Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2015

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

PHSCE1

INSTRUCTIONS AND INFORMATION

1.   Write your FULL NAME and SURNAME on the ANSWER BOOK.

2.   The question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.

3.   Start EACH question on a new page in the ANSWER BOOK.

4.   Number the answers correctly according to the numbering system used in this question paper.

5.   Leave ONE line open between two subquestions for example between QUESTION 2.1 and QUESTION 2.2.

6.   You may use a non-programmable calculator.

7.   You may use appropriate mathematical instruments.

8.   You are advised to use the attached DATA SHEETS.

9.   Show ALL formulae and substitutions in ALL calculations.

10.   Round off your final numerical answers to a minimum of TWO decimal places.

11.   Give brief explanations, motivations, et cetera where required.

12.   Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write the letter (A–D) next to the question number (1.1–1.10) in your ANSWER BOOK for example 1.11 D.

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

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

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

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

    D   net force acting on the passenger is reduced, since the change in momentum is increased.   (2)

1.2   An astronaut has a weight of W on earth. He lands on a planet with mass three times greater than the earth and a radius twice that of the earth. What is the weight of the astronaut on this planet? Take the radius of the earth as R.

    A $\frac{3}{16}$ W

    B $\frac{3}{4}$ W

    C $\frac{3}{2}$ W

    D   3 W   (2)

1.3 $(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$ when only … are present.

    A   frictional forces

    B   tension forces

    C   applied forces

    D   gravitational forces   (2)

1.4 An object is thrown vertically downwards towards the ground from height *h* with a velocity *v*. The object strikes the ground and bounces upwards. It is caught when it reaches its maximum height after the bounce. Which ONE of the following velocity versus time graphs best represents the motion of the object?

A

B

C

D (2)
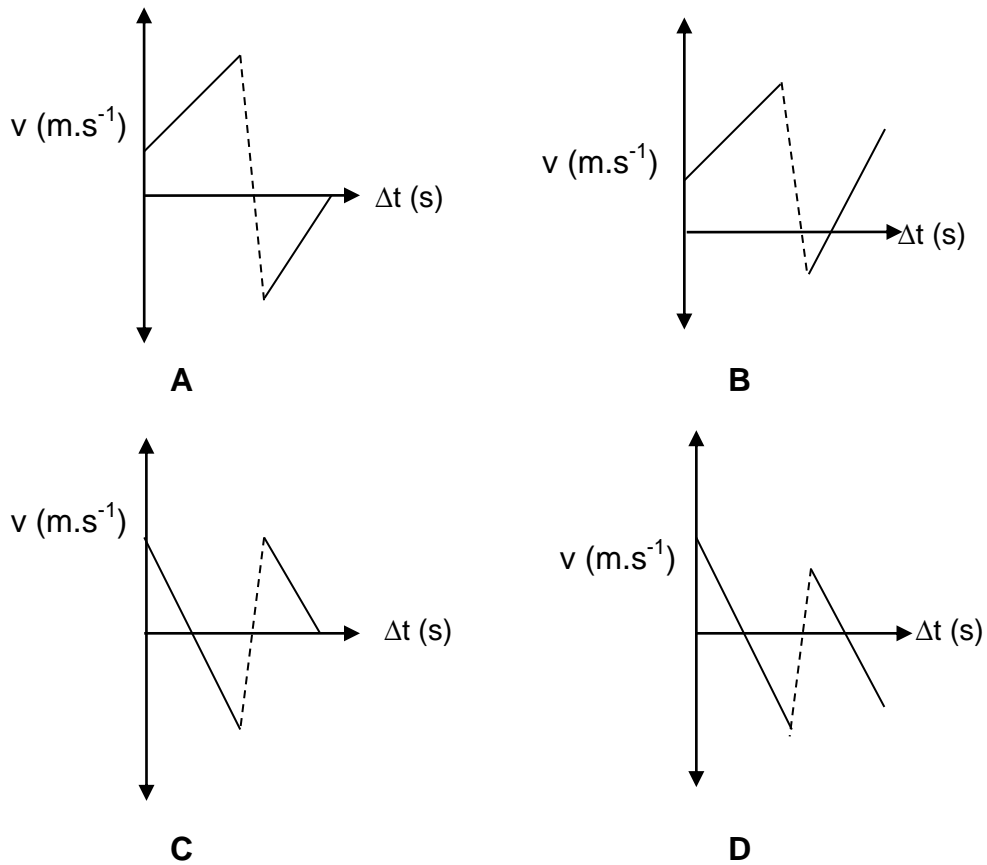
1.5 Astronomers obtained the following spectral lines of an element:
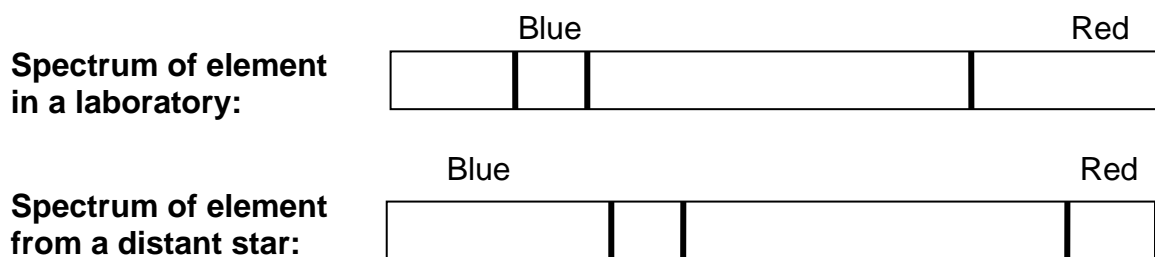
The observation confirms that the ...

A star is moving closer towards earth.

B earth is moving towards the star.

C temperature of earth is increasing.
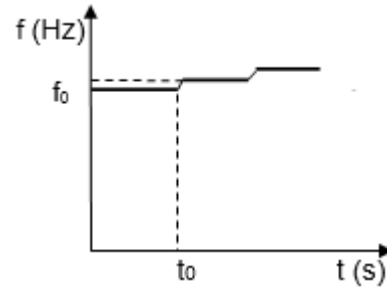
D universe is expanding. (2)

1.6 A stationary fire truck sounds its siren at frequency f_0. A girl walks at a constant velocity towards the fire truck. She passes the fire truck and then walks away from it.
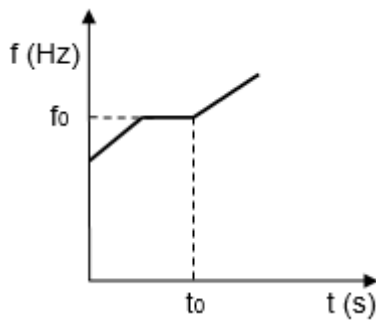
Which ONE of the graphs below shows the changes in frequency heard by the girl over the distance she walks?
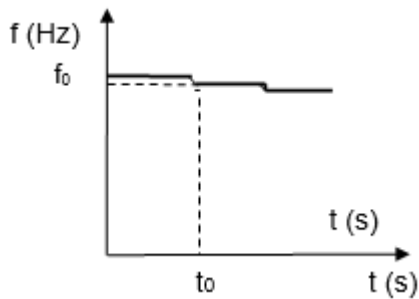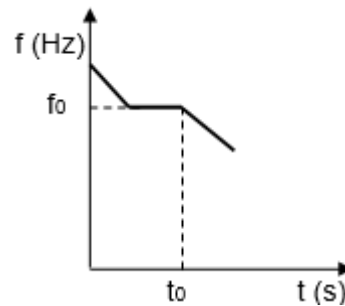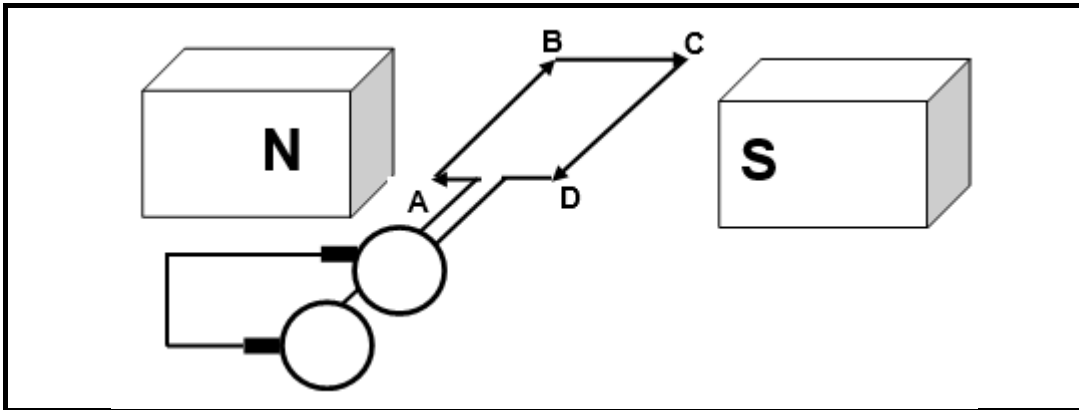

1.7 Two spheres, A and B, have charges of +1 C and +2 C respectively. They are brought into contact with each other and then moved to their original positions.

The amount of charge transferred is …

A   0,5 C from B to A.

B   0,5 C from A to B.

C   1,5 C from B to A.

D   1,5 C from A to B.   (2)

1.8 A simplified diagram of a generator is shown below.

Coil ABCD rotates …

A clockwise.

B anticlockwise.

C clockwise, reaches the vertical position and then reverses its direction.

D anticlockwise, reaches the vertical position and then reverses its direction. (2)

1.9 The circuit diagram below contains a combination of resistors R_1, R_2 and R_3. The battery has an EMF of 12 V and an unknown resistor, *r*.
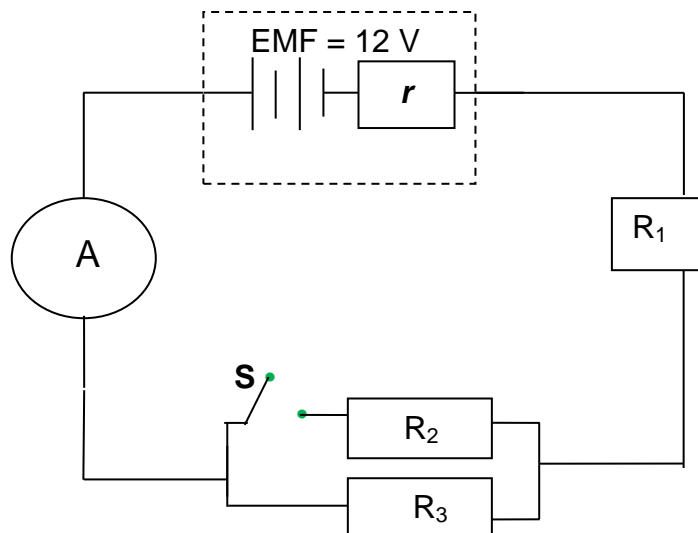
Switch S is now CLOSED.

	$R_{external}$	Reading on ammeter (A)	
A	Decreases	Increases	
B	Decreases	Remains constant	
C	Decreases	Decreases	
D	Increases	Increases	(2)

1.10 A neon tube lights up when a large external voltage is applied across it. Which ONE of the following best describes the type of spectrum observed when the gas inside the tube is observed through a diffraction grating?
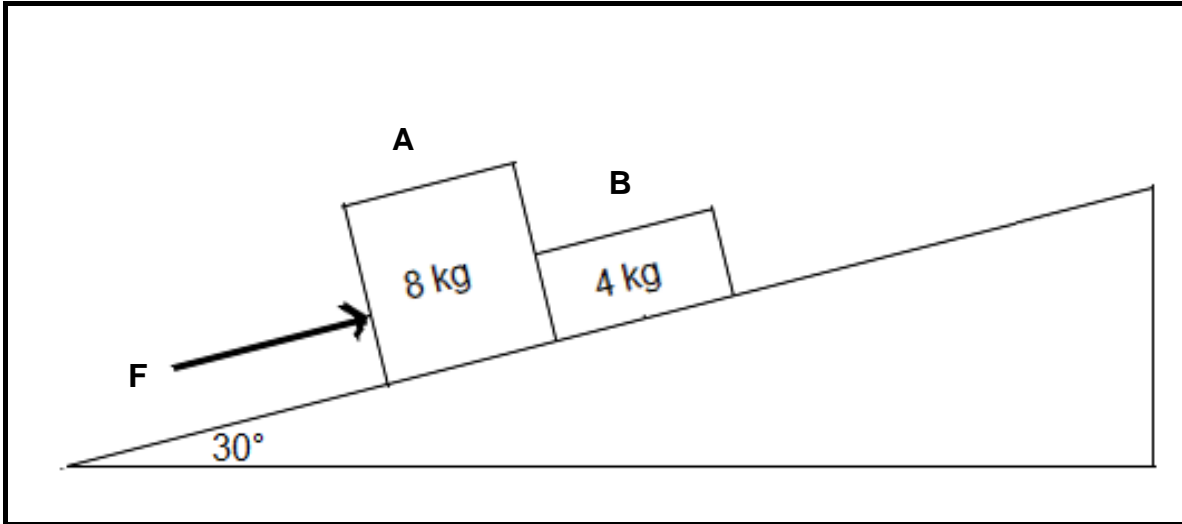
  A Absorption spectrum

  B Continuous emission spectrum

  C Line absorption spectrum

  D Line emission spectrum (2)

  [20]

QUESTION 2 (Start on a new page.)

Two objects, **A** and **B**, of mass 8 kg and 4 kg respectively, are in contact. They lie on a plane inclined at 30° to the horizontal. A force, **F**, applied parallel to the incline, pushes on the objects as shown in the diagram below.

2.1   State *Newton's Second Law of motion* in words.   (2)

The magnitude of kinetic frictional force acting on object **A** is 6,8 N and on object **B** is 3,4 N.

2.2   Draw a labelled free-body diagram of the forces acting on **B** as it moves up the inclined plane.   (4)

2.3   Calculate the:

2.3.1   Magnitude of **F** if the system moves up the inclined plane at CONSTANT VELOCITY.   (5)

2.3.2   Coefficient of kinetic friction for **B**.   (3)

2.4   The angle between the incline and the horizontal changes to 35°.

2.4.1   How will the answer in QUESTION 2.3.2 be affected? Write down INCREASES, DECREASES or REMAIN THE SAME.   (1)

2.4.2   How will the magnitude of the kinetic frictional force on object **B** be affected? Write INCREASES, DECREASES or REMAIN THE SAME. Explain your answer.   (3)

[18]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards at a velocity of 4 m.s⁻¹ from the roof of a building with a of height 10 m. The ball strikes the ground and rebounds to a height of 3 m.
Ignore the effects of friction.
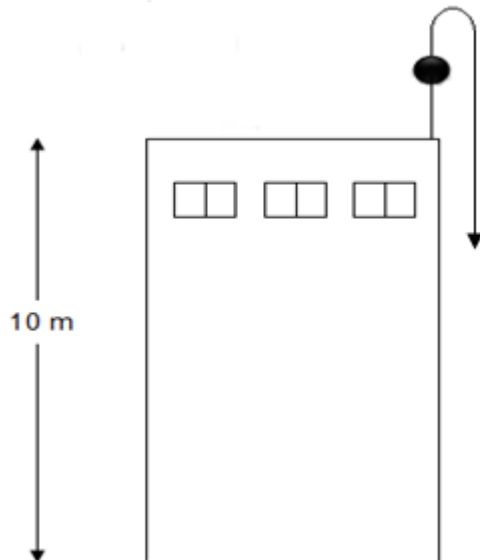
3.1   Calculate the:

     3.1.1   Time taken for the ball to reached its maximum height.   (3)

     3.1.2   Maximum height the ball reaches above the ground.   (4)

3.2   The ball strikes the ground 1,09 s after it was thrown and remains in contact with the ground for 0,2 s before bouncing upwards.

     Sketch a graph (not to scale) of position versus time representing the entire motion of the ball.

   USE THE GROUND AS ZERO REFERENCE.

     Indicate the following on the graph:

- Height from which the ball was thrown
- Maximum height of the ball from ground
- Height reached by the ball after bouncing
- Time the ball strikes the ground
- Contact time of the ball with the ground   (5)

[13]

QUESTION 4 (Start on a new page.)

A boy on a skateboard moves at 5 m.s^{-1} to the right towards point **A** at the bottom of a slope which is 1,6 m high. He is carrying a 4 kg parcel. The total mass of the boy, his skateboard and the parcel is 70 kg. He needs to increase his speed, in order to reach point **B** at the top of the slope. He decides that if he throws the parcel horizontally, it will increase his forward velocity.
IGNORE ALL FRICTION.
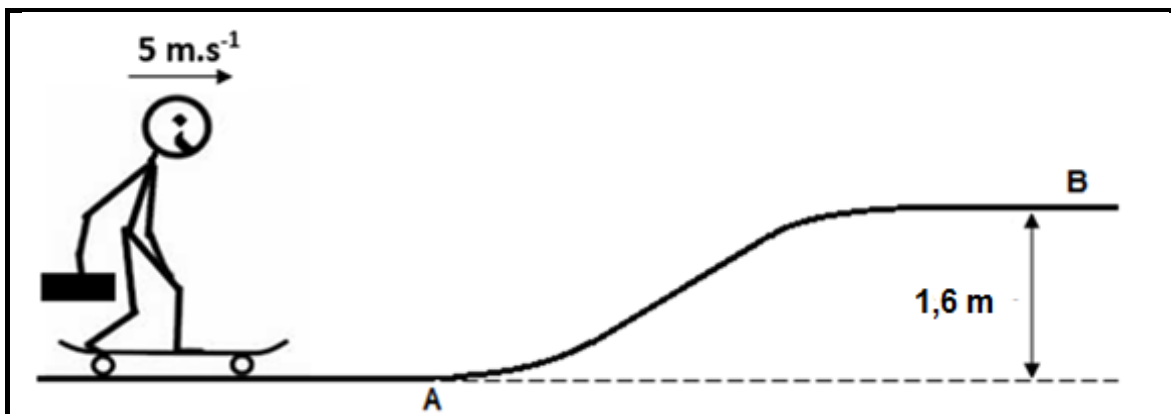
4.1 In which direction must the boy throw the parcel in order to increase his forward velocity? (**TO THE LEFT** or **TO THE RIGHT**) (1)

4.2 Give the name of Newton's law of Motion that you used to obtain your answer in QUESTION 4.1. (1)

4.3 State the *Principle of conservation of mechanical energy.* (2)

4.4 Calculate the velocity of the boy immediately after the parcel leaves his hand in order for him to reach the top of the slope at point **B**. (4)

4.5 Calculate the minimum velocity with which he must throw the parcel in order for him to reach the top of the slope at point **B**. (4)

4.6 How will the answer in QUESTION 4.4 be affected, if the boy throws the same parcel with higher velocity in the same direction as indicated in QUESTION 4.1?

Write down INCREASES, DECREASES or REMAIN THE SAME.
Explain your answer. (3)

[15]

QUESTION 5 (Start on a new page.)

During a fire extinguishing operation, a helicopter remains stationary (hovers) above a dam while filling a bucket with water. The bucket, of mass 80 kg, is filled with 1 600 kg of water. It is lifted vertically upwards through a height of 20 m by a cable at a CONSTANT SPEED of 2 m.s^{-1}. The tension in the cable is 17 000 N.
Assume there is no sideways motion during the lift.
Air friction is NOT ignored.

17 000 N
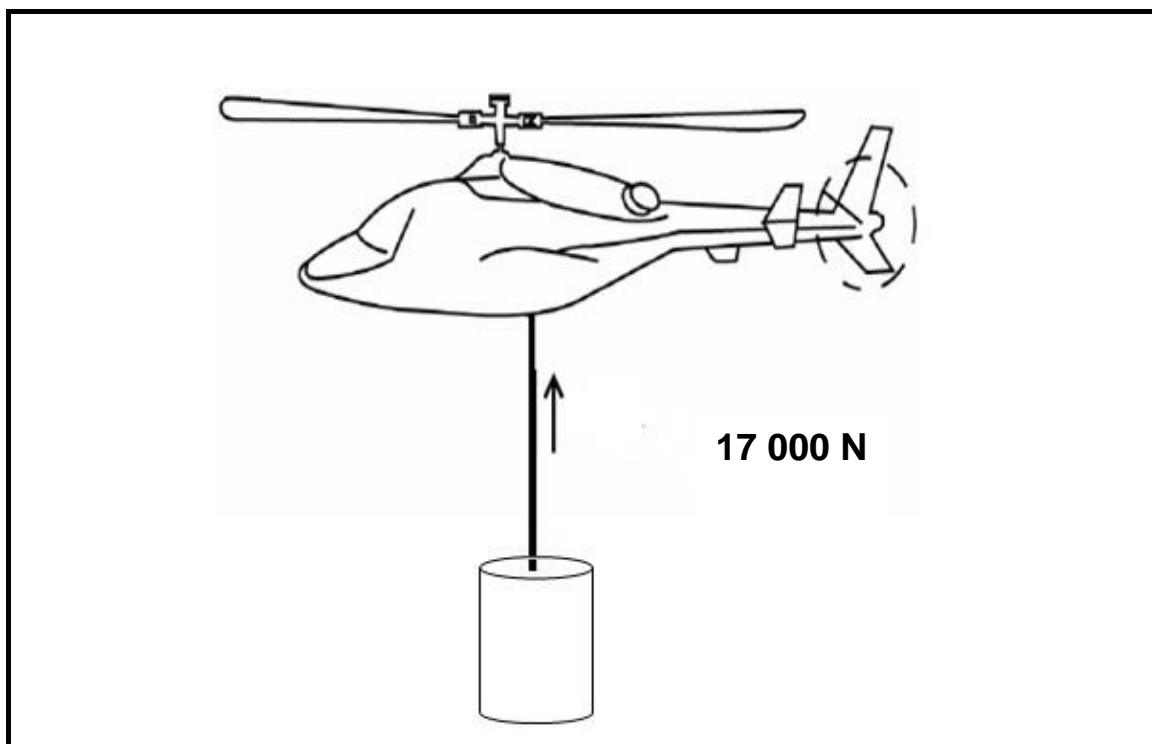
5.1 State the *work-energy theorem* in words. (2)

5.2 Draw a labelled free body diagram showing ALL the forces acting on the bucket of water, while being lifted upwards. (3)

5.3 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)

[10]

QUESTION 6 (Start on a new page.)

A siren of a stationary ambulance emits sound waves of frequency 280 Hz. A car is moving towards a stationary ambulance at a constant speed that is 310 m.s$^{-1,}$ **lower** than the speed of sound in air.

6.1 Define the *Doppler Effect.* (2)

6.2 Calculate the frequency of sound detected by the driver of the car. Use the speed of sound in air as 340 m.s^{-1}. (5)

6.3 How will the answer in QUESTION 6.2 be affected if the car moves away from the ambulance at the same constant speed?

Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

Explain the answer. (3)

6.4 Give ONE use of the Doppler flow meter. (1)

6.5 When a line in a hydrogen spectrum is measured in a laboratory, it has a wavelength of 1,32 x 10^{-15} m. The same line in the light of a star has a wavelength of 1,38 x 10^{-15} m.

Is the star moving TOWARDS, or AWAY from the earth?

Explain your answer. (2)

[13]

QUESTION 7 (Start on a new page.)

A -3 nC charge Q_1 is placed 10 cm away from a +3 nC Q_2 charge as shown in the diagram below.
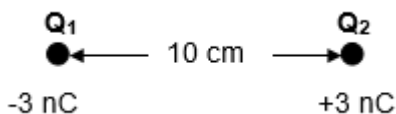
7.1   Draw the electric field pattern formed between the two charges.   (3)

7.2   A -2 nC charge Q_3 is placed 5 cm away from Q_2 as indicated in the diagram below.
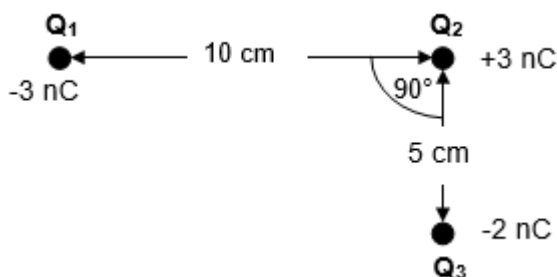
Draw a force diagram showing the electrostatic forces exerted on Q_2 by Q_1 and Q_3 respectively.   (2)

7.3   Calculate the net force exerted on Q_2 by Q_1 and Q_3 respectively.   (8)

7.4   An unknown point charge **R** is placed 3 cm away from point **P** as shown in the sketch below.
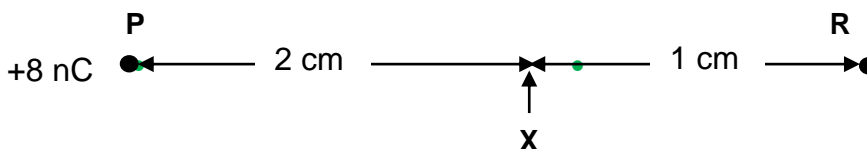
Calculate the charge on **R** if the net electric field strength at point **X** is zero.   (5)
          [18]

QUESTION 8 (Start on a new page.)

The light bulb shown below is able to operate either with direct current or with alternating current. It displays its optimum operating conditions and the accompanying graph displays the current type that is being used.
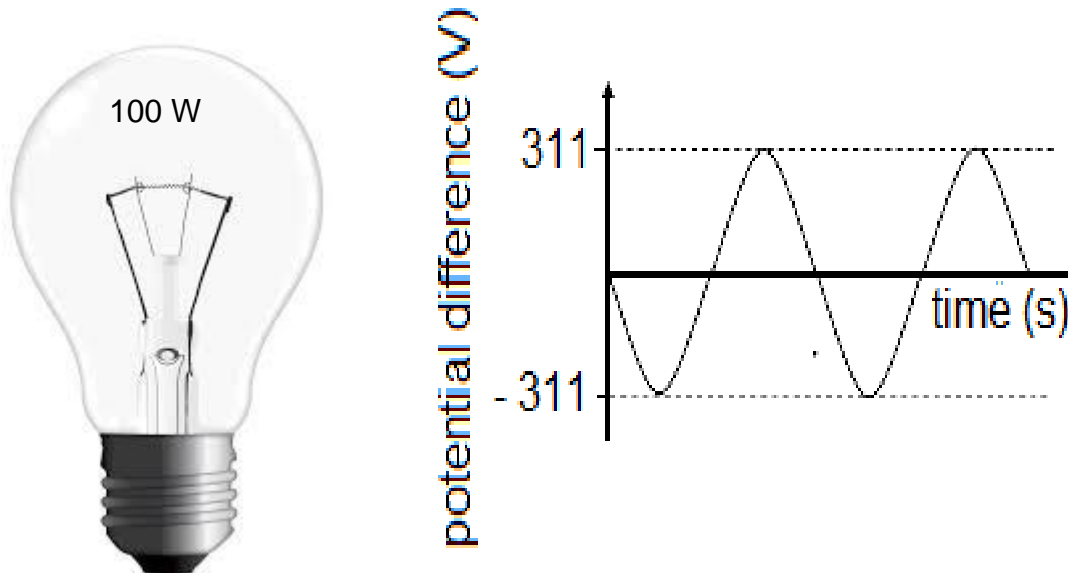
8.1   Is the bulb operating with direct current, or alternating current?   (1)

8.2   Explain the meaning of 100 W.   (1)

8.3   Calculate the rms current in the bulb when it is connected in a circuit.   (4)

8.4   Explain why ESKOM prefers AC instead of DC for long distance
       transmission of electricity.   (2)
                                                                                    [8]

QUESTION 9 (Start on a new page.)

Learners conduct an experiment as shown in the diagram below.
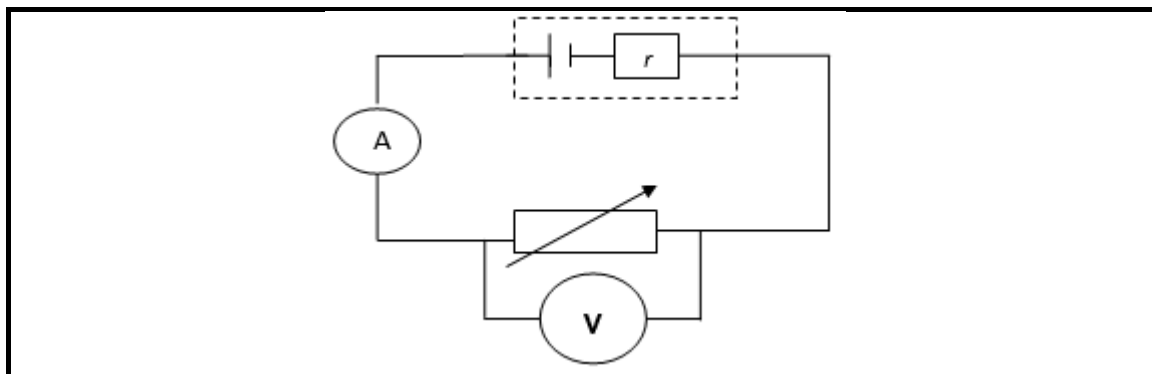
The results obtained are shown in the graph below.

GRAPH OF CURRENT VERSUS POTENTIAL DIFFERENCE
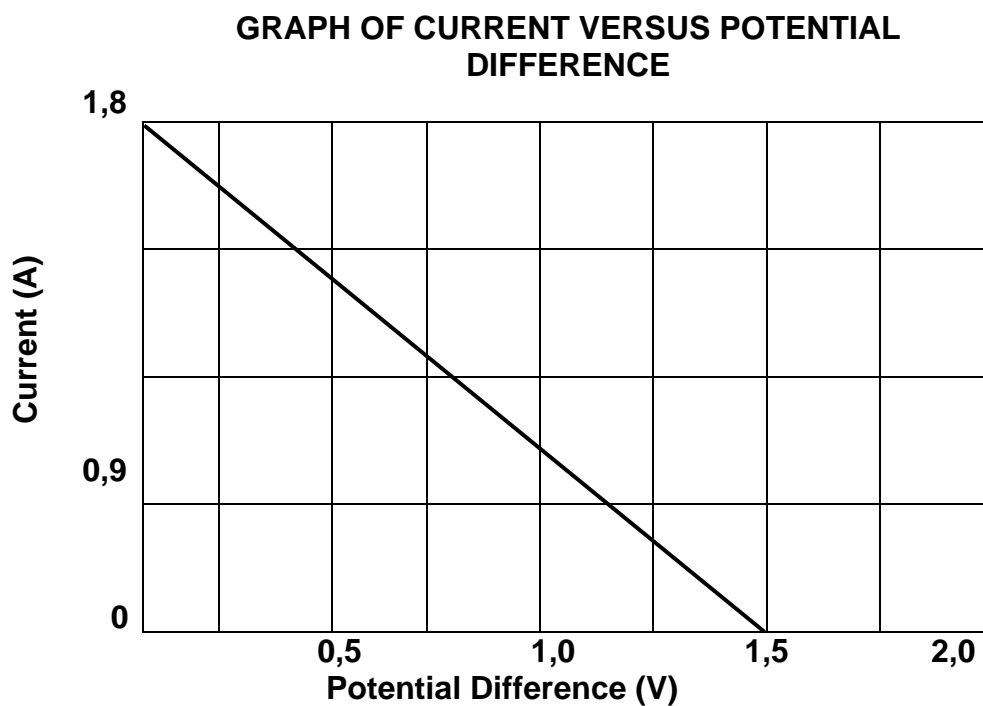
9.1   Use the graph to determine the following:

        9.1.1   Emf (ε) of the battery   (1)

        9.1.2   Internal resistance of the battery, WITHOUT USING THE
                EQUATION $\varepsilon = I(R + r)$ IN YOUR CALCULATIONS   (4)

9.2   The resistance of the rheostat is now increased.

     9.2.1   How will this change the voltmeter reading?
               Write down INCREASES, DECREASES or REMAIN THE
               SAME.   (1)

     9.2.2   Explain your answer.   (3)

9.3   Four identical cells, EACH with a emf of 1,5 V and an internal resistance
     of 0,25 Ω are connected in series with each other and to the resistors as
     shown below.
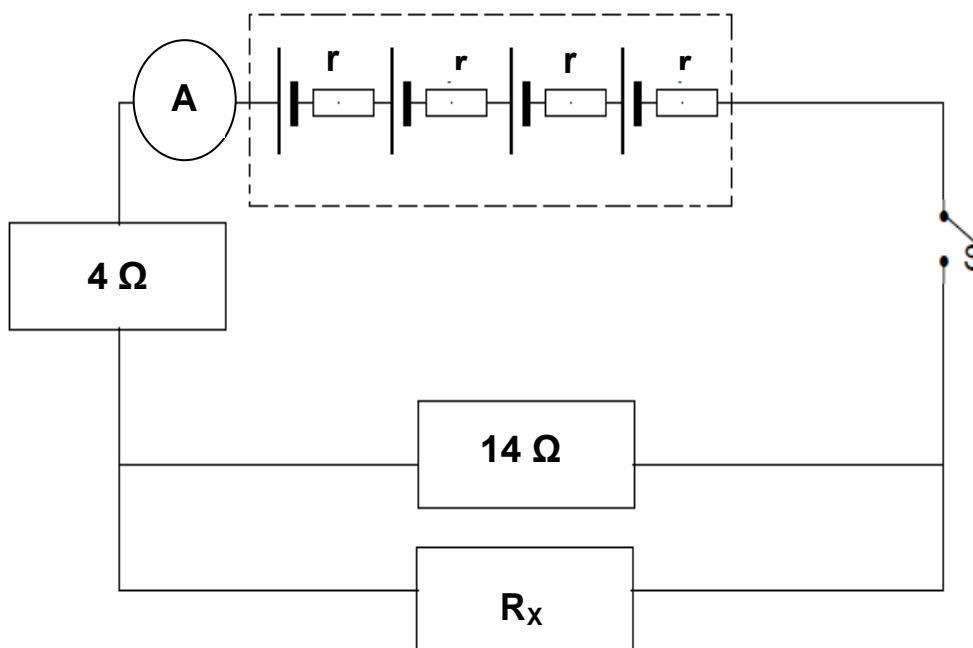
     9.3.1   Write down the potential difference across the cells when the
               switch is open.

     9.3.2   When switch S is closed, the potential difference across the 4 Ω
               resistor is 2 V.

               Calculate the: (2)

               (a)   Current in the circuit   (3)

               (b) R_x (8)
                                                            [22]

QUESTION 10 (Start on a new page.)

The simplified diagram below illustrates how an emitter, when light shines on it, emits electrons.

10.1   What phenomenon is displayed in the diagram?   (1)

The incident monochromatic light transfers energy to the emitter. The emitter releases $1,01 \times 10^9$ photo-electrons per second. The threshold frequency of the emitter is $1,21 \times 10^{15}$ Hz.

(**NOTE**: ONE photon releases ONE electron.)

10.2   Define the term *threshold frequency (cut-off frequency).*   (2)

10.3   Calculate the current flowing through the ammeter.   (5)
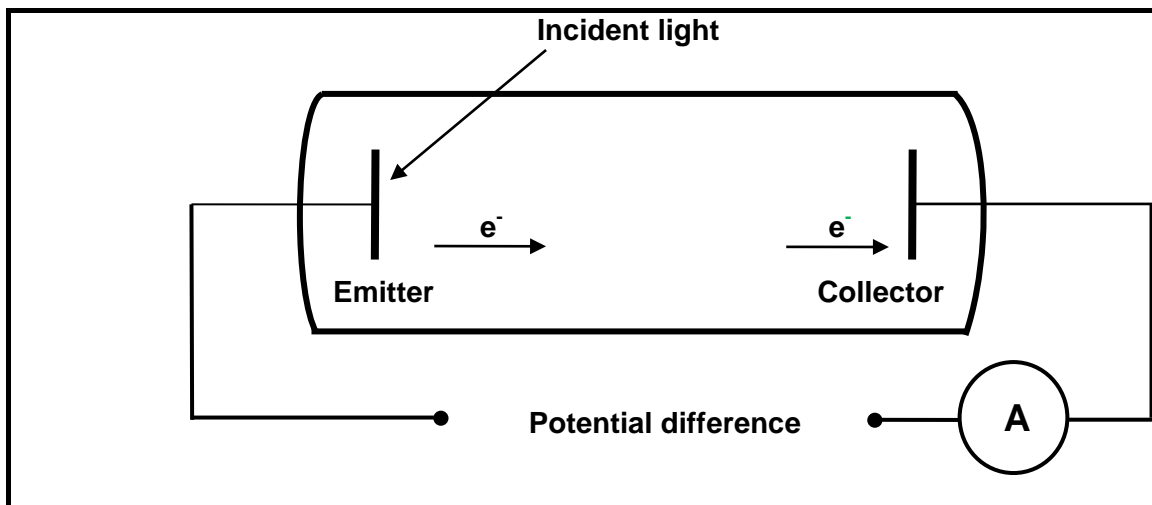
10.4   The brightness of the incident light is now decreased.

        What effect will this change have on the current strength in QUESTION 10.3?

        Write down INCREASES, DECREASES or REMAIN THE SAME.   (1)

10.5   The emitter is replaced by another one with a threshold frequency greater than $1,21 \times 10^{15}$ Hz. The same monochromatic light was used.

        10.5.1   How does this change have an effect on the kinetic energy of the photoelectrons released?

                  Write down only GREATER THAN, SMALLER THAN or STAYS THE SAME.   (1)

        10.5.2   Explain your answer in QUESTION 10.5.1.   (2)

10.6   White light shines through a cold diluted gas and photons with specific frequencies are absorbed and appear as black lines in the continuous spectrum.

        Differentiate between an absorption spectrum and a line emission spectrum.   (2)
                                                                                     [14]

                                                                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 *Swaartekragversnelling*	g	$9,8 \text{ m} \cdot \text{s}^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11} \text{ N} \cdot \text{m}^2 \cdot \text{kg}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8 \text{ m} \cdot \text{s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J} \cdot \text{s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \text{ kg}$
Mass of earth *Massa op aarde*	M	$5,98 \times 10^{24} \text{ kg}$
Radius of earth *Radius van aarde*	R_E	$6,38 \times 10^3 \text{ km}$

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{\,max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \dfrac{Gm_1 m_2}{d^2}$	$g = G\,\dfrac{M}{d^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x \cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \dfrac{1}{2} mv^2$ or/*of* $E_k = \dfrac{1}{2} mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \dfrac{W}{\Delta t}$
$P_{av} = Fv$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \dfrac{1}{f}$
$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \dfrac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\dfrac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \dfrac{1}{2}mv^2$ or/ *of* $K_{max} = \dfrac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \dfrac{kQ_1Q_2}{r^2}$	$E = \dfrac{kQ}{r^2}$
$E = \dfrac{V}{d}$	$E = \dfrac{F}{q}$
$V = \dfrac{W}{q}$	$n = \dfrac{Q}{q_e}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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