NATIONAL
SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages, 1 graph sheet and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.

2. This question paper consists of ELEVEN questions. Answer ALL the questions in the ANSWER BOOK except QUESTION 6.2 which has to be answered on the graph paper attached to this question paper. Write your name in the appropriate space on the graph paper.

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 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 motivations, discussions, 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 only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1   Two vectors, **P** and **Q**, act simultaneously at point **O** as shown in the diagram below. The magnitude of **Q** is greater than the magnitude of **P**.
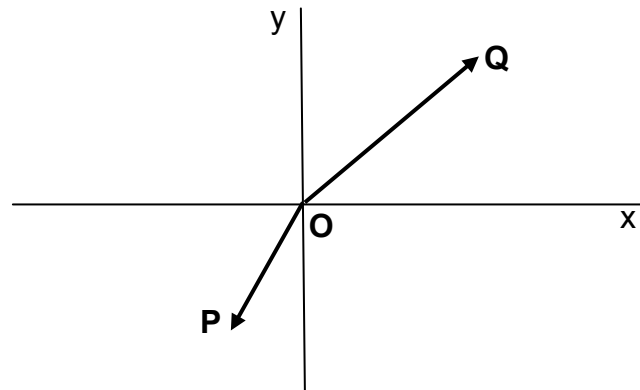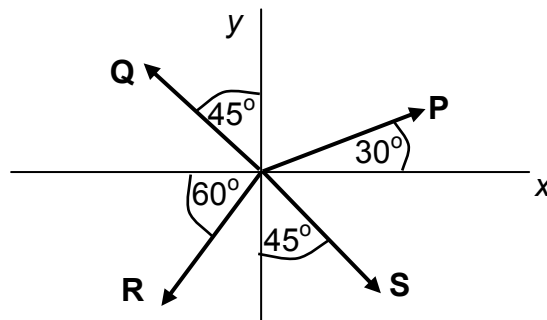
Which ONE of the following could represent the resultant **R** of the two vectors?

(2)

1.2 Forces **P**, **Q**, **R** and **S** all have the same magnitude. The forces act at the same point in the directions shown in the diagram.

Which ONE of the following combinations CORRECTLY shows the vectors having the greatest magnitude for the x-component and for the y-component?

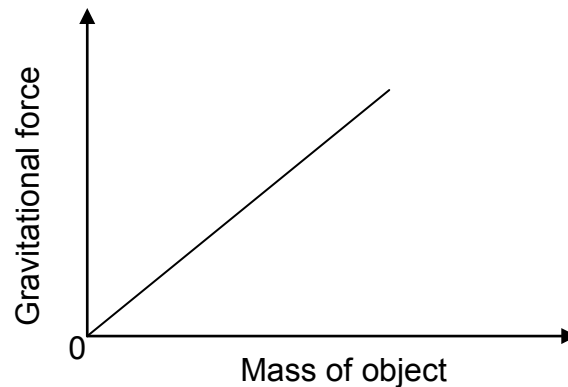|	x-component	y-component
A	Vector **P**	Vector **R**
B	Vector **P**	Vector **Q**
C	Vector **R**	Vector **Q**
D	Vector **R**	Vector **S**

(2)

1.3 If the resultant (net) force acting on an object is zero, the object …

A slows down.

B accelerates uniformly.

C changes its direction of motion.

D continues moving with constant velocity. (2)

1.4   A graph of the gravitational force versus the mass of an object is shown below.

Which ONE of the following CORRECTLY represents the slope of the graph?

A   Velocity of the object

B   Weight of the object

C   Acceleration due to gravity (g)

D   Universal gravitation constant (G)   (2)

1.5   A light wave travels obliquely from air into a glass block and its speed changes.

Which ONE of the combinations below CORRECTLY describes the changes in the **FREQUENCY** of the wave and **REFRACTIVE INDEX** of the block *compared to that of air?*

|	FREQUENCY	REFRACTIVE INDEX
A	Remains the same	Increases
B	Remains the same	Decreases
C	Increases	Decreases
D	Decreases	Increases

(2)

1.6   Sound waves bend readily around buildings whereas light waves only bend very slightly around buildings.

Which ONE of the following statements BEST explains this observation?

A   Sound waves have much longer wavelengths than light waves.

B   Sound waves have much shorter wavelengths than light waves.

C   Sound waves have higher frequencies compared to light waves.

D   Sound waves have greater amplitudes compared to light waves.   (2)

1.7   The electrostatic force between two charged spheres, a distance r apart, is F. When the charge on each sphere is doubled and the distance between the spheres is also doubled, the force between the spheres will now be …

       A   ½ F

       B F

       C   2F

       D   4F (2)

1.8   The electrostatic force F between two charged particles is positive. Which ONE of the following is CORRECT?

       A   The magnitudes of the two charges are equal.

       B   One charge is positive while the other is negative.

       C   The electrostatic force between the charges is attractive.

       D   The electrostatic force between the charges is repulsive.   (2)

1.9   A conducting wire, **XY**, moves between two magnets as shown below.
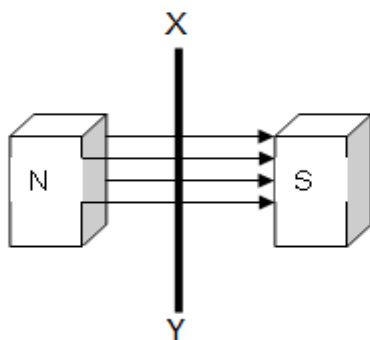
       Which ONE of the following actions can lead to an increased induced current in wire **XY**?

       Move the wire…

       A   quickly and parallel to the magnetic field.

       B   slowly and parallel to the magnetic field.

       C   quickly and perpendicular to the magnetic field.

       D   slowly and perpendicular to the magnetic field.   (2)

1.10 A learner wants to measure the current in and the potential difference across a resistor **R** in a circuit.

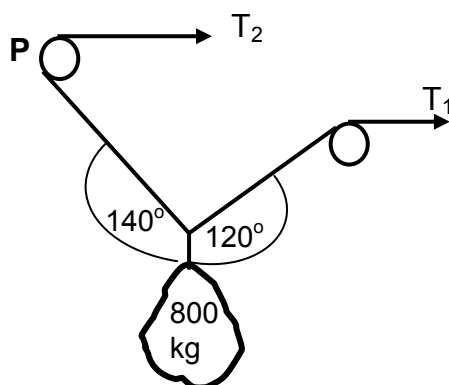In which ONE of the following circuits will the learner be able to take these readings?
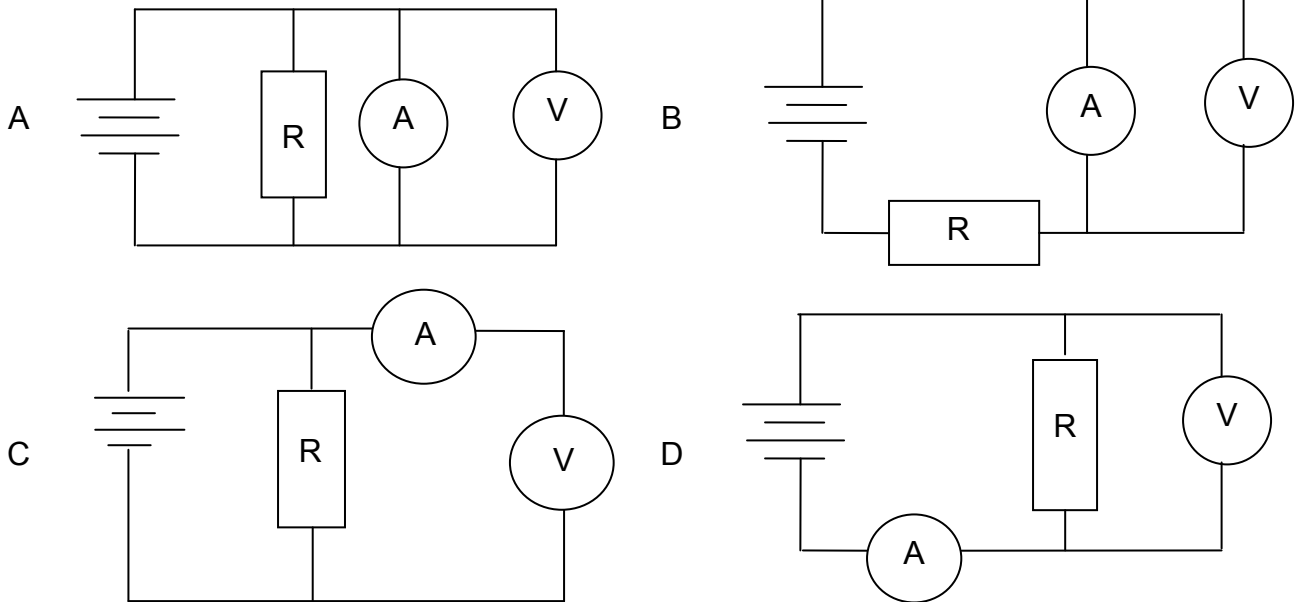
(2)
[20]

QUESTION 2   (Start on a new page.)

The diagram below shows a rope and pulley arrangement of a device being used to lift an 800 N object. Assume that the ropes are light and inextensible and also that the pulley is light and frictionless.


Determine the:

2.1   Magnitudes of the tensions T_1 and T_2 (7)

2.2   Magnitude and direction of the reaction force at pulley **P** (4)

[11]

QUESTION 3   (Start on a new page.)

A block **Q** of mass 70 kg is at rest on a table. It is connected to block **P** by means of two light inextensible strings knotted at **S**. A third string is arranged in such a way that the string connecting block **Q** is **horizontal** as shown in the diagram below. The coefficient of static friction between block **Q** and the surface of the table is 0,25. The knot **S** is in equilibrium.
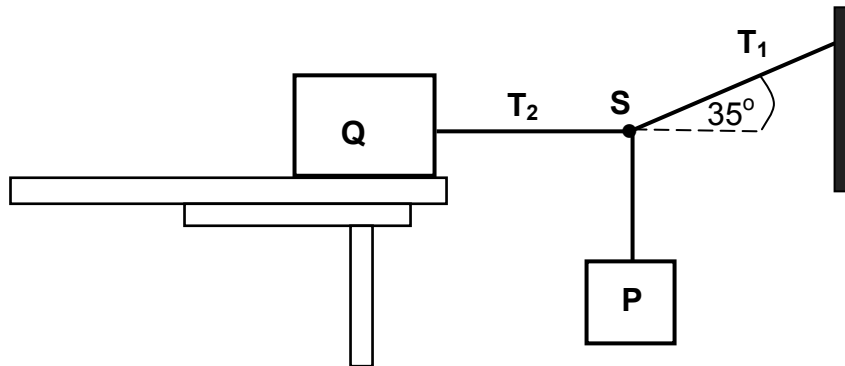
The tension in the string connecting block **Q** is T_2 and that for the string that pulls at 35° is T_1 as shown in the diagram.

3.1   Define the term *static frictional force* in words. (2)

3.2   Explain what is meant by *the knot S is in equilibrium.* (2)

3.3   Draw a labelled free-body diagram to show all the forces acting on:

3.3.1   The knot at **S** (3)

3.3.2   Block **Q** (4)

3.4   Calculate the maximum weight of block **P** for which block **Q** will just begin to slip. (7)

[18]

QUESTION 4   (Start on a new page.)

A block of mass 8 kg resting on a rough horizontal table is connected by a light inextensible string which passes over a light frictionless pulley to another block of mass 5 kg. The 5 kg block hangs vertically as shown in the diagram below.

A 15 N force is applied to the 8 kg block at an angle of 30° to the horizontal, causing the block to slide to the left.
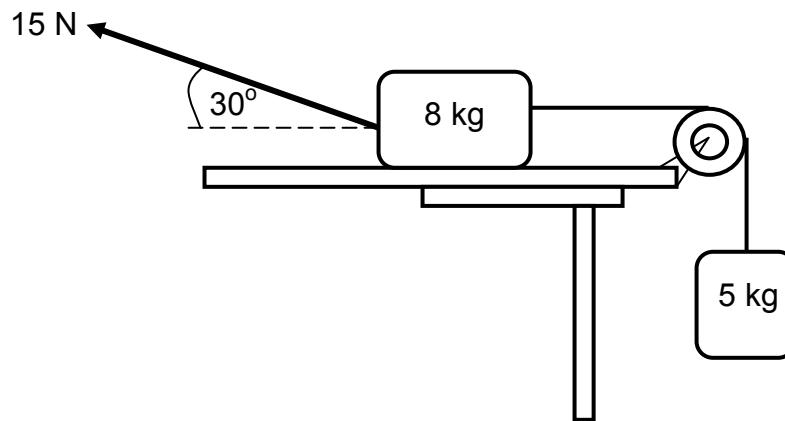
The coefficient of kinetic friction between the 8 kg block and the surface of the table is 0,25. Ignore the effects of air friction.

4.1   Draw a free-body diagram showing ALL the forces acting on the 8 kg block.   (5)

4.2   Write down Newton's second law of motion in words.   (2)

Calculate the magnitude of the:

4.3   Normal force acting on the 8 kg block   (3)

4.4   Tension in the string connecting the two blocks   (6)
[16]

QUESTION 5   (Start on a new page.)

5.1   Write down Newton's law of universal gravitation in words.   (2)

An object weighing 140 N on the surface of the earth is moved to a position which is $6,7 \times 10^6$ m above the surface of the earth.

5.2   Calculate the percentage by which its weight will change.   (8)
[10]

QUESTION 6   (Start on a new page.)

Learners investigate how the path of a light ray incident on an air-glass boundary changes as it enters the glass medium.

Their results are shown in the table below.

angle i°	angle r°	sin i	sin r
15	10	0,259	0,174
25	16	0,423	0,276
45	28	0,707	0,469
55	33	0,819	0,545
60	35	0,866	0,574
70	39	0,940	0,629

6.1   For this investigation, write down the:

      6.1.1   Dependent variable (1)

      6.1.2   Independent variable (1)

      6.1.3   Constant (control) variable (1)

6.2   Draw an appropriate graph of the data in the table and use it to obtain the refractive index of the glass material.

   USE THE GRAPH PAPER ATTACHED TO YOUR QUESTION PAPER TO ANSWER THIS QUESTION. (8)

6.3   Use the result in QUESTION 6.2 to calculate the speed of light through the glass material. (3)

[14]

QUESTION 7   (Start on a new page.)

In the diagram below (not to scale), a ray of light, **PO**, is travelling from flint glass towards the boundary with crown glass.

The angle of incidence of ray **PO** at the boundary between the two surfaces ($\angle PON^{/}$) is 21º.
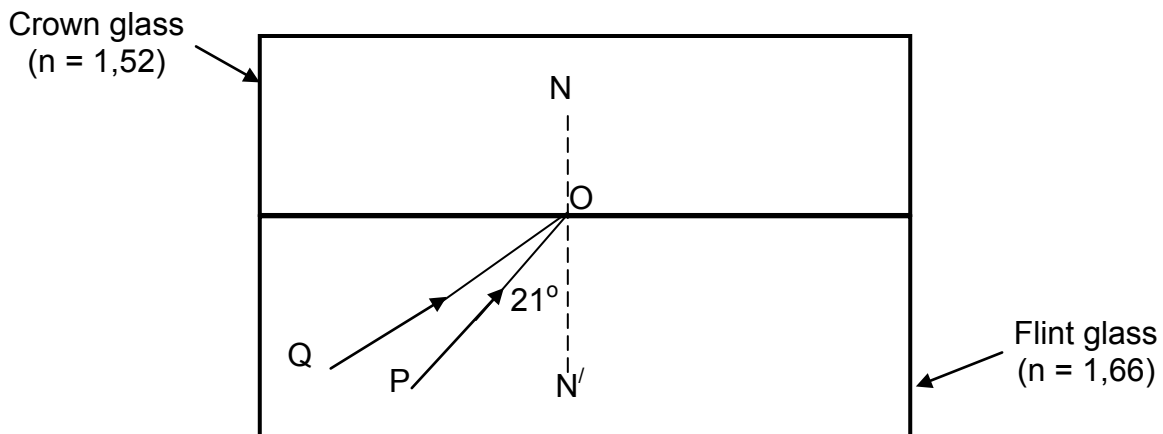
7.1   Write down Snell's law in words.   (2)

The refractive indices of crown glass and flint glass are 1,52 and 1,66 respectively as shown in the diagram above.

7.2   Calculate the critical angle for the boundary between the two glass materials.   (3)

Copy the diagram into your ANSWER BOOK.

7.3   On your diagram draw a ray to show what happens to light ray **PO** at the boundary between the two glass surfaces. Label the ray **OX**.   (1)

7.4   Ray **QO** is incident at the boundary at 40º.

       Draw a ray to show what happens to light ray **QO** at the boundary between the two glass surfaces. Label the ray **OY**. Include the angle $\angle N^{/}OY$ on your drawing.   (2)

7.5   How does the speed of light in the crown glass compare to that in the flint glass? Write down only GREATER THAN, LESS THAN or EQUAL TO.   (1)
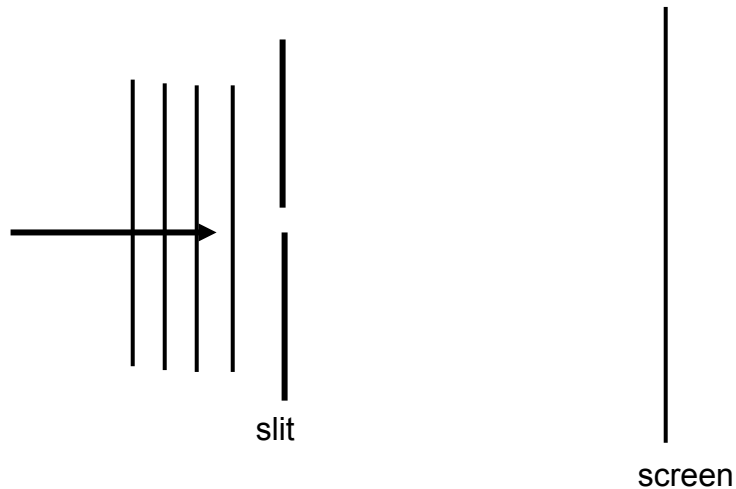
[9]

QUESTION 8   (Start on a new page.)

Diffraction provides evidence that light can behave as a wave.

8.1   Define the term *diffraction* in words.   (2)

In the diagram below a plain wave front of light of wavelength 6×10^{-7} m approaches a narrow opening. Diffraction effects are observed on a screen placed some distance from the slit as shown in the diagram below.

slit

screen

8.2   Describe the pattern observed on the screen.   (2)

8.3   Two important principles explain the diffraction pattern.

Write down the NAME of each of these principles.   (2)

8.4   The width of the slit (opening) is increased slightly. Describe how this change will affect the:

8.4.1   Diffraction pattern observed   (1)

8.4.2   Brightness of the diffraction pattern observed   (1)

8.5   The width of the slit is kept constant but light of wavelength 4×10^{-7} m is now used. Describe how this change will affect the diffraction pattern obtained.   (1)

[9]

QUESTION 9   (Start on a new page.)

Two point charges of +2 µC and +3 µC are placed a distance of 0,2 m apart. **P** is a point on the line joining the two charges, a distance of x m from the 3 µC charge such that the **net electric field at point P** is zero.
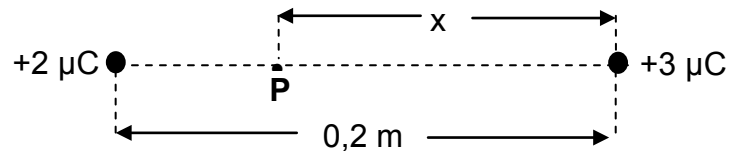
9.1   Define the term *electric field at a point* in words.   (2)

9.2   Calculate the distance **x**.   (7)

A -4 µC charge is now placed a distance of 0,1 m from the +3 µC charge as shown in the sketch below.
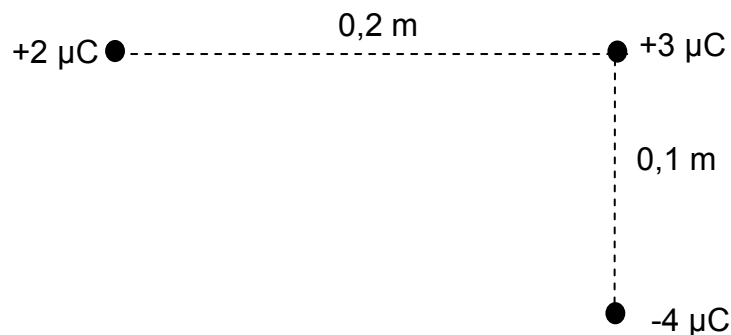
9.3   Calculate the *magnitude* of the electrostatic force experienced by the +3 µC charge due to the presence of the other two charges.   (5)

[14]

QUESTION 10   (Start on a new page.)

In the diagram below a bar magnet is being pushed into a coil. The current induced in the coil is in the direction indicated.
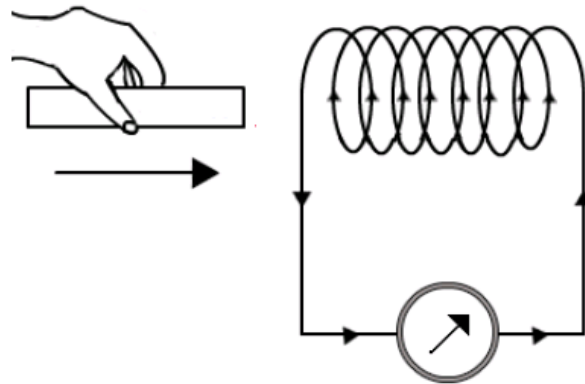
10.1   Write down the polarity (north pole or south pole) of the end of the coil facing the bar magnet, as the bar magnet approaches the coil.   (2)

10.2   Which end of the bar magnet is approaching the coil? Write down only NORTH POLE or SOUTH POLE   (1)

10.3   Write down what will be observed on the galvanometer if the bar magnet is held stationary inside the coil. Give a reason for the answer.   (2)

Faraday's law of electromagnetic induction plays a very important role in the generation of electricity.

10.4   Write down Faraday's law of electromagnetic induction in words.   (2)

A coil of 100 turns, each of area $4,8 \times 10^{-4}$ m^2, is made from insulated copper wire. The coil is placed in a uniform magnetic field of 4×10^{-4} T in such a way that the angle between the magnetic field and the normal to the plane of the coil is 30°. The coil is then rotated so that the angle changes to 70° in a time interval of 0,2 s.

Calculate the:

10.5   Magnitude of the emf induced in the coil   (5)

10.6   Current induced in the coil if it has an effective resistance of 2 Ω   (3)
                                                                                                                                          [15]
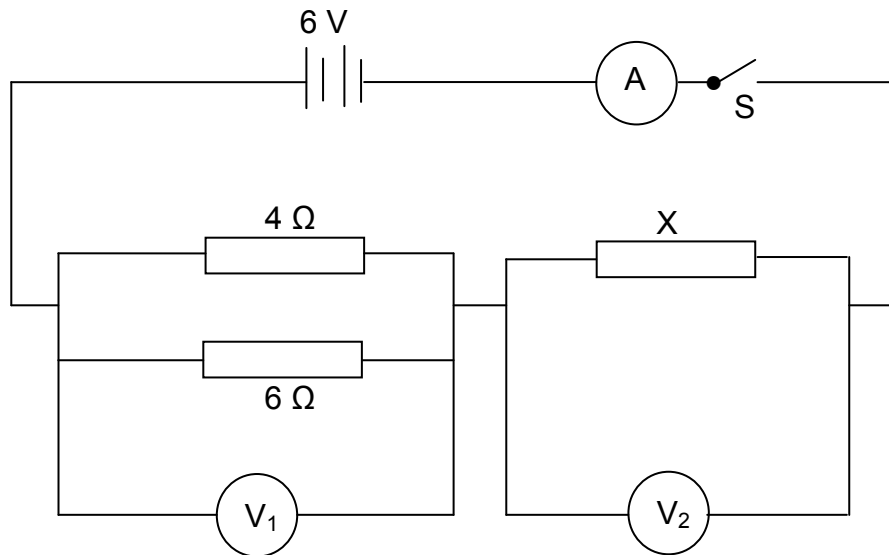
QUESTION 11   (Start on a new page.)

In the circuit below the internal resistance of the 6 V battery is negligible. The resistance of the connecting wires is negligible. When switch **S** is closed, the current in the 6 Ω resistor is 0,6 A.

11.1   State Ohm's law in words.   (2)

Calculate the:

11.2   Current passing through the 4 Ω resistor   (4)

11.3   Total current in the circuit   (2)

11.4   Resistance **X**   (3)

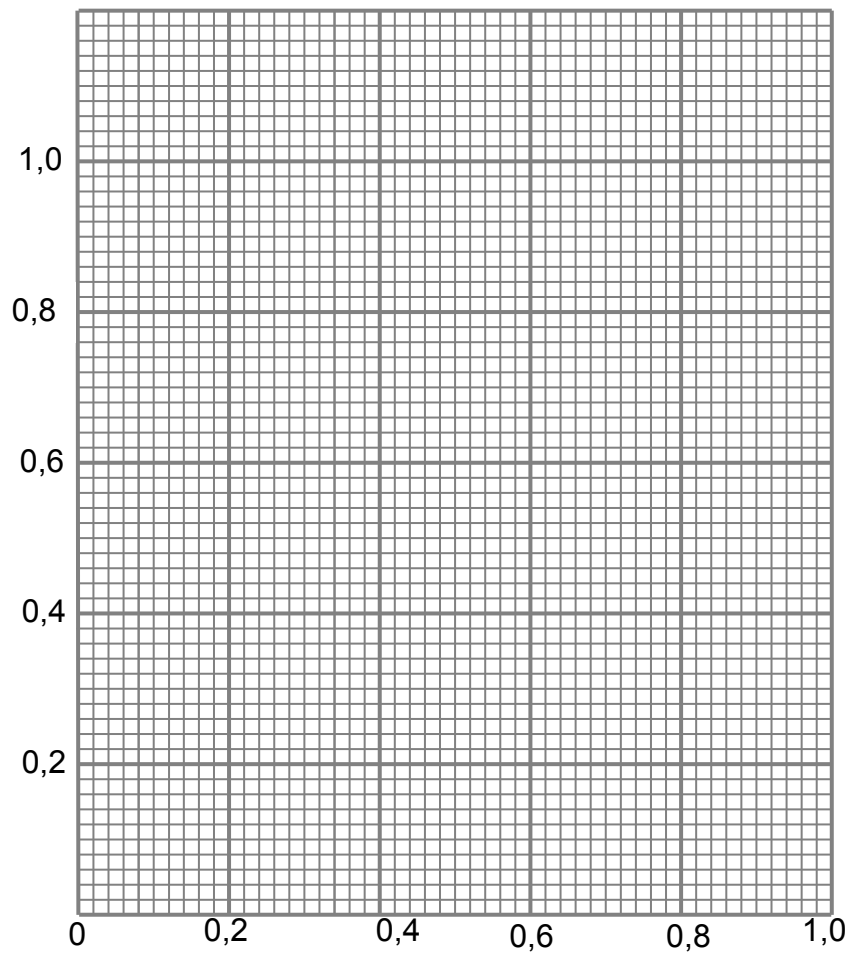The 4 Ω resistor gets hotter than the 6 Ω resistor after a while.

11.5   Explain this observation.   (3)

[14]

GRAND TOTAL: 150

NAME OF THE LEARNER:

GRAPH PAPER FOR QUESTION 6.2

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9{,}8 \ \text{m·s}^{-2}$
Gravitational constant *Swaartekragkonstante*	G	$6{,}67 \times 10^{-11} \ \text{N·m}^2\text{·kg}^{-2}$
Radius of Earth *Straal van Aarde*	R_E	$6{,}38 \times 10^6 \ \text{m}$
Coulomb's constant *Coulomb se konstante*	K	$9{,}0 \times 10^9 \ \text{N·m}^2\text{·C}^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3{,}0 \times 10^8 \ \text{m·s}^{-1}$
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 the earth *Massa van die Aarde*	M	$5{,}98 \times 10^{24} \ \text{kg}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\,\Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f{}^2 = v_i{}^2 + 2a\Delta x$	$\Delta x = \left(\dfrac{v_f + v_i}{2} \right) \Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$w = mg$
$F = \dfrac{Gm_1m_2}{r^2}$	$\mu_s = \dfrac{f_{s(max)}}{N}$
$\mu_k = \dfrac{f_k}{N}$	

EASTERN CAPE

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

$v = f \lambda$	$T = \dfrac{1}{f}$
$n_i \sin \theta_i = n_r \sin \theta_r$	$n = \dfrac{c}{v}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \dfrac{kQ_1Q_2}{r^2}$ (k = 9,0 x 10^9 N·m^2·C^{-2})	$E = \dfrac{F}{q}$
$E = \dfrac{kQ}{r^2}$ (k = 9,0 x 10^9 N·m^2·C^{-2})	$V = \dfrac{W}{Q}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\varepsilon = -N\dfrac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

CURRENT ELECTRICITY/*STROOMELEKTRISITEIT*

$I = \dfrac{Q}{\Delta t}$	$R = \dfrac{V}{I}$
$\dfrac{1}{R} = \dfrac{1}{r_1} + \dfrac{1}{r_2} + \dfrac{1}{r_3} + \ldots$	$R = r_1 + r_2 + r_3 + \ldots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \dfrac{V^2\Delta t}{R}$	$P = \dfrac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \dfrac{V^2}{R}$

EASTERN CAPE