Hillcrest High School

PHYSICAL SCIENCE P1

Nov 2024

Grade 11

MARKS: 121
TIME: 2,5 Hours

EXAMINER: Ms N. Badenhorst
MODERATOR: Mrs J. Knox-Whitehead

Instructions:

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (16)
   SECTION B (109)
4. Answer SECTIONS A and B in the ANSWER BOOK.
   Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to <u>two decimal</u> places

SECTION A

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 (1.1-1.7) in the answer book.

1.1 The driver of a truck places a suitcase on the level dashboard in front of him. He observes the suitcase is sliding towards the windscreen. At this instant the truck is probably moving…

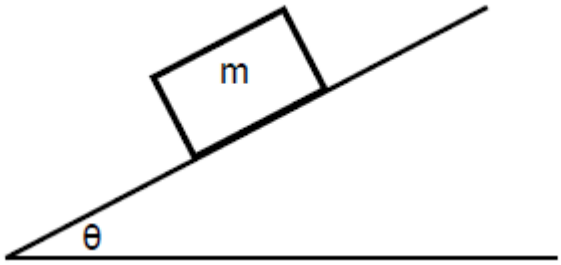
A forward at constant velocity

B backward and slowing down

C forward and slowing down

D back at constant velocity

1.2 A crate of mass m is stationary on a plane inclined at an angle Θ with the horizontal



Which one of the following statements regarding the magnitude of the frictional force acting on the crate is CORRECT?

The magnitude of the frictional force acting on the crate is…

A equal to the component of the weight of the crate which is parallel to the plane

B larger than the component of the weight of the crate which is parallel to the plane

C equal to the component of the weight of the crate which is perpendicular to the plane

D larger than the component of the weight of the crate which is perpendicular to the plane

1.3 An object has a weight of 540 N on planet X. What is the weight on earth, if the planet has half the mass of earth and a ¼ of earth's radius.

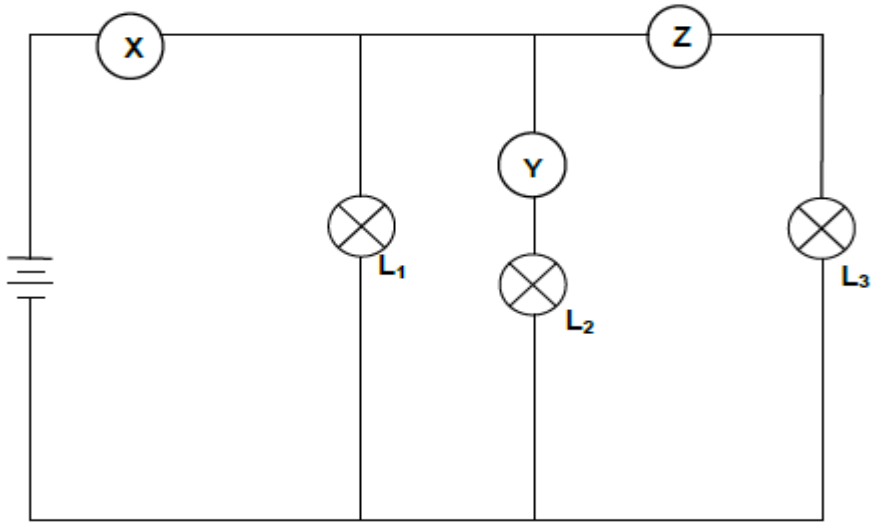
A 270 N

B 67,5 N

C 1080 N

D 4320 N

1.4 In the given circuit diagram below, the three light bulbs **L_1, L_2, L_3** are IDENTICAL. **X**, **Y** and **Z** are readings on the ammeters in the circuit.



Which ONE of the following mathematical equations is CORRECT?

A Y = X – Z

B X = 3Y

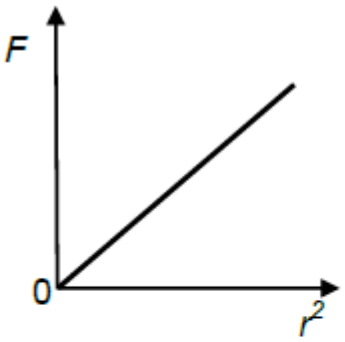
C X = Y + Z

D X = Y - Z

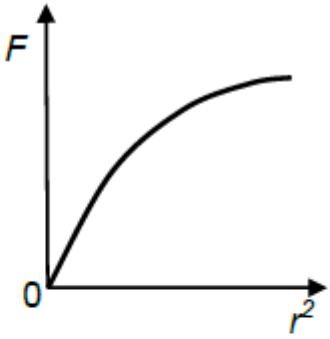
1.5 A proton and an electron are a distance *r* part. The magnitude of the electrostatic force that they exert on each other is *F*.

Which ONE of the following graphs shows the relationship between *F* and r^2 as the proton and the electron approach each other?

A

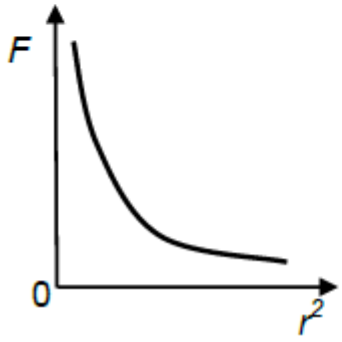


B

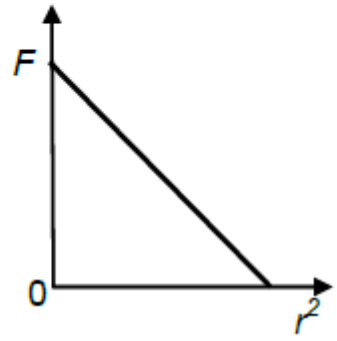


.

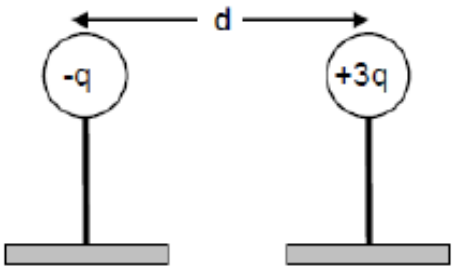
C



D



1.6 Two small identical metal spheres, on insulated stands, carry charges -q and +3q respectively. When the centres of the spheres are a distance **d** apart, the spheres exert an electrostatic force of magnitude *F* on each other



The spheres are now made to touch and brought back to the same positions as before.

The magnitude of the electrostatic force which the spheres now exert on each other, in terms of F, is:

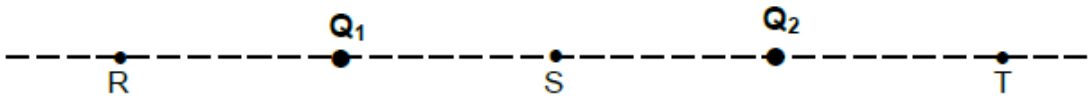
A $\frac{4}{3}F$

B $\frac{1}{3}F$

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

D $3F$

1.7 A *positive* point charge Q_1 and a *negative* point charge Q_2 of equal magnitudes are held at fixed positions, as shown in the diagram below.

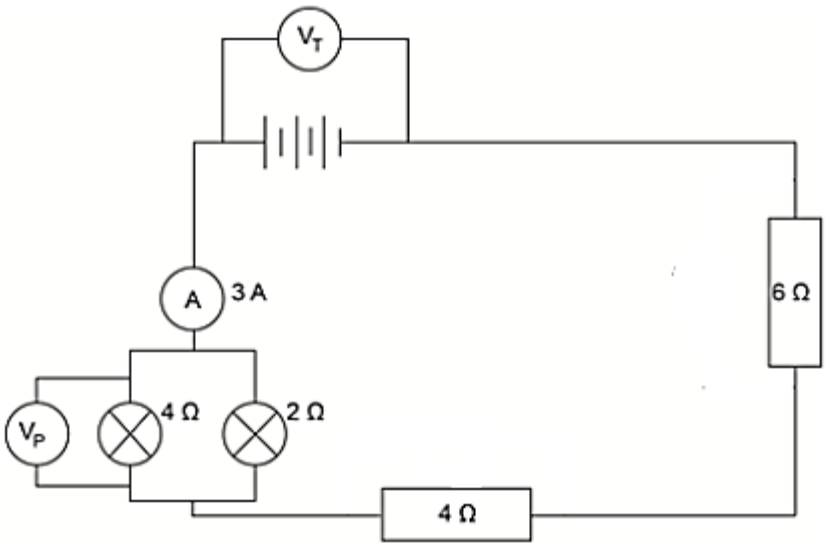


S is exactly halfway between Q_1 and Q_2.

Which ONE of the following combinations gives the correct direction of the net electric field due to the presence of the charges Q_1 and Q_2 at positions **R**, **S** and **T** respectively.

	R	S	T
A	Right	Left	Right
B	Right	Right	Left
C	Left	Right	Right
D	Left	Right	Left

1.8 The circuit diagram shows two light bulbs of resistance 4 Ω and 2 Ω each connected in parallel to the circuit. The two resistors of resistance 4 Ω and 6 Ω each are connected in series to the circuit.



If the 2Ω light bulb burns out what happens to the reading on V_p?

A Stays the same

B Decreases

C Increases

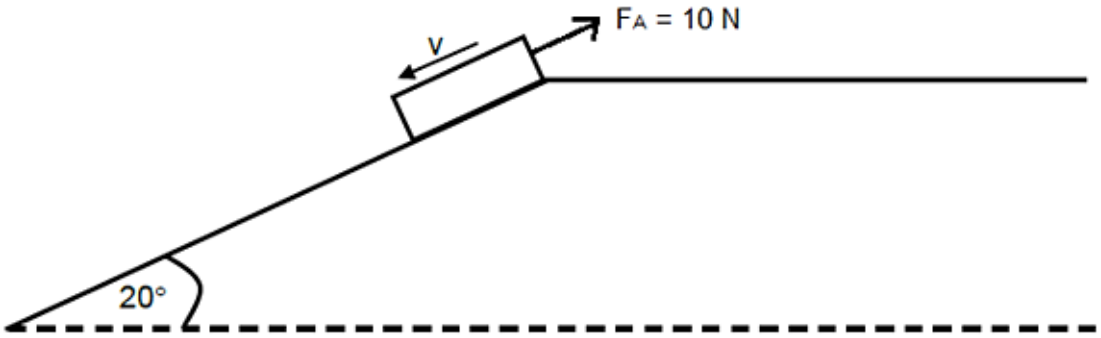
D Becomes zero

[2 x 8 = 16]

Section B

Question 2

A box of mass **65 kg** slides down an incline, as shown in the diagram below**.** A 10 N force is applied to the box while it slides down the incline.

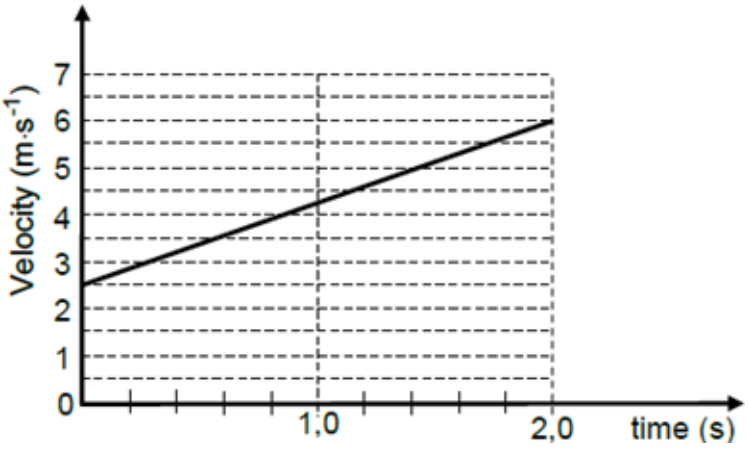


The incline makes an angle of 20° with the horizontal. The frictional force acting on the box is constant.

2.1.1 Define the term *frictional force*. (2)

2.1.2 Draw a labelled free-body diagram for the box as it slides down the incline. (4)

The velocity versus time graph for the box as it moves down the incline is shown below.

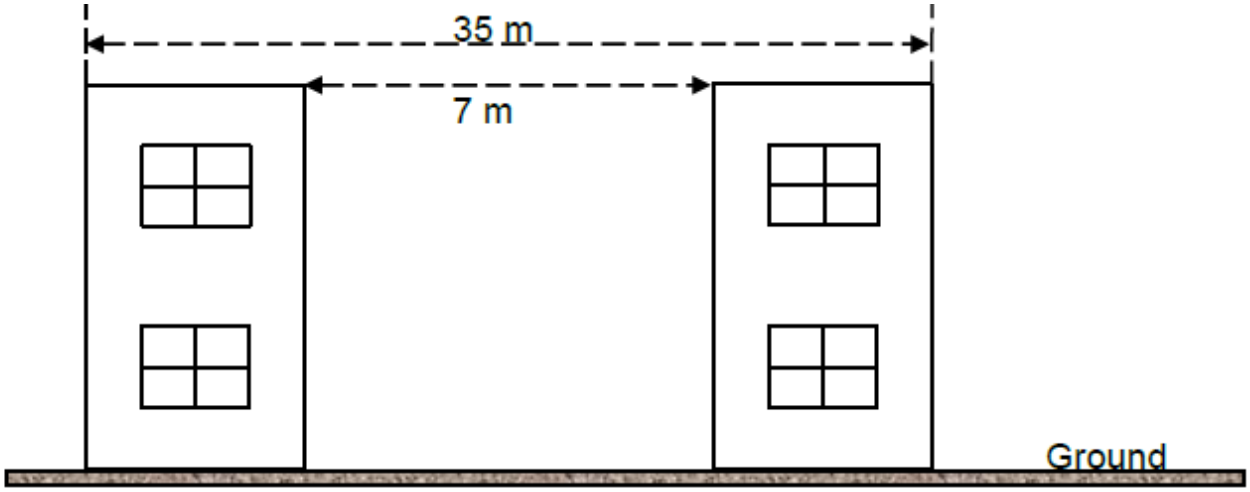


2.1.3 Use the data in the graph to show that the magnitude of the acceleration of the box is 1,75m.s^{-2}. (3)

2.1.4 State, in words, *Newton's second Law of motion*. (2)

2.1.5 Calculate the coefficient of kinetic friction experienced by the box. (6)

2.2 In two adjacent buildings of the same size, the two walls nearest one another are 7 m apart and the walls furthest from one another are 35 m apart, as the diagram below illustrates.



Use an appropriate calculation to show that the gravitational force that the two inner walls exert on each other is 25 times bigger than that of the two outer walls on each other (i.e. $F_{g(\text{inner walls})} = 25 \times F_{g(\text{outer walls})}$). (4)

[21]

Question 3

Mars has an average radius of 3390 km and a mass of 6,39 x 10^{23} kg. Mars has two moons.

3.1 State Newton's Law of Universal Gravitation in words. (2)

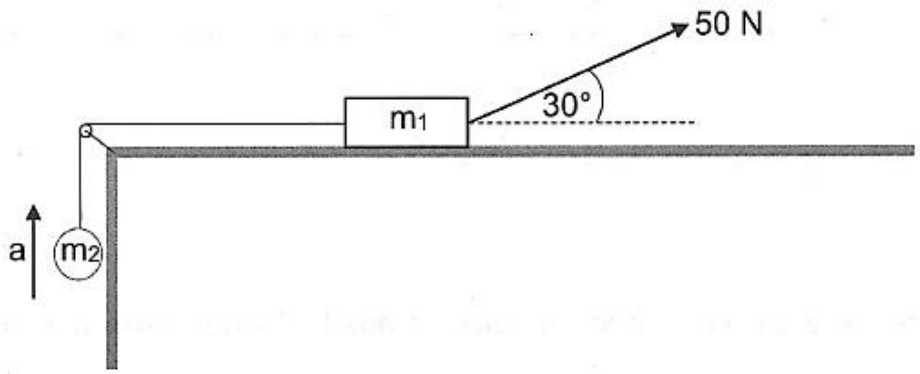
3.2 If the gravitational force exerted by Mars on one of its moons with mass 1,08 x 10^{16} kg is 5,71 x 10^{15} N, calculate the distance between the centre of this moon and the surface of Mars. (6)

[8]

Question 4

A block of mass $m_1 = 5$ kg, on a *rough*, horizontal surface is connected to a ball of mass $m_2 = 200$ g by a string over a frictionless pulley.

A force of magnitude 50 N at an angle of 30° with the horizontal is applied to the block, as shown in the diagram below.



The coefficient of kinetic friction between the block and the surface is 0,21. Ignore the effects of air resistance and the masses of the string and pulley.

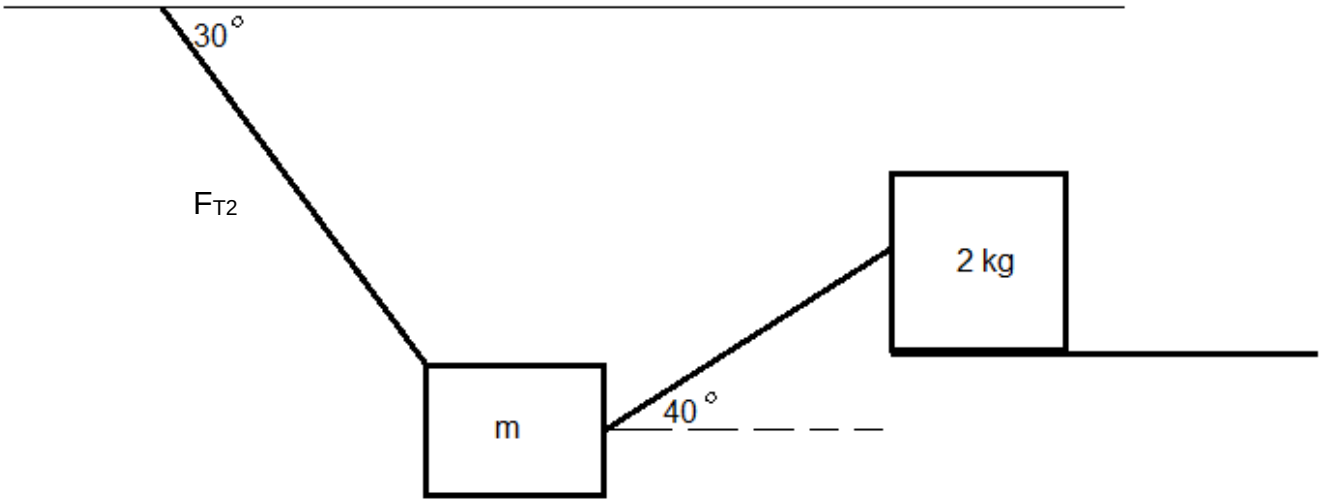
4.1 Draw a labelled free-body diagram for the block. (5)

4.2 Applying Newton's Second Law, calculate the tension in the string connecting the block to the ball. (5)

[10]

Question 5

A block of mass, m is suspended from a string attached to the ceiling and attached to a stationary block of mass 2 kg on a flat surface. The static friction between the 2 kg block and the surface is 3,92. The block, m is held is position.



5.1 Draw a fully labelled free-body diagram of all the forces acting on block m. (3)

5.2 Are the forces acting on block m in equilibrium? Explain your answer. (2)

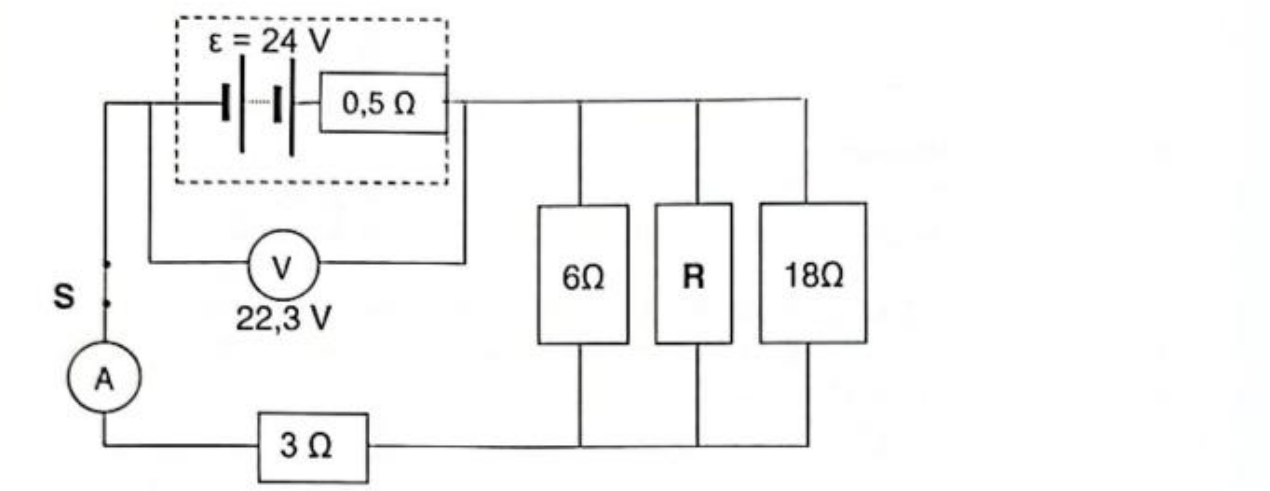
5.3 The maximum force that either string can support is 8 N. Calculate the maximum mass of the block that can be supported. (4)

[9]

Question 6

A battery with an internal resistance of 0,5 Ω and emf (Ɛ) of 24 V is connected to four resistors, a closed switch, a high resistance voltmeter(V) with 22,3 V and ammeter of negligible resistance, as shown in the diagram below.

The resistance of the connecting wires must be ignored.



6.1 Explain the term emf of 24 V with reference to work done. (2)

6.2 Calculate the:

6.2.1 Current in the 3 Ω resistor. (3)

6.2.2 Power dissipated in the 18 Ω resistor. (5)

6.2.3 Current in resistor R. (5)

Resistor R is removed from the circuit

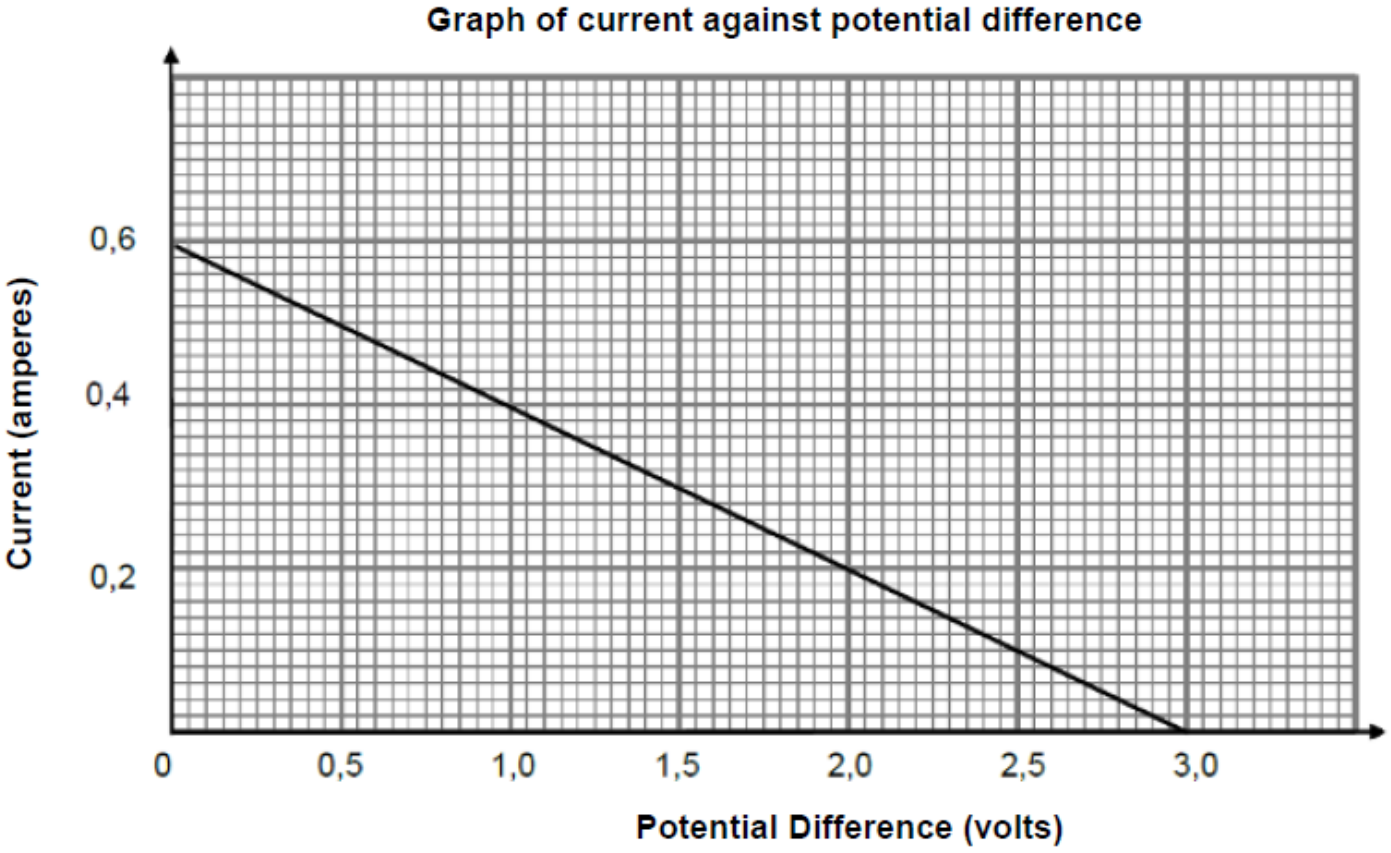
6.3 Will the power dissipated in the 18 Ω resistor INCREASE, DECREASE or REMAIN THE SAME? Explain the answer. (3)

6.4 Calculate the cost of running a 3000 W tumble dryer for 2 hours if the cost of electricity is currently R2,72 per kWh. (4)

[22]

Question 7

A learner sets up a circuit to determine the emf (ε) and internal resistance (r) of a battery. The learner obtained the following graph from the data of the investigation.



7.1 Define, in words, the term *internal resistance*. (2)

7.2 Using the **graph ONLY** determine the value of the following:

7.2.1 Emf (**ε**) of the battery (1)

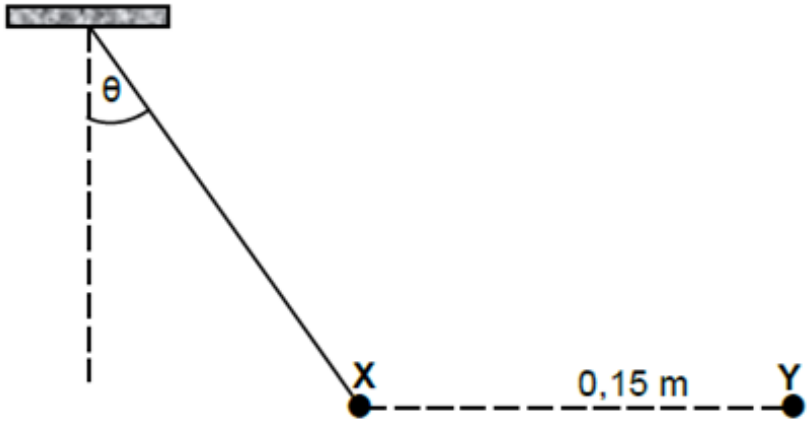
7.2.2 'Lost' volts when the current in the circuit is 0,2 A (2)

7.2.3 Internal resistance of the battery (3)

[8]

Question 8

8.1 A small sphere **X** having a mass of 8×10^{-2} kg and a charge of $+6 \times 10^{-7}$ C hangs vertically by a thin wire of negligible mass. When the charge **Y** of -9×10^{-7} C is brought closer to the sphere, the wire makes an angle θ to the vertical when brought to rest 0,15 m away from the charge **Y**, as shown in the diagram below.



8.1.1 State *Coulomb's Law* in words. (2)

8.1.2 Draw a labelled free-body diagram for the sphere **X** when at rest. (3)

Calculate the:

8.1.3 Electrostatic force exerted by sphere **X** on charge **Y** (3)

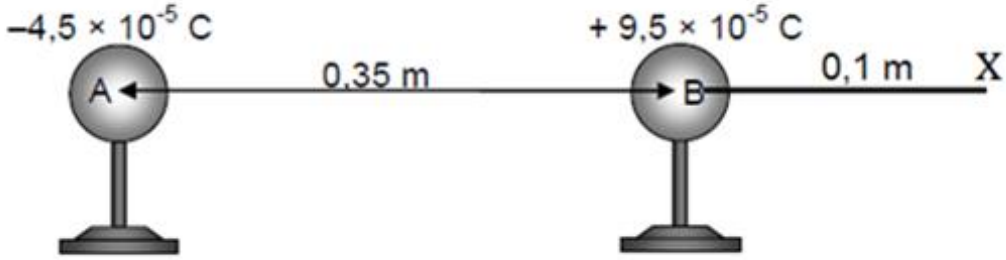
8.1.4 Angle θ shown in the diagram (3)

8.1.5 Tension in the wire (2)

[13]

Question 9

The diagram below shows two spheres, A of charge $-4,5 \times 10^{-5}$ C and B of charge $+ 9,5 \times 10^{-5}$ C on insulated stands. The distance between the centres of the two spheres is 0,35 m.



9.1 Draw the field pattern diagram for the net electric field present between the two charges. (2)

9.2 The two charges are brought into contact and then separated by 0,35 m again.

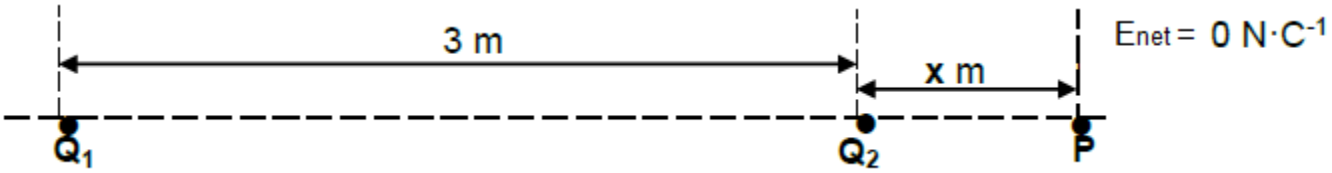
9.2.1 Calculate the new charge on the spheres after they touched. (2)

9.2.2 Calculate the net electric field at a point X (0,1 m to the right of B) as a results of A and B. (5)

[9]

Question 10

Two point charges, $\mathbf{Q_1}$ and $\mathbf{Q_2}$, with charges -16×10^{-7} C and $+4 \times 10^{-7}$C respectively, are placed 3 m apart as shown in the diagram below. The diagram is not drawn to scale.



The net electric field at point **P** due to the presence of the two point charges, is ZERO.

Determine the value of **x**, shown in the diagram.

[5]

Total 121

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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