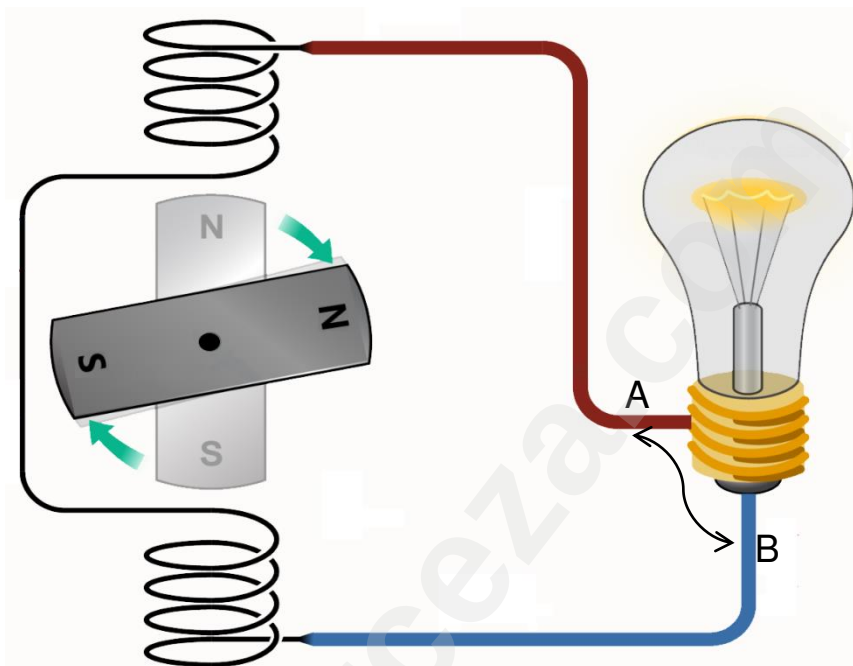


- 7.2.1 Define *emf*. (2)
- 7.2.2 Calculate the current in the $8\ \Omega$ resistor. (3)
- 7.2.3 Define *resistance*. (2)
- 7.2.4 Calculate the equivalent resistance of the resistors in parallel. (2)
- 7.2.5 Calculate the internal resistance of the battery. (4)
- 7.2.6 Calculate the work done in driving the charges through the $20\ \Omega$ resistor in 0,2 s. (4)

[21]

QUESTION 8

Consider the diagram shown below when answering the questions that follow.

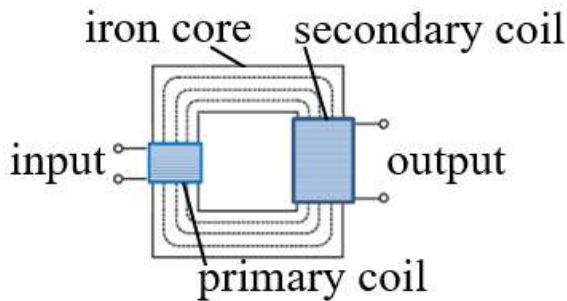
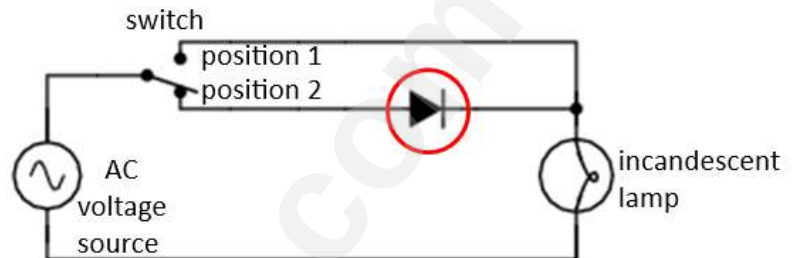


- 8.1 State *Lenz's Law*. (2)
- 8.2 State whether **AC**, **DC** or **NO CURRENT** will pass through the light bulb when the magnet is stationary. Give a reason for your answer. (3)
- 8.3 The magnet is being rotated in a clockwise direction as shown in the diagram. When the magnet is in the vertical position, with the North end of the magnet at the top, in which direction will the current flow through the light bulb? Simply state **A to B** or **B to A**. (2)
- 8.4 Name one method that could increase the brightness of the bulb without changing or replacing any components in the diagram. (2)
- 8.5 Explain with reference to any physical law(s), why the method that you have named in question 8.4 above would result in an increase the brightness of the bulb. (4)

[13]

QUESTION 9

Transform current or rectify current? That is the question! Consider the diagrams below when answering the questions that follow.

DIAGRAM 1**DIAGRAM 2**

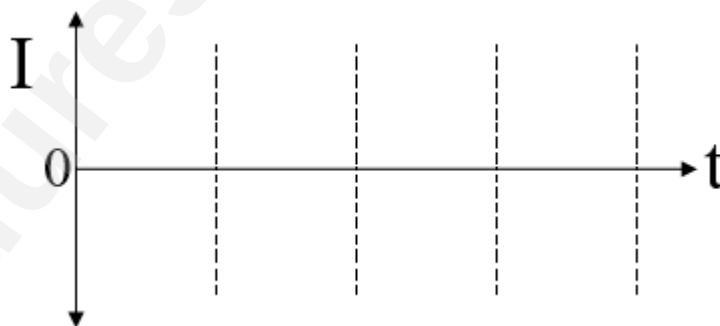
9.1 In diagram 1, there are 100 turns on the primary coil and 400 turns on the secondary coil. The potential difference across the primary coil is 230 V and the maximum value of the flux in the iron core is 0,01035 Wb.

9.1.1 Calculate the emf induced across the secondary coil. (3)

9.1.2 Define *magnetic flux linkage*. (2)

9.1.3 Calculate the flux linkage of the primary coil. (2)

9.2 In diagram 2, the switch is shown to be in position 2. A copy of the sketch graph shown below, can be found on the front inside cover of your answer booklet.

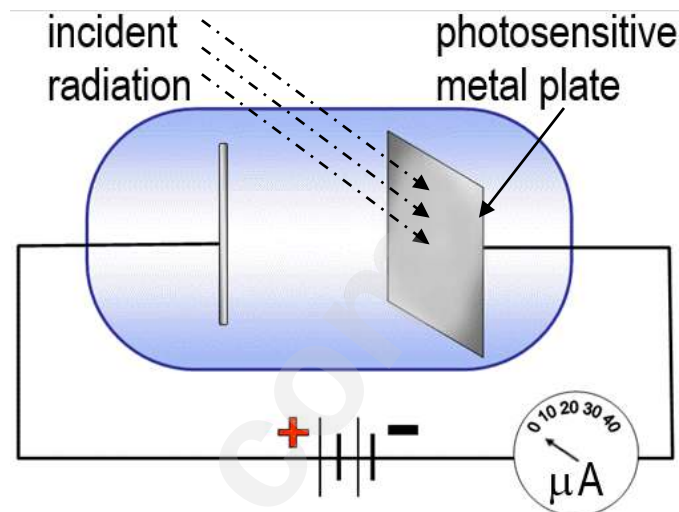


Complete the sketch graph to illustrate how the diode rectifies the current from the AC voltage source, to pass through the incandescent lamp. (2)

[9]

QUESTION 10

In an experiment to determine the effect of varying the frequency and intensity of light on the current generated in a photoelectric cell the apparatus setup was as follows. Various frequencies and intensities of light were shone onto a photosensitive metal plate and the ammeter reflected the flow of current as a result of electrons being emitted from the photosensitive metal.



Some of the results of the experiment are reflected below:

Frequency (Hz)	Intensity (Cd)	Current (μA)
$4,00 \times 10^{14}$	10	0
$4,50 \times 10^{14}$	10	0
$5,00 \times 10^{14}$	10	0
$5,01 \times 10^{14}$	10	20
$5,01 \times 10^{14}$	20	40
$6,50 \times 10^{14}$	10	30

- 10.1 Name the phenomenon upon which this experiment relies. (1)
- 10.2 Identify the dependent variable. (1)
- 10.3 What is the threshold frequency for this metal? (2)
- 10.4 Calculate the energy of a photon with this frequency. (3)
- 10.5 The work function of this metal is $3,0 \times 10^{-19}$ J. Calculate the maximum speed an electron has when it is released from the surface of the metal. (4)
- 10.6 Explain why the current doubled when the intensity was doubled (without changing the frequency). (2)

[13]**EXAMINATION TOTAL: 200 marks**

EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES

(PHYSICS)

TABLE 1 PHYSICAL CONSTANTS

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

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

$F_{\text{net}} = ma$	$F_{\text{net}} = \frac{\Delta p}{\Delta t}$ or $F_{\text{net}}\Delta t = m\Delta v$	$\Delta p = mv - mu$ or $\Delta p = mv_f - mv_i$
$p = mv$	$w = F_g = mg$	$F_f^{\text{max}} = \mu F_N$

WORK, ENERGY AND POWER

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

GRAVITATIONAL AND ELECTRIC FIELDS

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

ELECTRIC CIRCUITS

$I = \frac{Q}{t}$	$V = \frac{W}{q}$
$R = \frac{V}{I}$	$emf = I(R_{ext} + r)$
$R_s = R_1 + R_2 + \dots$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$P = \frac{W}{t} \quad \text{or} \quad W = Pt$	
$W = VIt \quad \text{or} \quad W = I^2 R t \quad \text{or} \quad W = \frac{V^2}{R} t$	
$P = VI \quad \text{or} \quad P = I^2 R \quad \text{or} \quad P = \frac{V^2}{R}$	

ELECTRODYNAMICS

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

PHOTONS AND ELECTRONS

PHOTONS AND ELECTRONS		
$c = f \lambda$	$E = hf$	or $E = \frac{hc}{\lambda}$
$E = W_0 + E_{K(max)}$	$W_0 = hf_0$	$E_{K(max)} = \frac{1}{2} m v_{max}^2$