HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 1- Physics

TRIALS 2021
TIME: 3 HRS

Total 150

Instructions

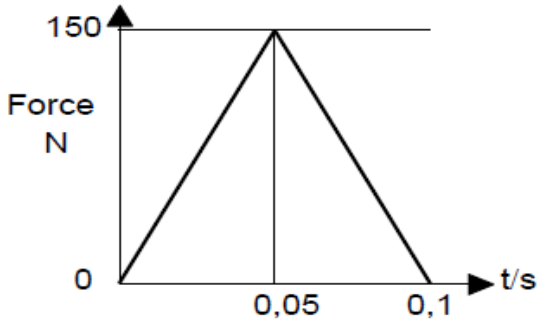
1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

   Answer SECTIONS A and B in the ANSWER BOOK.
4. 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 **two decimal** places

QUESTION 1 (Multiple-choice)

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) on your ANSWER BOOK.

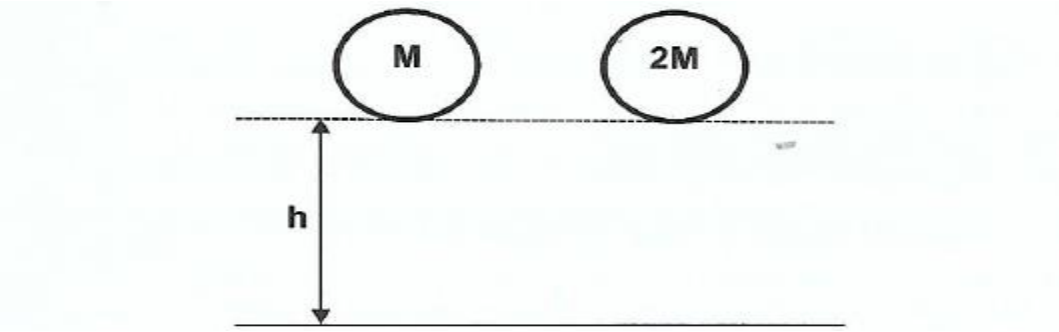
1.1 The graph below represents the change in force with time for a tennis ball that is thrown towards a tennis player and struck by the player in the opposite direction.



The area under the graph would give the…

A change in the kinetic energy of the tennis ball
B impulse experienced by the tennis ball
C power dissipated on the tennis ball
D momentum of the tennis ball

1.2 A metal ball with mass **M** and a second metal ball with mass **2M** has the same diameter. They are dropped from a height **h** as indicated in the diagram below.



The time it takes for the two balls to hit the ground in the absence of air friction is…

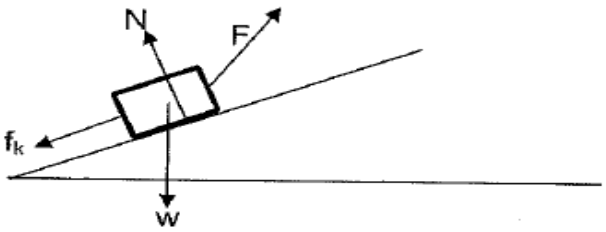
A $\frac{1}{2}$ the time for **M** as for **2M**.

B the same time.

C slightly longer for ball **M** as for **2M**.

D slightly longer for ball **2M** as for **M**.

1.3 Dan pulls a block across a rough surface at a constant speed. The forces acting on the block are shown in the diagram below. The forces are not drawn to scale.



Which one of the following relationships regarding **F, f_k, N** and **w** are correct?

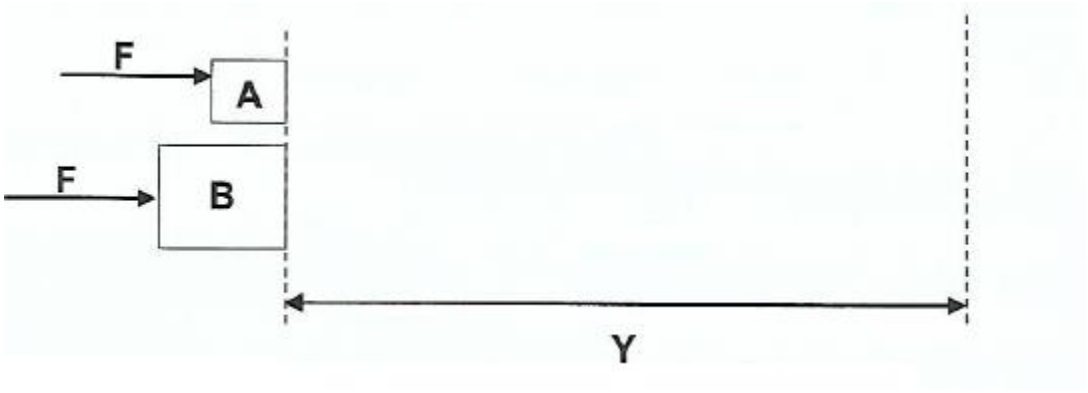
A $F = f_k$ and $N = w$

B $F > f_k$ and $N < w$

C $F < f_k$ and $N > w$

D $F = f_k$ and $N < w$

1.4 An aerial view of two metal blocks that are at rest on a frictionless horizontal surface is given below. Block **A** has a mass of **x** kg and block **B** has a mass **4x** kg. They are both pushed with a constant horizontal force **F** across the frictionless surface for distance **Y**.



How will their kinetic energy compare after moving the distance **Y**.

A The kinetic energy of **A** is four times smaller than **B**.

B The kinetic energy of **A** is four times larger than **B**.

C Their kinetic energy will be the same.

D The kinetic energy of **A** slightly larger than **B**.

1.5 A large truck collides head-on with a small compact car.

During the collision the magnitude of the force exerted by the…

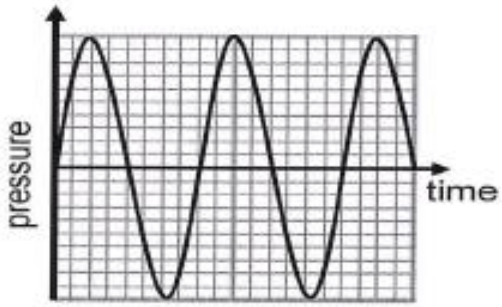
A truck on the car is greater than the car on the truck.

B truck on the car is equal to the car on the truck.

C car on the truck is greater than the truck on the car.

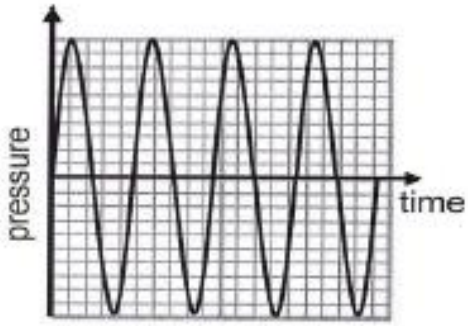
D truck and the car are proportional to their masses.

1.6 The pressure versus time graph below represents a sound in air emitted by a stationary source.

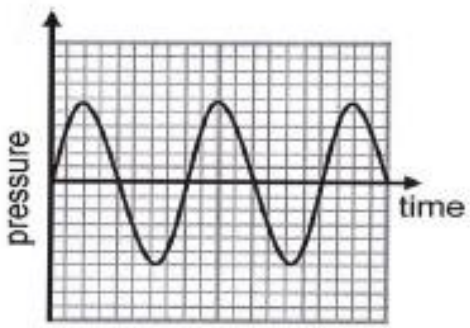


Which ONE of the following graphs best represents the sound wave, as observed by a stationary observer, if the source is moving away from the observer?

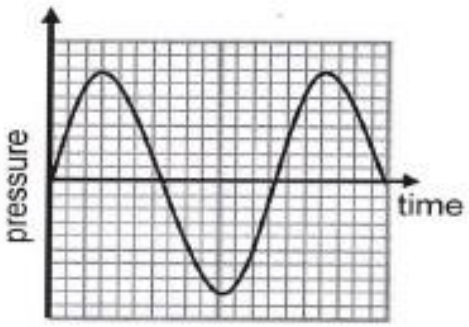
A



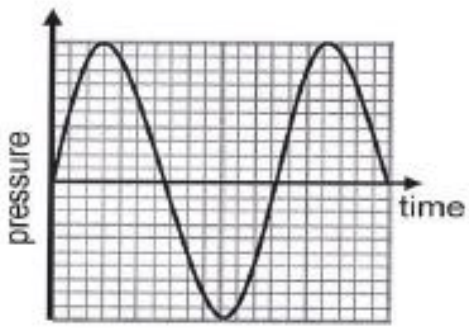
B



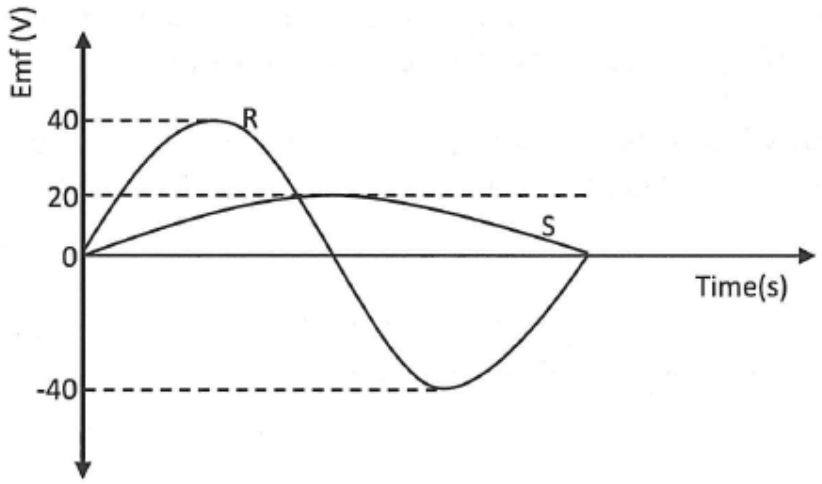
C



D



1.7 Graph **R** in the diagram below represents the output emf of an AC generator.



Which ONE of the following changes has been made to the generator to produce graph **S**?

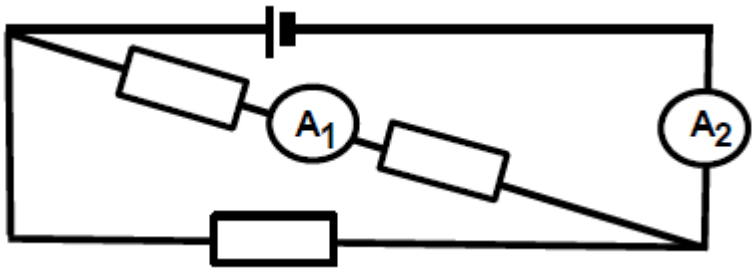
A The strength of the magnetic field has been halved

B The surface area of the coil has been halved

C The number of turns of the coil has been halved

D The speed of rotation of the coil has been halved

1.8 The three resistors in the circuit diagram shown below are identical.



If the reading on the ammeter $\mathbf{A_1}$ is **I**, what will be the reading on ammeter $\mathbf{A_2}$?

A $\frac{1}{2}$**I**

B 3**I**

C 2**I**

D **I**

1.9 Two small objects **P** and **R** carry charges +Q and +Q respectively. They exert a force $\frac{1}{3}$ **F** on each other.

R is now charged to +6 Q as shown in the diagram.

If the distance between **P** and **R** remains the same, what is the force on **P**?

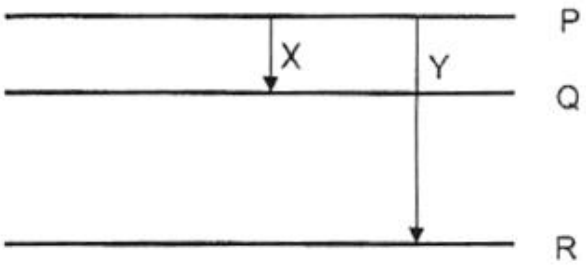
A 3F

B 2F

C F

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

1.10 The diagram below represents 3 energy levels **P**, **Q**, and **R** in a certain atom.



Which ONE of the following statements is TRUE?

Compared to that of transition **Y** …

A the wavelength of a photon emitted as a result of transition X is longer.

B the wavelength of a photon emitted as a result of transition X is shorter.

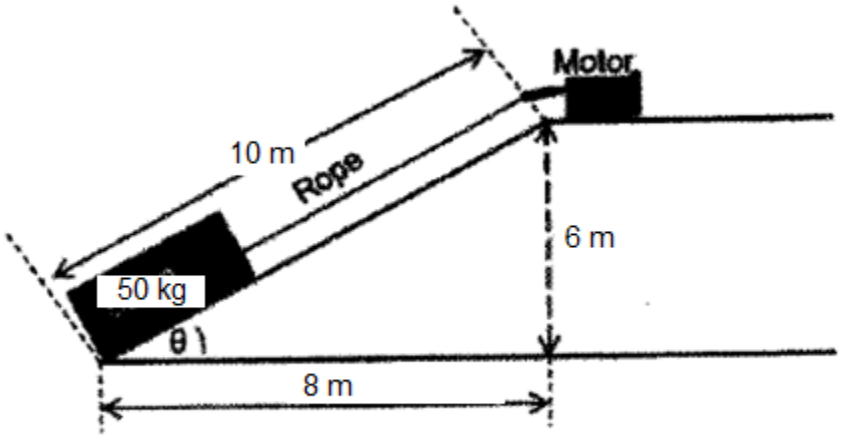
C the frequency of a photon emitted as a result of transition X is higher.

D the frequency of a photon emitted as a result of transition X is the same. **[2 x 10 = 20]**

Section B:

Question 2

A motor is used to pull a 50 kg block up the incline by means of a light (massless). Inextensible rope, as the diagram below illustrates.



The coefficient of kinetic friction between the block and the incline is 0,70.

2.1 Define the term *kinetic frictional force* in words. (2)

2.2 Suggest a reason as to why the coefficient of kinetic friction is dimensionless (has no units). (1)

The block moves up the incline at CONSTANT VELOCITY.

2.3 What is the numerical value of the RESULTANT/NET FORCE, along the incline, on the block as it is being pulled? (1)

2.4 State, in words, Newton's First Law of Motion. (2)

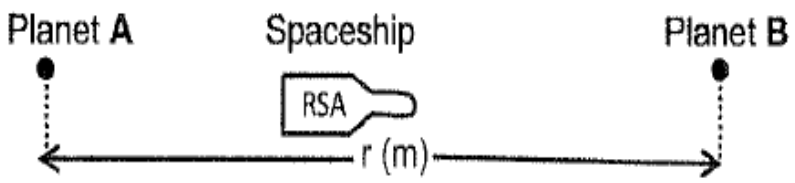
2.5 Draw a labelled free-body diagram showing ALL the forces acting on the block as it is being pulled up the incline. (4)

2.6 Show, by means of an appropriate calculation, that the tension in the rope is 568,4 N. (6)

[16]

Question 3

A spaceship of mass 'm' kg, leaves planet **A** and sets out into space towards a newly discovered planet **B**, as shown in the diagram below.



After travelling 60% of the way to planet **B**, the commander discovers that the **net force** of the two planets on the spaceship is ZERO.

3.1 Give a reason why Newton's Law of Universal Gravitation is referred to as an **inverse square Law**. (1)

3.2 Show, by means of an appropriate calculation, that the ratio of the masses of the two planets is given by $\mathbf{M_A:M_B = 9:4}$ (4)

[5]

Question 4

A fire breaks out on the top floor in an apartment building. A 90 kg man hangs on the side of the balcony. The fire fighters arrive and see the man hanging on for dear life. They get out an air mattress to save the man's life. The moment the mattress is inflated the man loses his hold and falls to the ground. The fire fighters run the 20 m with a constant velocity of 4,8 $m.s^{-1}$ to get the mattress in place just in time to break the man's fall and save his life.

4.1 Define the term projectile. (2)

4.2 Calculate the height of the building. (4)

4.3 Define impulse. (2)

4.4 If it takes the man 1,2 s to come to rest after hitting the mattress, calculate the force that the mattress exerts on the man. (6)

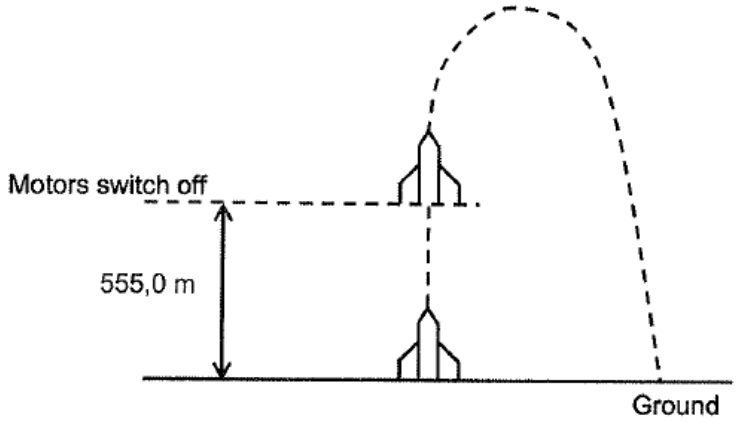
4.5 By using physics principles, in conjunction with equations, explain why the mattress saves the man's life. (3)

[17]

Question 5

A 7200 kg rocket blasts off vertically **from rest** from the launch pad with a constant upwards acceleration of 2,20 $m.s^{-2}$.

When it has reached the height of 555,0 m, its engines suddenly fail, (its motors switch off). The diagram below shows the path followed by the rocket.



Ignore the effects of air resistance.

5.1 Show, by means of suitable calculations, that the maximum height that this rocket reaches above the ground is **679,592 m**. (5)

5.2 Hence determine the:

Time taken after the engine failure for the rocket to come crashing down to the ground. (3)

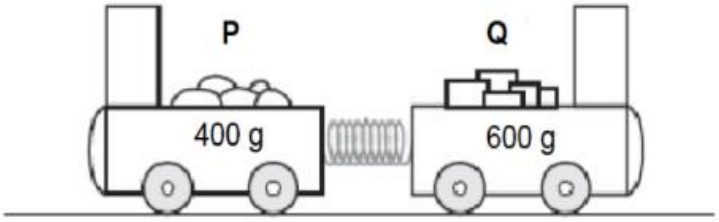
5.3 Sketch a velocity versus time graph for the motion of the rocket from the moment of engine failure until it crashes to the ground. Take the time when the rocket's engines fail as t = 0 s. Clearly show the values of the following on the graph:

- Time at which the rocket crashes to the ground (2)

[10]

Question 6

The diagram below shows two trolleys, **P** and **Q**, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of **P** and **Q** are 400 g and 600 g respectively.



When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley **Q** then moves to the right at 4 $m.s^{-1}$.

6.1 State the *Principle of Conservation of Linear Momentum in words*. (2)

6.2 Calculate the:

6.2.1 Velocity of trolley **P** after the trolleys are released. (4)

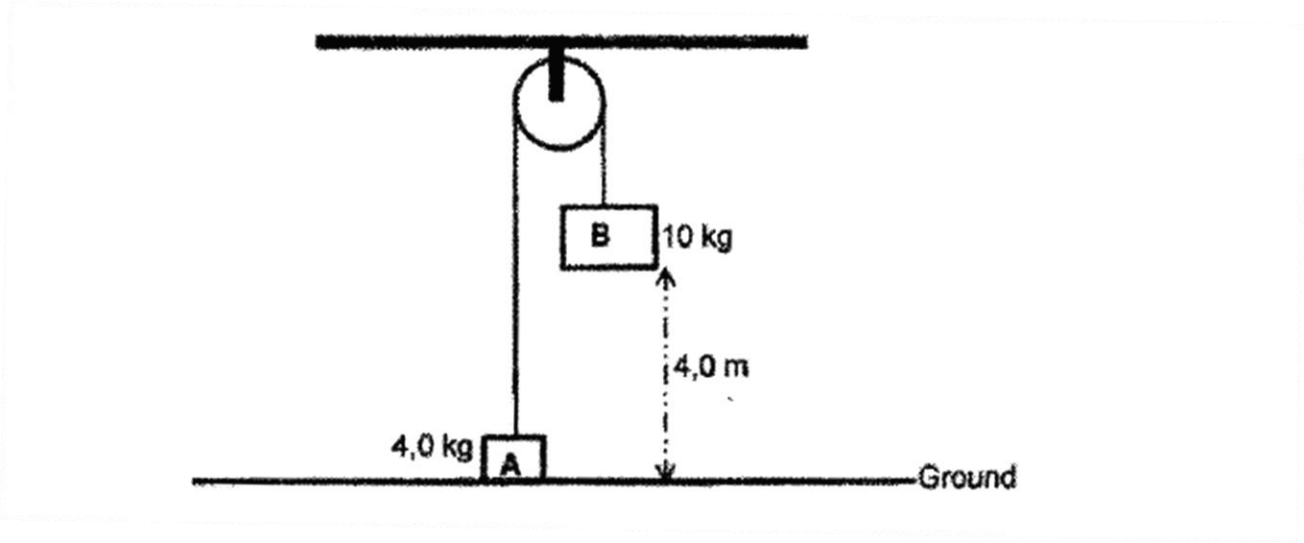
6.2.2 Magnitude of the average force exerted by the spring on trolley **Q**. (4)

6.3 How does the acceleration of the trolley **P** compare to that of trolley **Q**? Choose from GREATER THAN, SMALLER THAN and THE SAME AS. (1)

[11]

Question 7

Blocks A (4kg) and B (10kg) in the diagram below are connected by a light (massless) inextensible string passing over a light, frictionless pulley.



Block **B** is released from rest at a height of 4,0 m above the ground. Ignore the effects of air resistance.

7.1 Draw a labelled free-body diagram for block B indicating ALL the forces acting on it as it moves downwards. (2)

7.2 State the NAME of the *conservative force* acting on block **A** while moving upwards. (1)

7.3 State, in words, the *work-energy theorem*. (2)

7.4 Prove, by using calculations, that the tension in the string is 56N.* (3)

7.5 Use the **work-energy theorem** to calculate the speed with which block B hits the ground. (4)

7.6 Calculate the time it takes block **A** to travel 4,0 m upwards. (3)

[15]

Question 8

A commuter train travelling at a constant speed of 40 $m.s^{-1}$ blows its horn as it passes a stationary boy. The frequency of the sound emitted by the horn is 320 Hz.

8.1 State the Doppler Effect in words. (2)

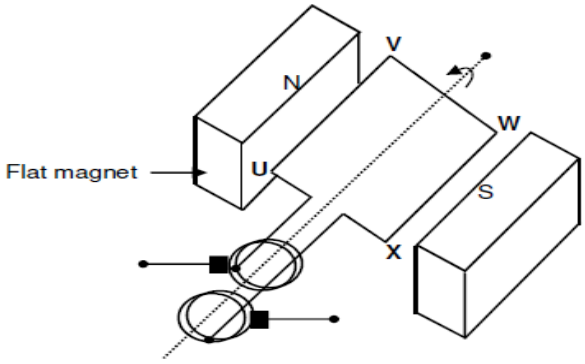
8.2 Calculate the WAVELENGHT of the sound observed by the boy when the train moves away from him. Take the speed of sound in air to be 343 $m.s^{-1}$. (6)

8.3 Write down ONE use of the Doppler Effect in medicine. (1)

[9]

Question 9

9.1 A simplified diagram of a generator is shown below.



9.1.1 What type of generator, AC or DC is shown in this diagram?
Give a reason for your answer. (2)

9.1.2 The coil is rotated in an anticlockwise direction as shown in the diagram. In what direction will the current in the section **WX** of the loop move? Only write **W** to **X** or **X** to **W**. (1)

9.1.3 Name the principle on which a generator operates. (1)

9.2 An electric hair dryer is rated at 1500 W at 240 V. The rated power of this hair dryer, or of any other AC device, is THE AVERAGE POWER drawn by the device. The rated voltage is the *rms voltage. Assume that the hair dryer is a pure resistor.*

Calculate the:

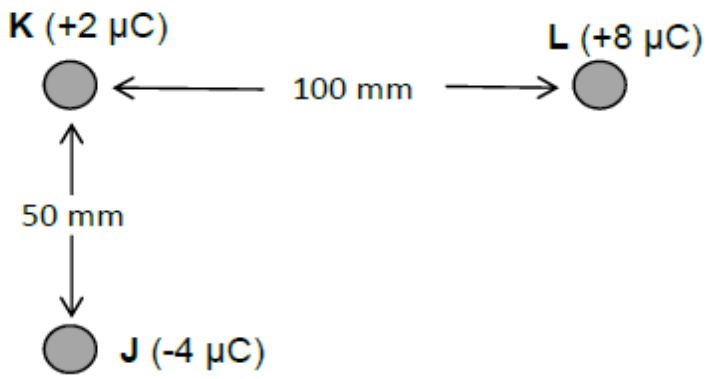
9.2.1 Resistance of the hair dryer (3)

9.2.2 Maximum current delivered to the hair dryer (5)

[12]

Question 10

Three charges J, K and L are arranged on a horizontal plane so that angle LKJ is a 90º angle. The charges are -4 µC and + 2 µC and +8 µC respectively. J and K are 50 mm apart and K and L are 100 mm apart. J and L are fixed in position while K is free to move.



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

10.2 Calculate the magnitude of the electrostatic force between charges J and K. (4)

10.3 Draw a free-body diagram showing the electrostatic forces exerted on K due to charges J and L. Also show on the vector diagram how the net force can be determined. (3)

10.4 Calculate the magnitude and direction of the net electrostatic force exerted on K due to charges J and L. (4)

10.5 Define, in words, *electric field at a point*. (2)

10.6 Calculate the magnitude of the net electric field at K. Give your answer in scientific notation. (3)

[18]

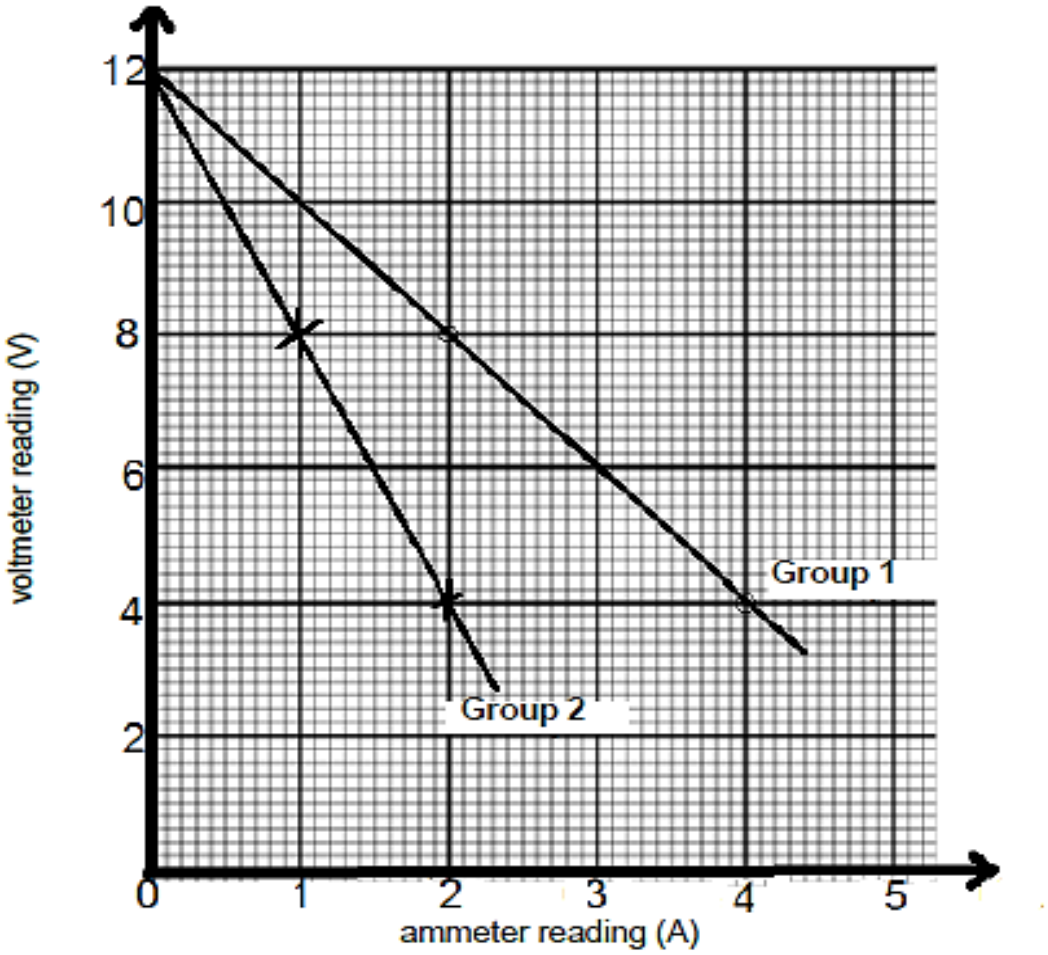
Question 11

11.1 Grade 12 learners are conducting an experiment to determine the INTERNAL RESISTANCE of a battery. The learners were divided into two groups:

Group **1** used battery 1 with an internal resistance r_1

Group **2** used battery 2 with an internal resistance r_2

The results of each group are shown in the graph below

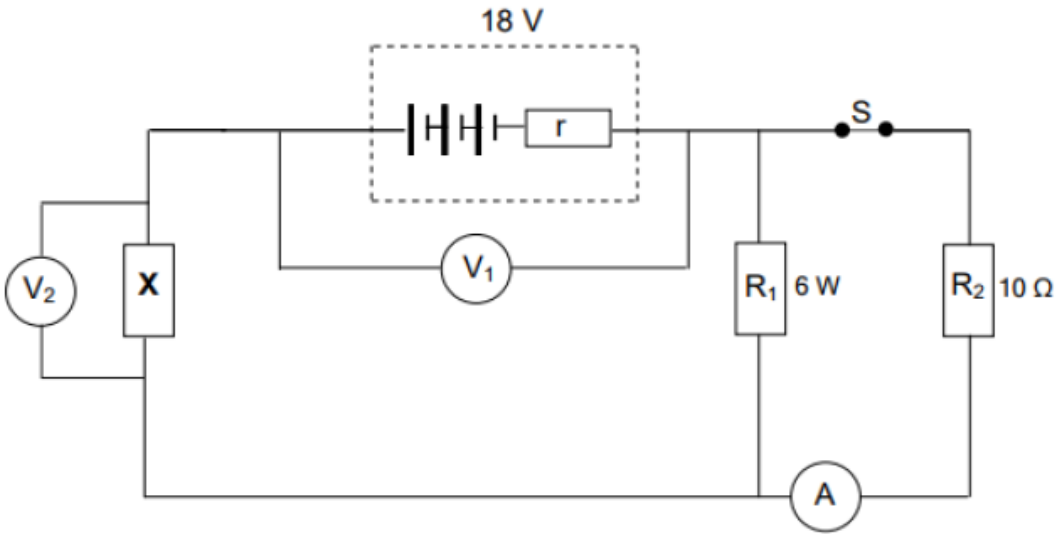


11.1.1 Explain why the voltmeter reading across the battery decreases as the current increases. Use appropriate equation(s) in physics in your explanation. (3)

11.1.2 Which group, **1** or **2**, used a battery with greater internal resistance? (1)

11.1.3 Use the graph to determine the internal resistance of the battery used by leaners in group 1. (3)

11.1.4 In the circuit diagram below, resistor $\mathbf{R_1}$ is rated at 6 W and resistor $\mathbf{R_2}$ has a resistance of 10 Ω. **X** is a resistor with an unknown resistance.
The resistance of the switch, ammeter and connecting wires are negligible, while the voltmeters have a very high resistance.
The emf of the battery is 18 V and its internal resistance r is unknown.



When switch **S** is closed, the ammeter **A**, reads 1,2 A while voltmeter $\mathbf{V_2}$ reads 3,8 V.

12.2 Explain what is meant by "*The emf of the battery is 18 V*", as stated above. (2)

12.3 If the internal resistance, r, is 1,29 Ω, calculate the resistance of resistor **X**. (6)

12.4 Switch S is now opened. How will the reading on each of the following voltmeters be affected? State only INCREASES, DECREASES or REMAINS CONSTANT.

(a) voltmeter V_1 (1)

(b) voltmeter V_2 (1)

[17]

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	$9,8\ m{\cdot}s^{-2}$
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*

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

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* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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