Western Cape Government
Education

PHYSICAL SCIENCES PAPER 1 (Physics)

SEPTEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the first page of your ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions on your ANSWER BOOK.
3. Start EACH question on a NEW SIDE of your RULED A4 PAPER. Use BOTH sides of the page in order to avoid wasting paper.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example between QUESTION 1.1 and QUESTION 1.2.
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**. In multi-step calculations, intermediate steps, round of to **four 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. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10), for example 1.11 D.

1.1 A car is moving at a **constant velocity**.
Which ONE of the following statements about the forces acting on the car is always CORRECT?

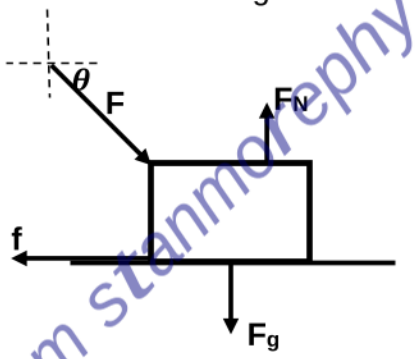
A There is a non-zero net force acting on the car.

B The normal force acting on the car is equal to the weight of the car.

C There are no forces acting on the car.

D The net force acting on the car is zero. (2)

1.2 The force diagram below shows the forces acting on a box.



Which ONE of the following equations for the magnitude of the normal force (F_N) is CORRECT?

A $F_N = F\cos\theta + mg$

B $F_N = F\sin\theta + mg$

C $F_N = mg - F\cos\theta$

D $F_N = mg - F\sin\theta$ (2)

1.3 An object mass m_2 attracts another object mass m_1 with a force **F**.
If the mass m_2 is doubled, the force m_2 exerts on m_1 will be …

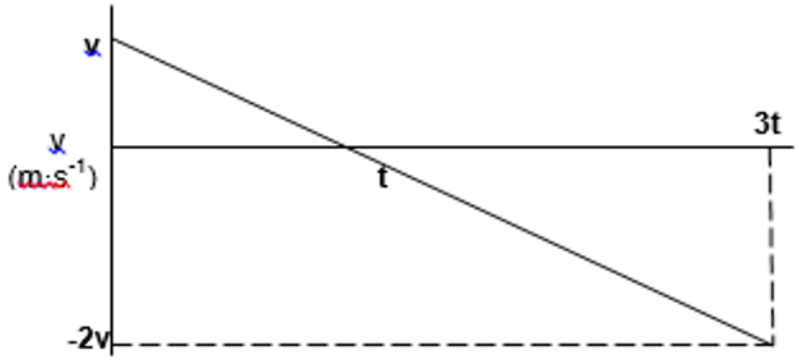
A ¼ **F**

B **F**

C 2 **F**

D **4** F (2)

1.4 The velocity versus time graph below represents the movement of an object that is initially projected vertically upward. Ignore the effects of friction.



The maximum height that the object reaches above the projection point is given by…

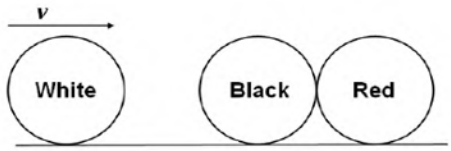
A $\frac{1}{2}$ **vt**

B Zero

C 2 **vt**

D $\frac{2}{3}$ **vt** (2)

1.5 A black and a red snooker ball are stationary and in contact with each other on a smooth table. A white ball, with the same mass, **m**, as the other two, moves towards the black ball on the line of contact of the black and red balls, with a velocity **v**. It collides elastically with the black ball and stops.



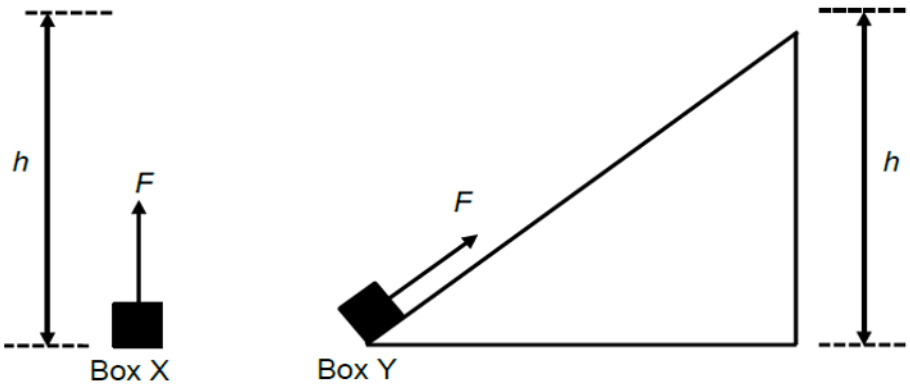
The velocities of the three balls directly after the collision will be:

	White ball	Black ball	Red Ball
A	$\frac{1}{3}v$	$\frac{1}{3}v$	$\frac{1}{3}v$
B	0	$\frac{1}{2}v$	$\frac{1}{2}v$
C	0	0	v
D	$\frac{2}{3}v$	$\frac{1}{3}v$	0

(2)

1.6 Two boxes **X** and **Y** have the same mass. Box **X** is lifted through a vertical height **h** by a force of magnitude **F**.

Box **Y** is pulled up a slope by a force of the same magnitude to reach the same vertical height, as shown.

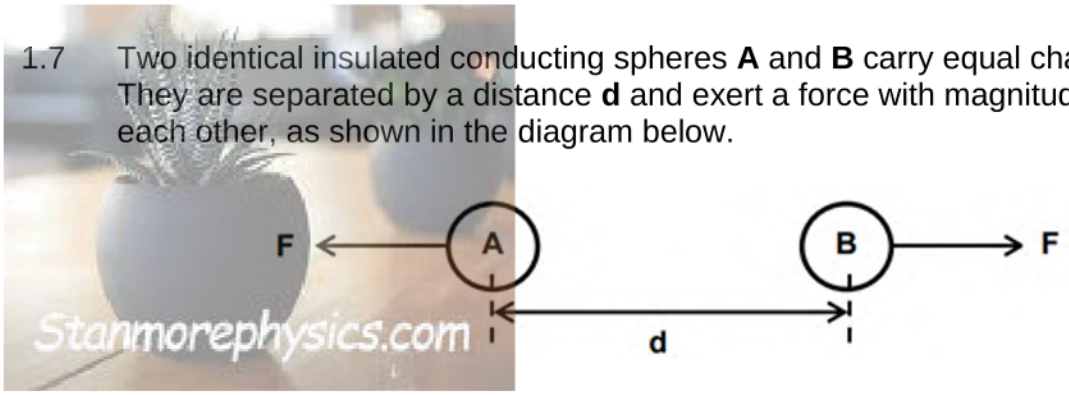


Which statement is correct?

	Change in gravitational potential energy of the boxes	Amount of work done by *F*
A	Is the same for box **X** and box **Y**	Is more for box **Y** than for box **X**
B	Is the same for box **X** and box **Y**	Is the same on **X** and **Y**
C	Is more for box **Y** than for box **X**	Is more for box **Y** than for box **X**
D	Is more for box **Y** than for box **X**	Is the same on **X** and **Y**

(2)

1.7 Two identical insulated conducting spheres **A** and **B** carry equal charges. They are separated by a distance **d** and exert a force with magnitude **F** on each other, as shown in the diagram below.



A third identical UNCHARGED sphere **C** touches **A**, and is then removed.
If the distance between spheres **A** and **B** remains the same, then the magnitude of the electrostatic force exerted on sphere **B** is now:

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

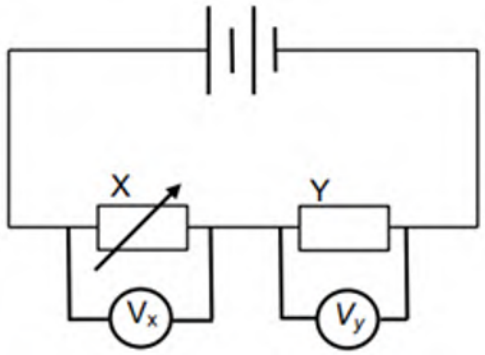
B $\frac{1}{4}$**F**

C 2**F**

D 4**F**

(2)

1.8 In the circuit diagram below **X** is a variable resistor (rheostat) and **Y** is a resistor with a fixed resistance. The internal resistance of the battery and the resistance of the wires are negligible, while the voltmeters have a very high resistance.



What happens to the readings on voltmeters $\mathbf{V_x}$ and $\mathbf{V_y}$ respectively if the resistance of resistor **X** is increased?

	$\mathbf{V_x}$	$\mathbf{V_y}$
A	Decreases	Increases
B	Decreases	Remains the same
C	Increases	Decreases
D	Increases	Remains the same

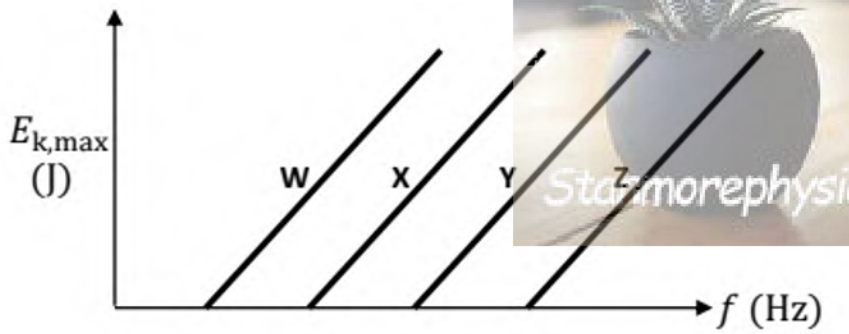
(2)

1.9 Choose the option that correctly differentiates between an AC generator and a DC motor.

	The AC generator …	**The DC motor …**
A	… converts mechanical energy to electrical energy with the aid of slip rings.	… converts electrical energy to mechanical energy with the aid of slip rings.
B	… converts electrical energy to mechanical energy with the aid of slip rings.	… converts mechanical energy to electrical energy with the aid of a split-ring commutator.
C	… converts electrical energy to mechanical energy with the aid of a split-ring commutator.	… converts mechanical energy to electrical energy with the aid of slip rings.
D	… converts mechanical energy to electrical energy with the aid of slip rings.	… converts electrical energy to mechanical energy with the aid of a split-ring commutator.

(2)

1.10 The following graph shows four different results (**W**, **X**, **Y**, and **Z**) from an experiment involving the photoelectric effect.



Which ONE of the following best describes the four lines on the graph?
The lines are for ...

A ... the same material, with different frequencies of light used.

B ... the same material, with the same threshold frequencies of light used.

C ... different materials, all with different threshold frequencies.

D ... different materials, all with the same threshold frequency. (2)

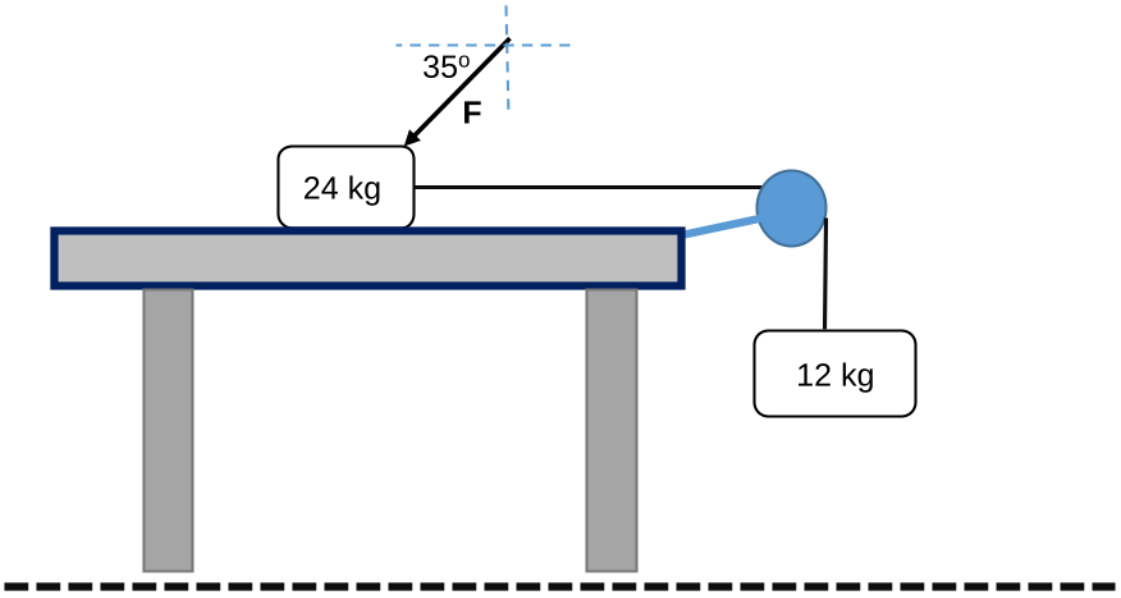
[20]

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.
5. For multi-step calculations, keep answers to intermediate steps to a minimum of FOUR decimal places.

QUESTION 2 (Start on a new page)

A block of mass 24 kg is on a rough horizontal table. A force **F** is applied to the 24 kg block at an angle of 35^0 to the horizontal. The 24 kg block experiences a force of friction of 7 N as it moves. The block is connected by a light inextensible rope which passes over a light frictionless pulley to another block of mass 12 kg, which hangs vertically, as shown in the diagram below.
Ignore the effects of air resistance.



The 24 kg block moves to the left at CONSTANT VELOCITY.

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

2.2 What is the resultant force acting on the system? (1)

2.3 Draw a fully labelled free body diagram for all the HORIZONTAL forces acting on the 24 kg body. (3)

2.4 Calculate the tension in the rope. (3)

2.5 Calculate the magnitude of force **F**. (3)

2.6 Force **F** is now removed. Does the magnitude of the normal force, INCREASE, DECREASE or REMAIN THE SAME? (1)
[13]

QUESTION 3 (Start on a new page)

Neptune is the eighth and most distant planet in our solar system. It is dark, cold, and whipped by supersonic winds. It is a giant ice planet and has 14 known moons. Neptune's largest moon **Triton** circles its planet in a direction opposite to the planet's rotation. The mass of Triton is 2,1390 x 10^{22} kg and has a diameter of 2 706 km.

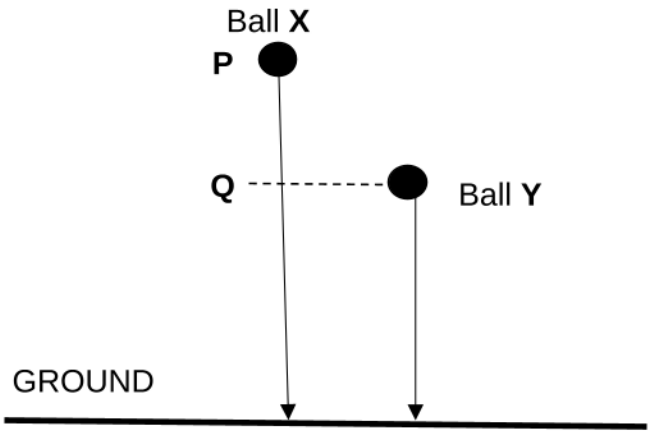
3.1 State Newton's Universal Gravitational law, in words (2)

3.2 Calculate the gravitational acceleration an object would experience on the surface of Triton. (4)

3.3 If the space agency sends a robotic spacecraft of mass 15 000 kg to Triton, calculate the force of attraction when the robotic spacecraft is at a height of 50 km, above the surface of Triton. (4)
[10]

QUESTION 4 (Start on a new page)

A ball **X** of mass 50 g is thrown vertically downwards with a kinetic energy of 2,704 J from a point **P**, above the ground as shown below. At the same instant, a second identical ball **Y** is dropped from a point **Q**, which is located below point **P**. Ball **Y** strikes the ground with a velocity of 19,6 $m \cdot s^{-1}$.
Both balls hit the ground at the same time. Ignore the effects of friction and take downward direction as POSITIVE



4.1 Define the term *free fall*. (2)

4.2 Calculate the time taken for ball **Y** to reach the ground. (3)

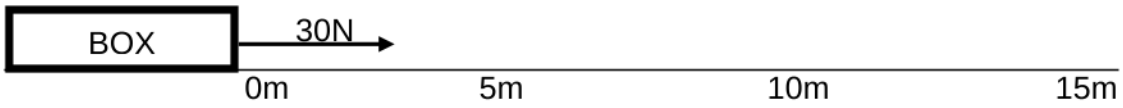
4.3 Calculate the speed with which ball **X** strikes the ground. . (5)

4.4 On the same system of axes, sketch the velocity-time graph for the entire motion of both balls **X** and **Y**. Indicate the following values on your graph:
- The time taken for the balls to strike the ground
- The initial and final velocity of ball **X**
- The initial and final velocity of ball **Y** (5)

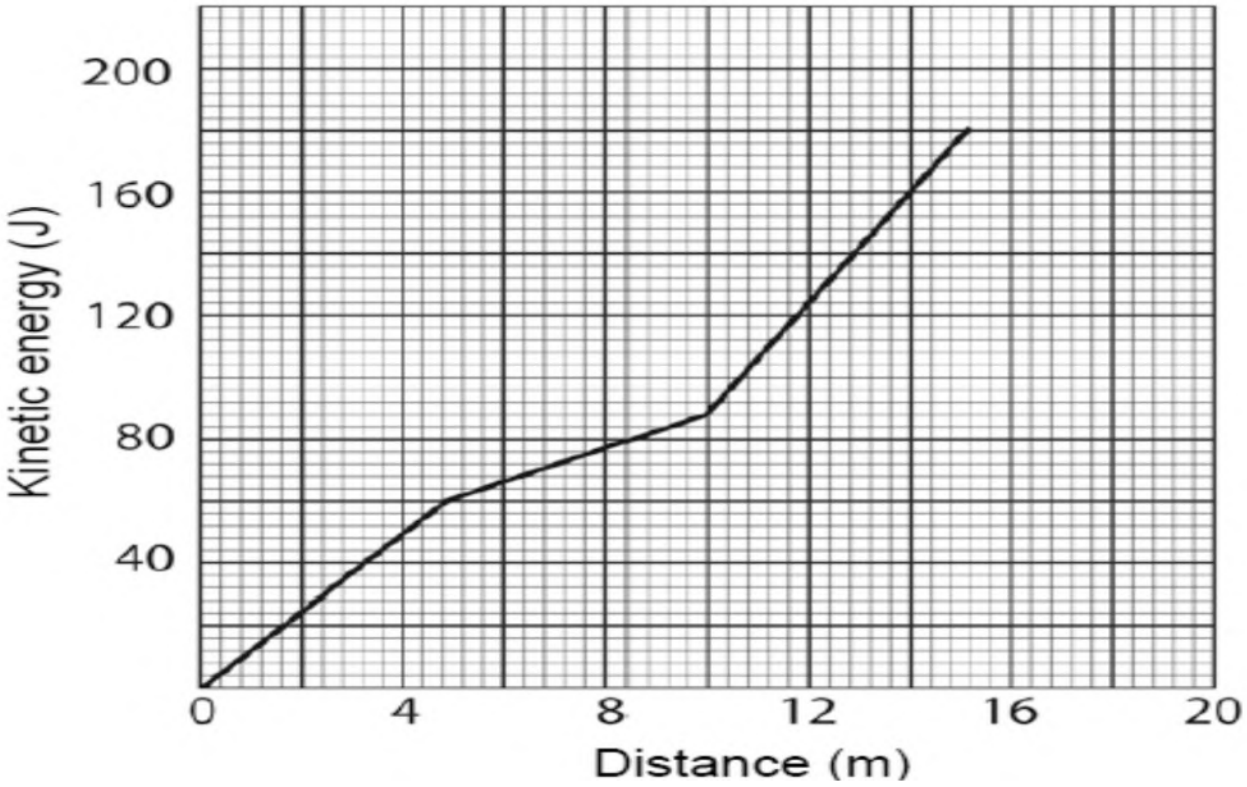
[15]

QUESTION 5 (Start on a new page)

A box is pushed from rest with a constant applied force of 30 N over a horizontal surface which has three different regions. Each region is 5 m long and exerts a different frictional force on the box as it moves through.



The graph below shows the kinetic energy of the object as a function of the distance from the starting position as the object experiences the constant applied force of 30 N. The first region is from (0 to 5) m, the second region is from (5 to 10) m and the third region is from (10 to 15) m.



5.1 State the work-energy theorem in words. (2)

5.2 Use the work-energy theorem to show that the gradient (slope) of the graph represents the net force experienced by the object. (2)

5.3 Calculate the net force experienced by the object in the third region between 10 m and 15 m. (4)

5.4 Hence determine the magnitude of the force of friction experienced by the block as it moves over the third region. (3)

5.5 Which region, FIRST, SECOND or THIRD offers the largest frictional force? (1)

5.6 Explain your answer in QUESTION 5.5 without any calculation. (2)
[14]

QUESTION 6 (Start on a new page)

6.1 A bird, flying at a constant speed, emits sounds with a frequency of 90 Hz. A stationary observer with a sonic detector detects the sound from the bird at 88 Hz.

6.1.1 State the Doppler Effect in words. (2)

6.1.2 Calculate the speed with which the bird is flying. (5)

6.2 The velocities of galaxies relative to the earth can be determined by studying the red shift observed in their spectrums. The table below shows the velocities of three galaxies, **D**, **E** and **F**, relative to the earth.

Galaxies	**D**	**E**	**F**
Speed (x10^7) m·s^{-1}	0,15	1,52	2,44

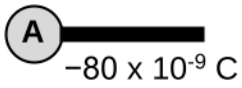
6.2.1 What is meant by the term 'red shift'? (2)

6.2.2 Which galaxy **D**, **E** or **F** shows the greatest red shift? Give a reason for your answer. (2)

[11]

QUESTION 7 (Start on a new page)

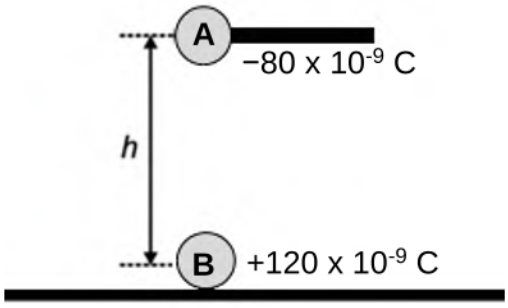
In the diagram below a small metal sphere **A** on an insulating rod has a charge of -80×10^{-9} C.



7.1 Describe the term *electric field* in words. (2)

7.2 Calculate the number of electrons sphere **A** has in excess. (3)

Sphere **A** is now kept vertically above another sphere **B** of mass 0,01 kg lying on a horizontal insulated surface. The charge on sphere **B** is $+120 \times 10^{-9}$ C. Sphere **A** is slowly brought closer to sphere **B** in order to pick it up.
Ignore the effects of air resistance.



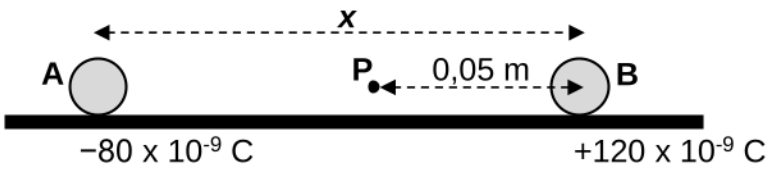
7.3 Draw a diagram that shows the electric field pattern between spheres **A** and **B**. (3)

At a certain height **h** Sphere **B** is <u>just</u> lifted off the surface due to its attraction to sphere **A**.

7.4 Draw a free body diagram showing all the forces acting on sphere **B** at this instant. (2)

7.5 Calculate the height **h** in the diagram at this instant. (4)

Sphere **A** is now placed on the horizontal insulated surface, a distance ***x*** from sphere **B** as shown in the diagram below. **P** is a point between **A** and **B,** 0,05 m from **B**.
The magnitude of the **net** electric field intensity at point **P** as a result of the presence of spheres **A** and **B** is $54,45 \times 10^{4}$ N·C^{-1}.

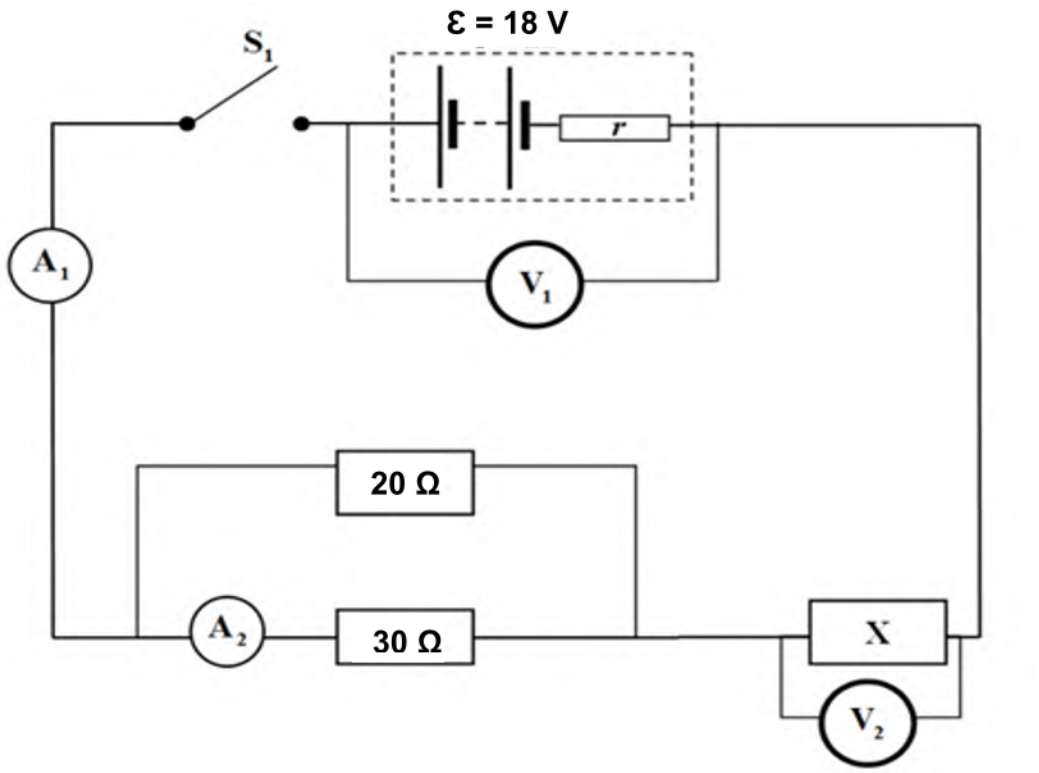


7.6 Draw a labelled vector diagram indicating the directions of the electric field at point **P** as a result of spheres **A** and **B** respectively. (2)

7.7 Calculate the distance ***x*** between spheres **A** and **B**. (6)
[22]

QUESTION 8 (Start on a new page)

In the circuit represented below, the ammeters, connecting wires and switch have negligible resistance while the voltmeters have a very high resistance. **X** is a resistor with an unknown resistance. The battery has an emf of 18 V while its internal resistance is unknown.



Switch S is now CLOSED. Ammeter A_2 reads 0,3 A and voltmeter V_2 reads 6,8 V.

8.1 Define the term *emf* of a battery. (2)

8.2 Calculate the reading on ammeter A_1. (4)

8.3 Calculate the total **external** resistance of the circuit. (4)

8.4 Calculate the internal resistance ***r*** of the battery. (4)

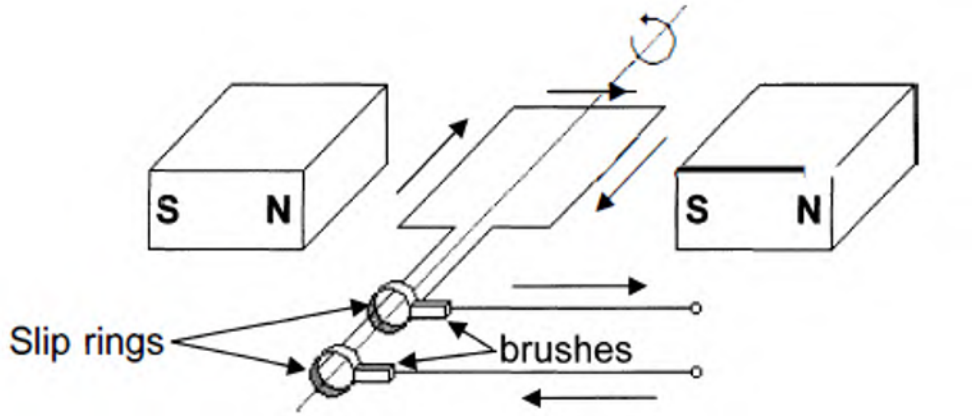
8.5 Resistor **X** is now replaced with another resistor with a LOWER resistance. How will the reading on voltmeter V_1 be affected by this change? Write down only INCREASE, DECREASE or REMAINS THE SAME. (1)

8.6 Explain your answer in QUESTION 8.5 without any calculation. (3)

[18]

QUESTION 9 (Start on a new page)

A simplified sketch of a generator is shown below.



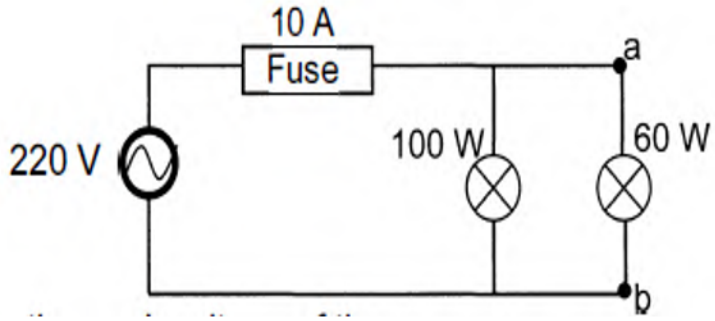
9.1 The north and south poles of the magnet remains unchanged. If the coil is rotated in the direction as shown in the sketch, will the induced current flow in the direction as indicated. Answer only YES or NO. (1)

9.2 Is the output voltage AC or DC? Give a reason for your answer. (2)

9.3 What would happen to the output voltage if the coil is rotated faster? Answer INCREASE, DECREASE or REMAINS THE SAME (1)

9.4 What is the position of the coil relative to the magnetic field when the output voltage is a maximum? Answer PARALLEL or PEPENDICULAR (1)

9.5 Lights in households are connected in parallel, as shown in the simplified circuit below.



Two light bulbs rated at 100 W; 220 V and 60 W; 220 V respectively are connected to an AC source of rms value 220 V. The fuse in the circuit can allow a maximum current of 10 A. Ignore the resistance of the conducting wires

9.5.1 Calculate the peak voltage of the source. (3)

9.5.2 Calculate the resistance of the 100 W light bulb, when operating at optimal conditions. (3)

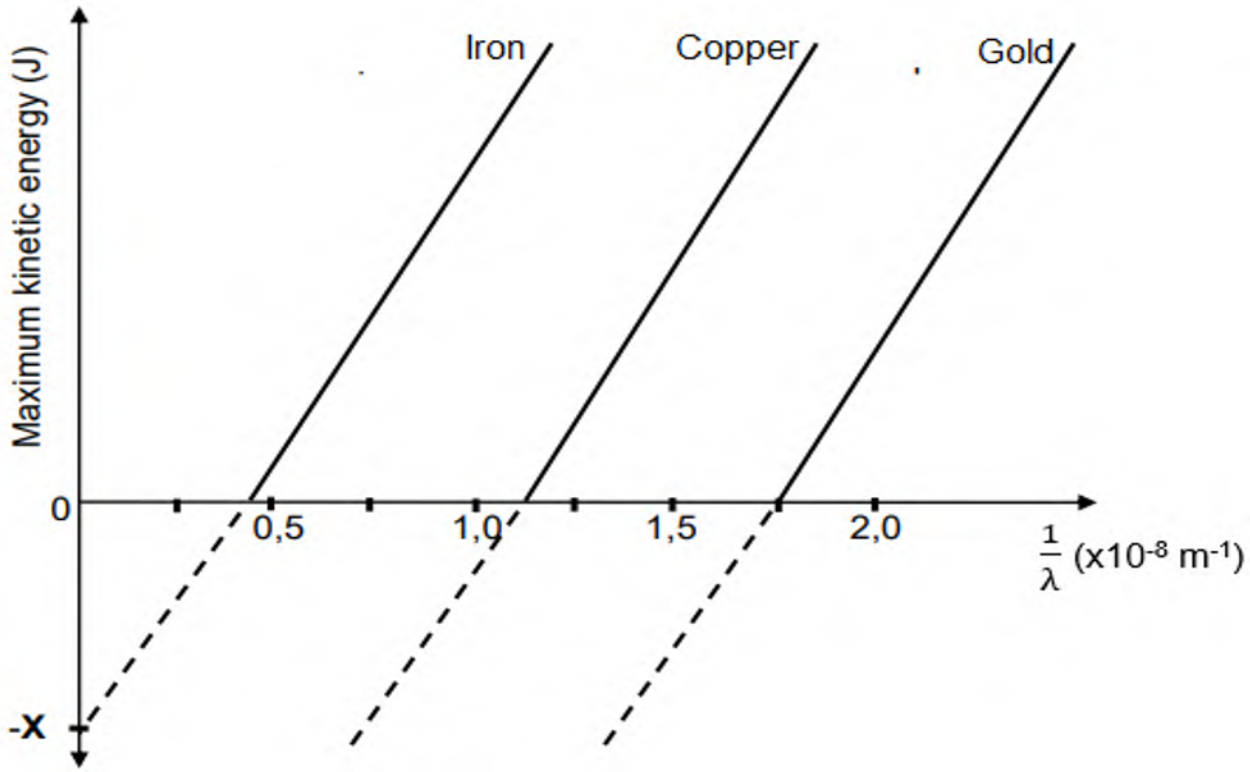
9.5.3 The 60 W light bulb is now removed and replaced by an electric iron, with a power rating of 2 200 W. Explain, with the aid of a calculation, why this is not advisable. (5)

[16]

QUESTION 10 (Start on a new page)

An experiment is conducted to investigate the relationship between the wavelength of light incident on a metal and the maximum kinetic energy of the emitted electrons from the surface of the metal. This experiment is conducted for three different metals, IRON, COPPER and GOLD

The graph below represents the results obtained:



10.1 State, in words what the photoelectric effect is. (2)

10.2 Write down the NAME(S) of the physical quantity/quantities represented by the gradient of the graph(s). (2)

10.3 Which ONE of the three metals needs incident light with the largest frequency for photo-electrons to be emitted? Give a reason for the answer. (2)

10.4 The symbol **X** in the above graph, represents the work function of IRON. If the work function for iron is 9,945 x 10^{-34} J, calculate the maximum velocity of an emitted electron from the surface of iron, if the wavelength of the incident light is 9 x 10^{-11} m. (5)
[11]

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

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

Western Cape Government
Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES PAPER 1 (Physics)

SEPTEMBER 2021

MEMORANDUM / MARKING GUIDELINES

MARKS: 150

TIME: 3 hours

QUESTION 1

1.1 D ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 A ✓✓ (2)

1.5 C ✓✓ (2)

1.6 A ✓✓ (2)

1.7 A ✓✓ (2)

1.8 C ✓✓ (2)

1.9 D ✓✓ (2)

1.10 C ✓✓ (2)

[20]

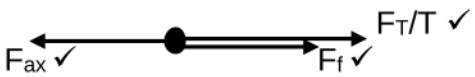
QUESTION 2

2.1 When a resultant (net) force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓ OR

The net force acting on an object is equal to the rate of change of momentum ✓✓of the object (in the direction of the force). [2 or 0] (2)

2.2 F_{net} = 0 Newton's ✓ (1)

2.3



[-1 for any additional forces] (3)

2.4 For the 12 kg block:

$T + F_g = ma$ ✓

$T + [-(12)(9,8)] = (12)(0)$ ✓

$T = 117,6$ N ✓ (3)

2.5 **positive marking from 2.4**

$$F_{net} = ma$$

$$F_{ax} + (T) + (F_f) = ma \quad ✓$$

$F\cos35^0 + (-117,6) + (-7) = 24(0)$ ✓

$F = 152,11$ N ✓ (3)

2.6 Decrease ✓ (1)

[13]

QUESTION 3

3.1 In an isolated (closed) system ✓ the total linear momentum remains constant✓ (is conserved). **OR**
In an isolated system ✓ The total linear momentum before collision equals the total linear moment after collision. ✓ (2)

3.2.1 Take Right as the positive direction:

$$\sum \vec{p}_{\text{i}} = \sum \vec{p}_{\text{f}}$$ ✓
$$m_5\vec{v}_{5,\text{i}} + m_3\vec{v}_{3,\text{i}} = M\vec{v}_f$$

$(5)(4) + (3)(0)$ ✓ $= (5 + 3)(\text{v})$ ✓

v = 2,5 m·s^{-1} right ✓ (4)

positive marking from 3.2.1

3.2.2
$$\vec{\text{F}}_{\text{net}}\Delta\text{t} = \Delta\vec{\text{p}}$$ ✓
$$\vec{\text{F}}_{\text{net}}\Delta\text{t} = \text{m}(\vec{\text{v}}_{\text{f}} - \vec{\text{v}}_{\text{i}})$$
$\vec{\text{F}}_{\text{net}}(0{,}3)$ ✓ $= 8(0 - 2{,}5)$ ✓

$\vec{\text{F}}_{\text{net}} = -66{,}67\text{N}$
$\vec{F}_{\text{net}}$ = 66,67 N left /opposite direction of motion ✓ (4)
[10]

QUESTION 4

4.1 Free fall as motion during which the only force acting on an object is the gravitational force ✓✓ (2)

4.2 $v_f = v_i + a\Delta t$ ✓
$19,6 = 0 + 9,8\Delta t$ ✓
$t = 2$ s ✓ (3)

positive marking from 4.2

4.3 (a) $E_K = {}^1/_2 mv_i^2$ ✓

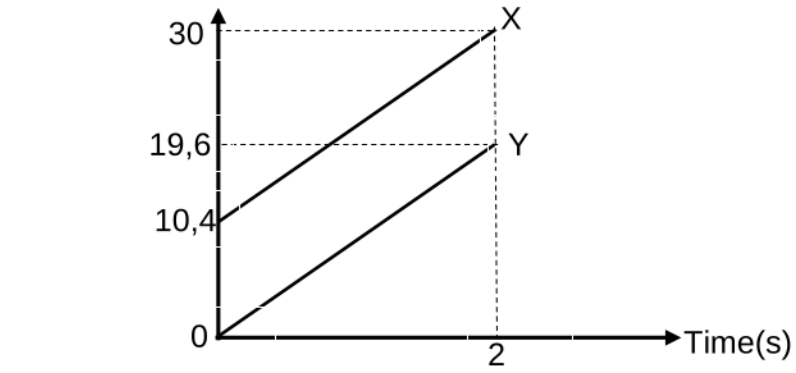
$2,704 = (0,5)(0,05)\ v_i^2$ ✓

$v_i = 10,4\ m.s^{-1}$

(b) $v_f = v_i + a\Delta t$ ✓

$v_f = (10,4) + (9,8)(2)$ ✓
$v_f = 30\ m.s^{-1}$ ✓ (5)

4.4



Criteria for graph	Marks
Time taken (2s) for both balls	✓
The initial and final velocity of ball **X**	✓
The initial and final velocity of ball **Y**	✓
Straight lines and Parallel lines	✓
Both axes labelled	✓

(5)
[15]

QUESTION 5

5.1 The total / net work done ✓on an object is equal to the change in the object's kinetic energy. ✓

OR

The work done on an object by a net force ✓is equal to the change in the object's kinetic energy. ✓ (2)

5.2

$$\text{Gradient/slope} = \frac{\Delta E_k}{\Delta x}$$

$$\text{But } W_{net} = \Delta E_k$$
$$F_{net}\,\Delta x \text{Cos}\theta = \Delta E_k$$
$$F_{net}\,\Delta x \text{Cos}0^0 = \Delta E_k \quad \checkmark$$

$$F_{net} = \frac{\Delta E_k}{\Delta x} = \text{gradient/slope} \checkmark \quad (2)$$

5.3 Third region C:

$$F_{net} = \frac{\Delta E_k}{\Delta x} \checkmark$$
$$= \frac{180 - 88}{15 - 10} \checkmark \checkmark$$
$$= 18{,}4 \text{ N} \checkmark \quad (4)$$

5.4
$$F_{net} = F_A + F_f \checkmark$$
$$18{,}4 = 30 - F_f \checkmark$$
$$F_f = 11{,}6 \text{ N} \checkmark \quad (3)$$

5.5 Second region B ✓ (1)

5.6 Second region B has the smallest gradient ✓
The net force (gradient) will be smallest ✓
∴ force of friction is the largest. (2)

[14]

QUESTION 6

6.1.1 The apparent/observed change in frequency (or pitch) of the sound detected by a listener ✓ because the sound source and listener have different velocities relative to the medium of sound propagation. ✓OR

The change in the (observed) frequency when there is relative motion between the source and the observer. ✓✓ [2 or 0] (2)

6.1.2

$f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$ ✓ OR $f_L = \frac{v}{v + v_S} f_s$

88 ✓ = $(\frac{340+0}{340+ v_S})(90)$ ✓

$(340 + v_s)$ = (340 x 1,0227)

v_s = 7,72 m.s^{-1} ✓ (4)

NB: if 6,8 m·s^{-1}: lose answer mark i.e. -1 accuracy

OPTION 2

$f_L = \frac{v}{v + v_S} f_s$ ✓

$\frac{f_L}{f_s} = \frac{v}{v + v_s}$

0,9778 ✓ = $(\frac{340}{340+ v_S})$ ✓

v_s = 7,72 m.s^{-1} ✓ NB: if 6,8 m.s^{-1} -1 for accuracy (4)

6.2.1 red light has a longer wavelength than blue light, thus a shift towards the red spectrum (longer wave-length, OR lower frequency✓) indicates that the source of the light is moving away✓ from the observer. (2)

6.2.2 Galaxy F ✓

From: $f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$

- Larger v_s ⇒ smaller f_L ⇒ larger λ ✓ (2)

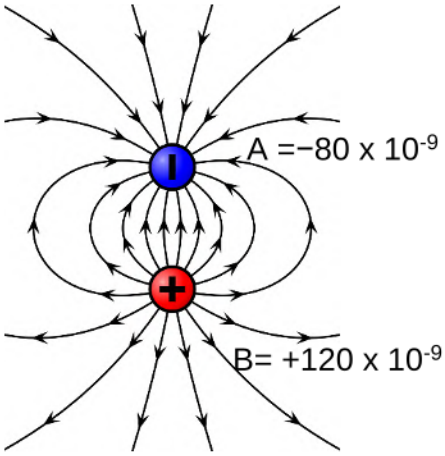
[11]

QUESTION 7

7.1 An Electric field as a region of space in which an electric charge experiences a force. ✓✓ (2)

7.2 $Q = n\,q_e$ ✓
$n = (-80\times10^{-9})/(-1{,}6\times10^{-19})$ ✓
$n = 5\times10^{11}$ electrons ✓ (3)

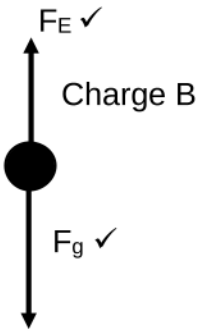
7.3



✓ shape between charges
✓ shape outside charges
✓ direction

(3)

7.4



(2)

7.5 $F_g = F_E$

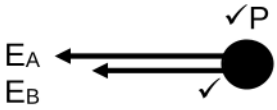
✓ any formula

$$mg = \frac{kQ_AQ_B}{r^2}$$

$$(0{,}01)(9{,}8) \checkmark = \frac{(9\times10^{9})(80\times10^{-9})(120\times10^{-9})}{r^2}\checkmark$$

r = 0,0296 m ✓ ACCEPT: r = 0,03 m (4)

7.6



(2)

7.7 (a) $E_A = kQ/r^2$ ✓
$=(9x10^9)(80x10^{-9}) /(x - 0,05)^2$ ✓

(b) $E_B = kQ/r^2$
$=(9x10^9)(120x10^{-9}) /(0,05)^2$ ✓
$=432\ 000\ N \cdot C^{-1}$

(c) $E_{NET} = E_A + E_B$
$54,45x10^4$ ✓ $= 720/(x - 0,05)^2 +$ ✓ 432 000

x = 0,13 m ✓ (6)

[22]

QUESTION 8

8.1 Maximum energy provided by a battery per unit charge passing through it ✓✓
OR Work done per unit Coulomb of charge ✓ ✓ OR
Maximum energy transfer per Coulomb of charge ✓✓ (2)

8.2 (a) $R_{30} = \frac{V}{I}$ ✓
$30 = V/0,3$ ✓

$V = 9\ V$

(b) $R = \frac{V}{I}$
$20 = \frac{9}{I}$ ✓

$I = 0,45A$

(c) $I_{cir} = 0,45 + 0,3 = 0,75A$ ✓ (4)

Positive marking from 8.2

8.3 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓
$\frac{1}{R_P} = \frac{1}{20} + \frac{1}{30}$ ✓
$R_p = 12\Omega$

$R_x = V_2/I_{cir}$
$R_x = 6,8/0,75$ ✓ $= 9,06\ \Omega$

$\therefore\ R_{ext} = 12 + 9,06 = 21,067\ \Omega$ ✓ (4)

Positive marking from 8.2 & 8.3

8.4 $Emf = I(R+r)$ ✓
18✓ $= 0,75(21,067 + r)$ ✓
$r = 2,93\ \Omega$✓ (4)

8.5 Decrease ✓ (1)

8.6 R_{ext} decreases
$\therefore\ I_{cir}$ increases ✓
$\therefore\ V_{lost}\ (= I\,r)$ increases ✓

From: $emf = V_{ext} + V_{lost}$
- Emf is constant ✓
- V_{lost} increases
- $\therefore\ V_{ext}\ (= V_1)$ decreases (3)

[18]

QUESTION 9

9.1 No ✓ (1)

9.2 AC ✓ slip rings ✓ (2)

9.3 Increase ✓ (1)

9.4 Parallel ✓ (1)

9.5.1 $V_{rms} = V_{max}/\sqrt{2}$ ✓
$220 = V_{max}/\sqrt{2}$ ✓
$V_{max} = 311{,}13V$ ✓ (3)

9.5.2 $P_{av} = V_{rms}^2/R$ ✓
$100 = (220)^2/R$
$R = 484\ \Omega$ ✓ (3)

9.5.3 $P_{ave} = V_{rms}.I_{rms}$ ✓
$2200 = 220\ I_{rms}$ ✓
$I_{rms} = 10A$ ✓
The electric Iron requires 10 A to function plus the current flowing through the 100 W bulb will result in the circuit current being > 10 A. ✓
thus the fuse will burn out. (4)
[15]

QUESTION 10

10.1 Process whereby electrons are ejected from a metal surface when light of a suitable frequency is shone on the metal surface ✓ ✓ (2)

10.2 Plank's constant ✓ + speed of light in a vacuum ✓
Accept: h ✓ + c ✓ (2)

10.3 Gold ✓
Largest threshold frequency ⇒ Smallest threshold wavelength
$\therefore \frac{1}{\lambda 0}$ will be largest ✓ (2)

10.4 $E = W_0 + E_k$
$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$ ✓ any

$\frac{(6{,}67\times10^{-34})(3\times10^{8})}{500\times10^{-9}}$ ✓ $= 2{,}98 \times 10^{-19}$ ✓ $+ \frac{1}{2}(9{,}11 \times 10^{-31})(v^2)$ ✓

$V = 4{,}74 \times 10^{5}\ m\cdot s^{-1}$ ✓ (5)
[11]
Total 150