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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2012

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions in the ANSWER BOOK.
3. This question paper consists of TWO sections:

SECTION A (25)
SECTION B (125)
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. Number the answers correctly according to the numbering system used in this question paper.
7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
8. Give brief motivations, discussions, et cetera where required.
9. Round off your final numerical answers to a minimum of TWO decimal places.

SECTION A**QUESTION 1: ONE-WORD ITEMS**

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

- 1.1 The type of energy an object has due to its motion (1)
- 1.2 The phenomenon which occurs when two light waves meet at a given point (1)
- 1.3 The unit of measurement of electrical resistance (1)
- 1.4 The basic principle on which electric generators function (1)
- 1.5 The type of line spectrum observed when electrons in an atom move from the excited state to the ground state (1)
- [5]**

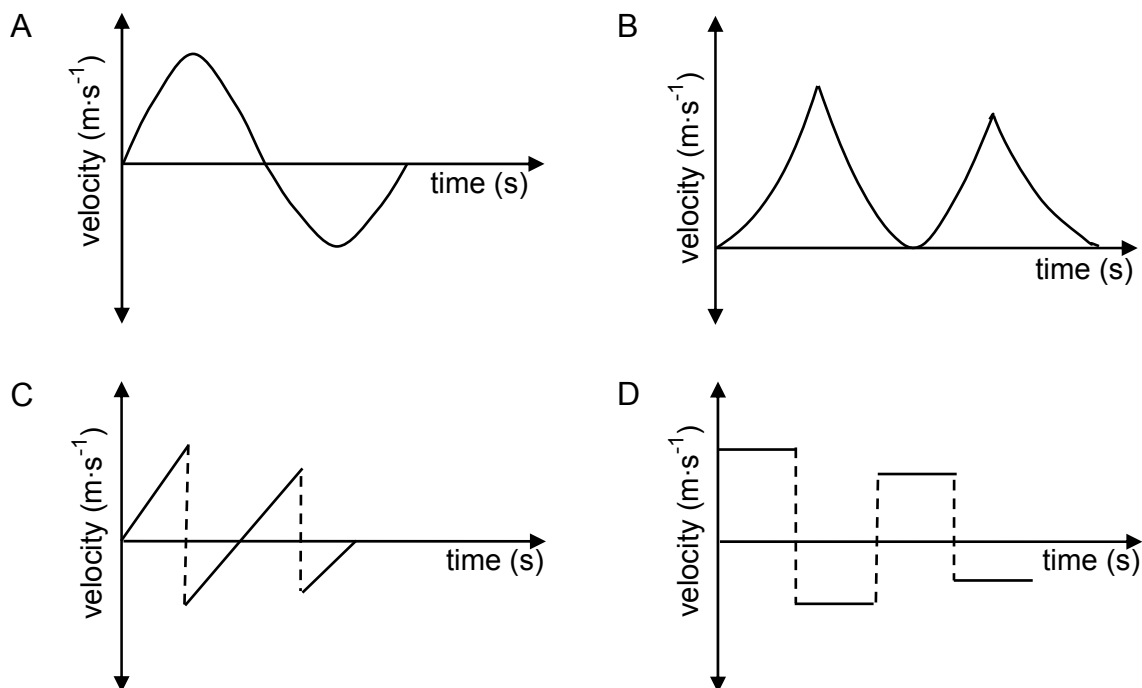
QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

- 2.1 A car of mass m collides head-on with a truck of mass $2m$. If the car exerts a force of magnitude F on the truck during the collision, the magnitude of the force that the truck exerts on the car is ...
- A $\frac{1}{2}F$
- B F
- C $2F$
- D $4F$ (2)
- 2.2 An object moves in a straight line on a ROUGH horizontal surface. If the net work done on the object is zero, then ...
- A the object has zero kinetic energy.
- B the object moves at constant speed.
- C the object moves at constant acceleration.
- D there is no frictional force acting on the object. (2)

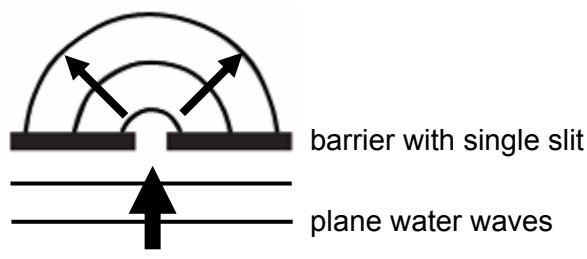
- 2.3 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. Ignore the effects of air resistance.

Which ONE of the following velocity-time graphs best represents the motion of the ball?



(2)

- 2.4 The diagram below shows plane water waves that spread out after passing through a single slit.



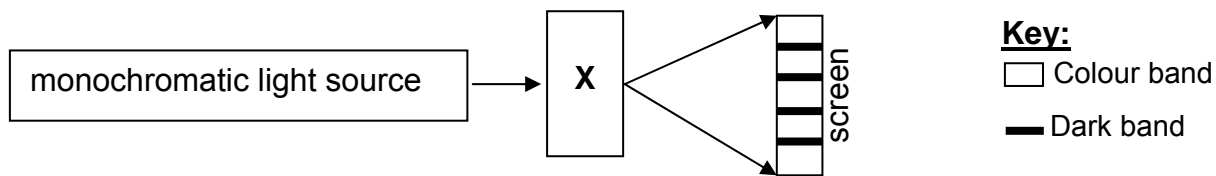
The wave phenomenon observed after the water waves pass through the slit is ...

- A reflection.
- B diffraction.
- C refraction.
- D photoelectric effect.

(2)

2.5 Monochromatic light from a point source passes through a device **X**.

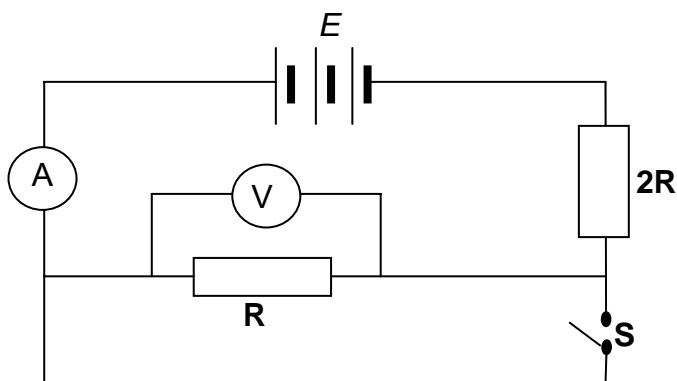
A pattern is observed on a screen, as shown in the diagram below.



From the observation on the screen, it can be concluded that device **X** is a ...

- A prism.
 - B single slit.
 - C double slit.
 - D concave lens.
- (2)

2.6 In the circuit diagram below, the internal resistance of the battery and the resistance of the conducting wires are negligible. The emf of the battery is E .



When switch **S** is closed, the reading on voltmeter **V**, in volts, is ...

- A 0
 - B $\frac{1}{3}E$
 - C $\frac{2}{3}E$
 - D E
- (2)

- 2.7 Two identical small metal spheres on insulated stands carry equal charges and are a distance d apart. Each sphere experiences an electrostatic force of magnitude F .

The spheres are now placed a distance $\frac{1}{2}d$ apart.

The magnitude of the electrostatic force each sphere now experiences is ...

A $\frac{1}{2}F$

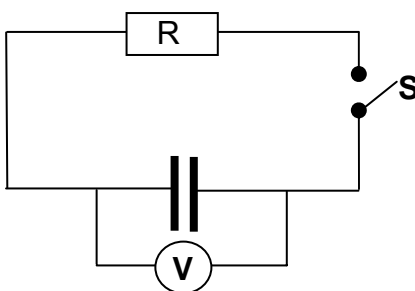
B F

C $2F$

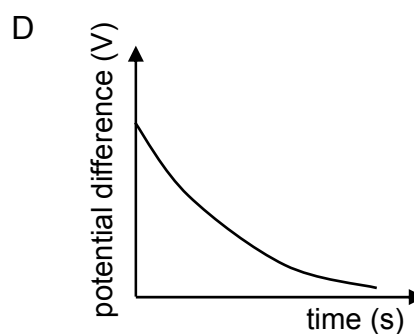
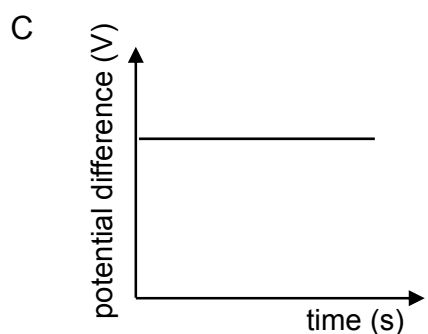
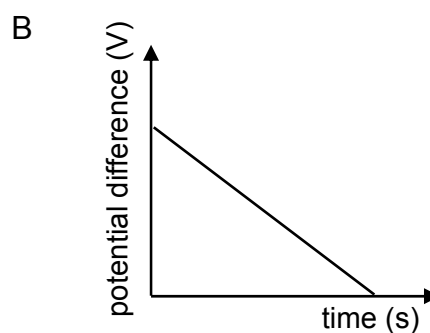
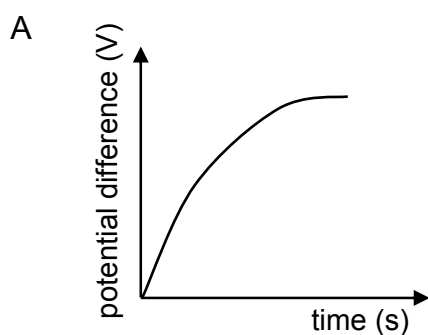
D $4F$

(2)

- 2.8 A fully charged capacitor is connected in a circuit, as shown below. The capacitor discharges when switch **S** is closed.

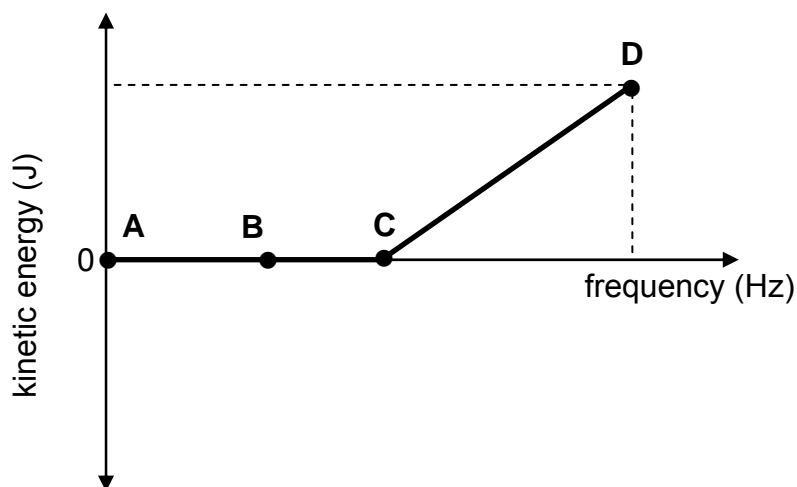


Which ONE of the following graphs correctly shows the change in the voltmeter reading with time when switch **S** is closed?



(2)

- 2.9 When light shines on a metal plate in a photocell, electrons are emitted. The graph below shows the relationship between the kinetic energy of the emitted photoelectrons and the frequency of the incoming light.



Which ONE of the points (**A**, **B**, **C** or **D**) on the graph represents the threshold frequency?

- A A
- B B
- C C
- D D

(2)

- 2.10 Overexposure to sunlight causes damage to plants and crops.

Which ONE of the following types of electromagnetic radiation is responsible for this damage?

- A Ultraviolet rays
- B Radio waves
- C Visible light
- D X-rays

(2)
[20]

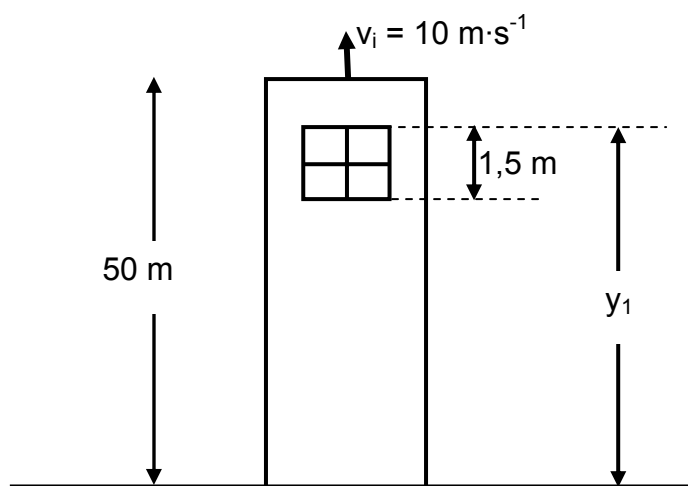
TOTAL SECTION A: 25

SECTION B**INSTRUCTIONS AND INFORMATION**

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A stone is thrown vertically upward at a velocity of $10 \text{ m}\cdot\text{s}^{-1}$ from the top of a tower of height 50 m. After some time the stone passes the edge of the tower and strikes the ground below the tower. Ignore the effects of friction.



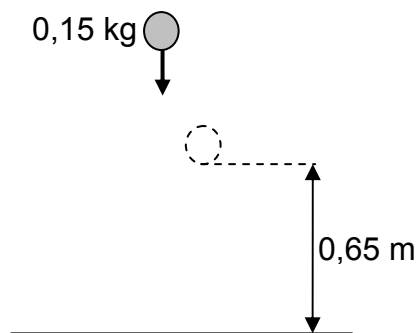
- 3.1 Draw a labelled free-body diagram showing the force(s) acting on the stone during its motion. (1)
- 3.2 Calculate the:
 - 3.2.1 Time taken by the stone to reach its maximum height above the ground (4)
 - 3.2.2 Maximum height that the stone reaches above the ground (4)
- 3.3 USING THE GROUND AS REFERENCE (zero position), sketch a position-time graph for the entire motion of the stone. (3)
- 3.4 On its way down, the stone takes 0,1 s to pass a window of length 1,5 m, as shown in the diagram above.
Calculate the distance (y_1) from the top of the window to the ground. (7)

[19]

QUESTION 4 (Start on a new page.)

The bounce of a cricket ball is tested before it is used. The standard test is to drop a ball from a certain height onto a hard surface and then measure how high it bounces.

During such a test, a cricket ball of mass $0,15\text{ kg}$ is dropped from rest from a certain height and it strikes the floor at a speed of $6,2\text{ m}\cdot\text{s}^{-1}$. The ball bounces straight upwards at a velocity of $3,62\text{ m}\cdot\text{s}^{-1}$ to a height of $0,65\text{ m}$, as shown in the diagram below. The effects of air friction may be ignored.



4.1 Define the term *impulse* in words. (2)

4.2 Calculate the magnitude of the impulse of the net force applied to the ball during its collision with the floor. (3)

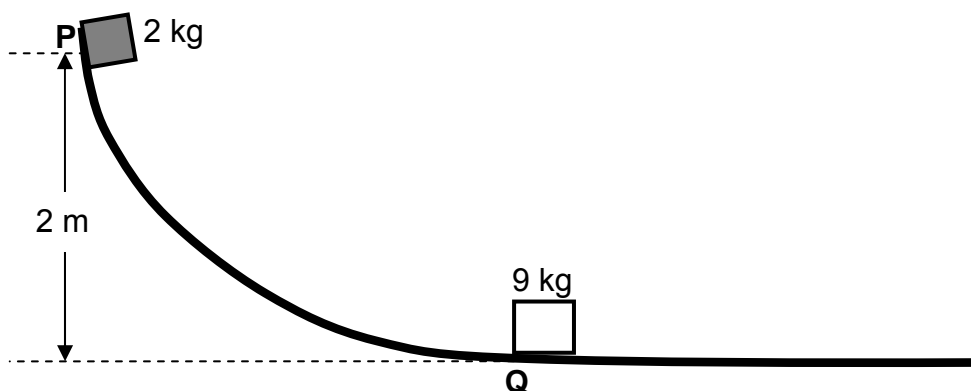
4.3 To meet the requirements, a cricket ball must bounce to one third of the height that it is initially dropped from.

Use ENERGY PRINCIPLES to determine whether this ball meets the minimum requirements.

(5)
[10]

QUESTION 5 (Start on a new page.)

A wooden block of mass 2 kg is released from rest at point **P** and slides down a curved slope from a vertical height of 2 m, as shown in the diagram below. It reaches its lowest position, point **Q**, at a speed of $5 \text{ m}\cdot\text{s}^{-1}$.



- 5.1 Define the term *gravitational potential energy*. (2)
- 5.2 Use the work-energy theorem to calculate the work done by the average frictional force on the wooden block when it reaches point **Q**. (6)
- 5.3 Is mechanical energy conserved while the wooden block slides down the slope? Give a reason for the answer. (2)
- 5.4 The wooden block collides with a stationary crate of mass 9 kg at point **Q**. After the collision, the crate moves to the right at $1 \text{ m}\cdot\text{s}^{-1}$.
- 5.4.1 Calculate the magnitude of the velocity of the wooden block immediately after the collision. (4)
- 5.4.2 The total kinetic energy of the system before the collision is 25 J. Use a calculation to show that the collision between the wooden block and the crate is inelastic. (5)
- [19]**

QUESTION 6 (Start on a new page.)

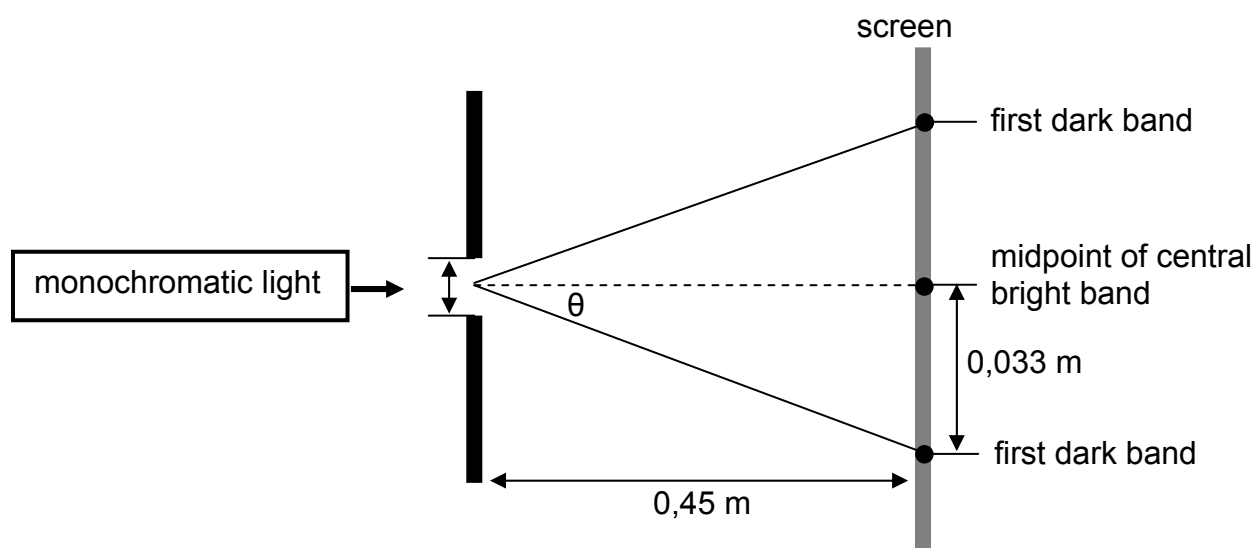
An ambulance approaches an accident scene at constant velocity. The siren of the ambulance emits sound waves at a frequency of 980 Hz. A detector at the scene measures the frequency of the emitted sound waves as 1 050 Hz.

- 6.1 Calculate the speed at which the ambulance approaches the accident scene. Use the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$. (4)
- 6.2 Explain why the measured frequency is higher than the frequency of the source. (2)
- 6.3 The principle of the Doppler effect is applied in the Doppler flow meter. State ONE positive impact of the use of the Doppler flow meter on humans. (2)
- [8]**

QUESTION 7 (Start on a new page.)

Learners investigate the change in the broadness of the central bright band formed when monochromatic light of different wavelengths passes through a single slit.

They set up the apparatus, as shown in diagram below, and measure the broadness of the central bright band in the pattern observed on the screen. The width of the slit is $5,6 \times 10^{-7}$ m.



7.1 Write down an investigative question. (2)

7.2 Which TWO variables are kept constant? (2)

7.3 In one of their experiments, the distance from the midpoint of the central bright band to the first dark band is measured to be 0,033 m.

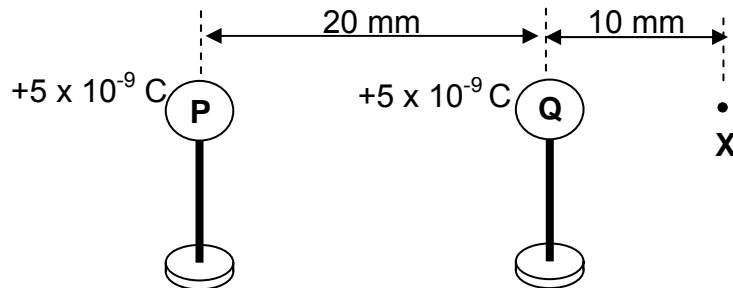
Calculate the wavelength of the light used in this experiment. (5)

7.4 How will the broadness of the central bright band of red light compare with that of blue light? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (2)
[11]

QUESTION 8 (Start on a new page.)

Two metal spheres, **P** and **Q**, on insulated stands, carrying charges of $+5 \times 10^{-9} \text{ C}$ and $+5 \times 10^{-9} \text{ C}$ respectively, are placed with their centres 20 mm apart. **X** is a point at a distance of 10 mm from sphere **Q**, as shown below.

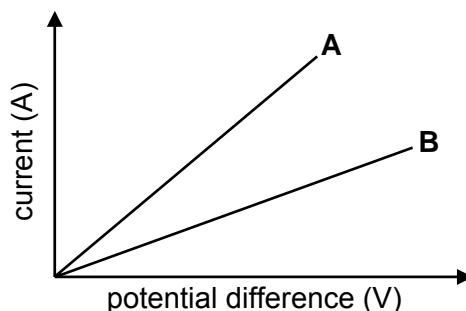


- 8.1 Define the term *electric field*. (2)
- 8.2 Sketch the net electric field pattern for the two charges. (3)
- 8.3 Calculate the net electric field at point **X** due to the presence of **P** and **Q**. (6)
- 8.4 Use your answer to QUESTION 8.3 to calculate the magnitude of the electrostatic force that an electron will experience when placed at point **X**. (3)
- [14]**

QUESTION 9 (Start on a new page.)

- 9.1 Learners use Ohm's law to determine which ONE of two resistors **A** and **B** has the greater resistance.

For each resistor, they measure the current through the resistor for different potential differences across its ends. The graph below shows the results obtained in their investigation.



- 9.1.1 The learners are supplied with the following apparatus:

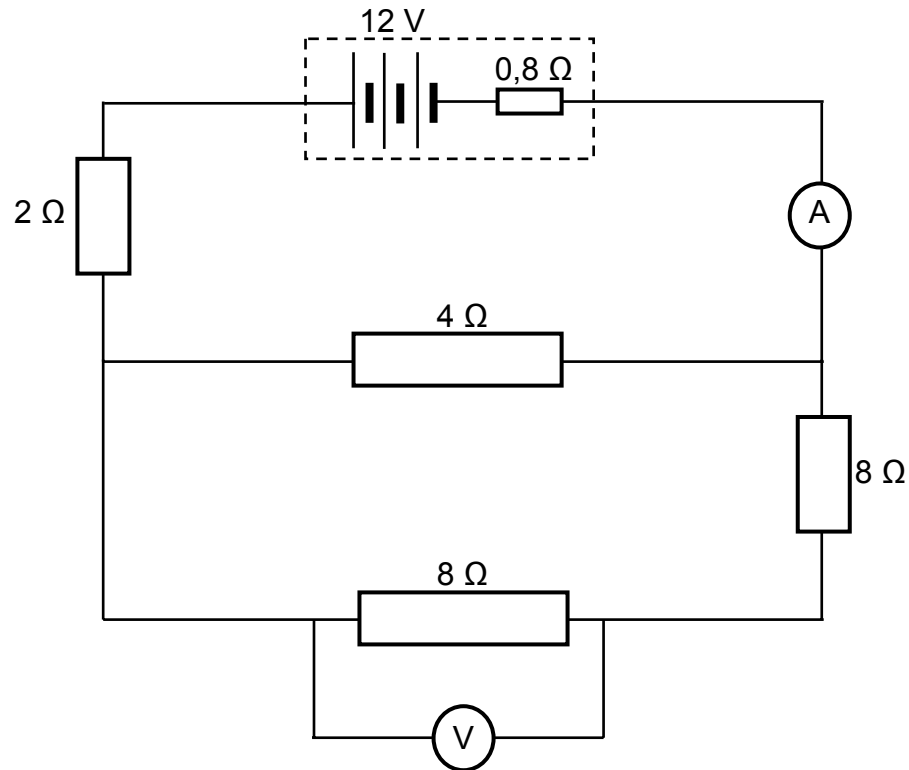
6 V battery
Voltmeter
Ammeter
Rheostat
Resistors **A** and **B**
Conducting wires

Draw a circuit diagram to show how the learners must use the above apparatus to obtain each of the graphs shown above. (4)

- 9.1.2 Write down ONE variable that must be kept constant during this investigation. (1)

- 9.1.3 Which ONE of **A** or **B** has the higher resistance?
Give an explanation for the answer. (3)

- 9.2 In the circuit diagram below, the battery has an emf of 12 V and an internal resistance of $0,8 \Omega$. The resistance of the ammeter and connecting wires may be ignored.

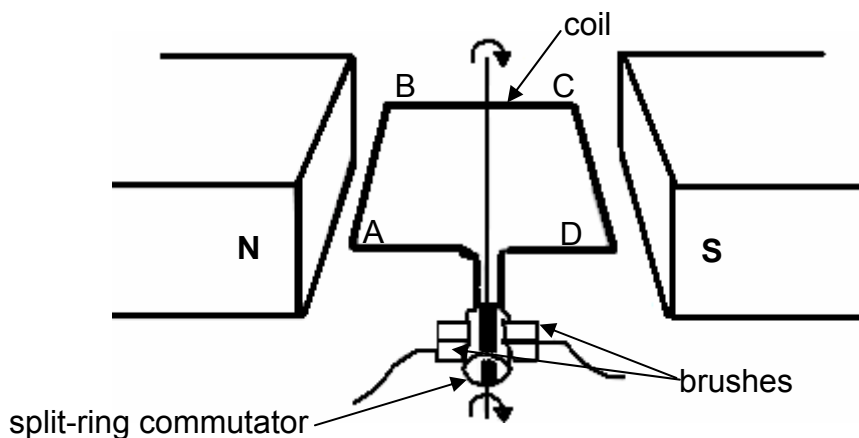


Calculate the:

- | | | |
|-------|-------------------------------------|-------------|
| 9.2.1 | Effective resistance of the circuit | (4) |
| 9.2.2 | Reading on the ammeter | (3) |
| 9.2.3 | Reading on the voltmeter | (4) |
| | | [19] |

QUESTION 10 (Start on a new page.)

- 10.1 The essential components of a simplified DC motor are shown in the diagram below.



When the motor is functioning, the coil rotates in a clockwise direction, as shown.

- 10.1.1 Write down the function of each of the following components:

- (a) Split-ring commutator (1)
- (b) Brushes (1)

- 10.1.2 What is the direction of the conventional current in the part of the coil labelled **AB**? Write down only FROM A TO B or FROM B TO A. (1)

- 10.1.3 Will the coil experience a maximum or minimum turning effect (torque) if the coil is in the position as shown in the diagram above? (1)

- 10.1.4 State ONE way in which this turning effect (torque) can be increased. (1)

- 10.2 Alternating current (AC) is used for the long-distance transmission of electricity.

- 10.2.1 Give a reason why AC is preferred over DC for long-distance transmission of electricity. (1)

- 10.2.2 An electric appliance with a power rating of 2 000 W is connected to a 230 V rms household mains supply.

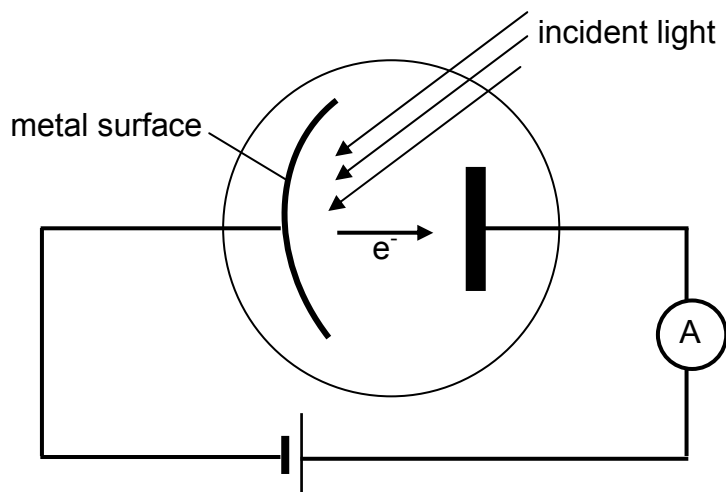
Calculate the:

- (a) Peak (maximum) voltage (3)
- (b) rms current passing through the appliance (3)

[12]

QUESTION 11 (Start on a new page.)

In the diagram shown below, electrons are released from a metal plate when light of a certain frequency is shone on its surface.



11.1 Name the phenomenon described above. (1)

11.2 The frequency of the incident light on the metal plate is $6,16 \times 10^{14}$ Hz and electrons are released with a kinetic energy of $5,6 \times 10^{-20}$ J.

Calculate the:

11.2.1 Energy of the incident photons (3)

11.2.2 Threshold frequency of the metal plate (5)

11.3 The brightness of the incident light is now increased. What effect will this change have on the following: (Write down only INCREASES, DECREASES or REMAINS THE SAME.)

11.3.1 The reading on the ammeter
Explain the answer. (2)

11.3.2 The kinetic energy of the released photoelectrons
Explain the answer. (2)
[13]

TOTAL SECTION B: 125
GRAND TOTAL: 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)****GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)****TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES**

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ϵ_0	$8,85 \times 10^{-12} \text{ F}\cdot\text{m}^{-1}$

TABLE 2: FORMULAE/TABEL 2: FORMULES**MOTION/BEWEGING**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h \frac{c}{\lambda}$
$\sin \theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_k = \frac{1}{2} mv^2$

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\epsilon_0 A}{d}$

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ϵ) = $I(R + r)$ emk (ϵ) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$ / $I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$	$P_{\text{average}} = V_{\text{rms}} I_{\text{rms}}$ / $P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$
$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$ / $V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{average}} = I_{\text{rms}}^2 R$ / $P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$
	$P_{\text{average}} = \frac{V_{\text{rms}}^2}{R}$ / $P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$