Education

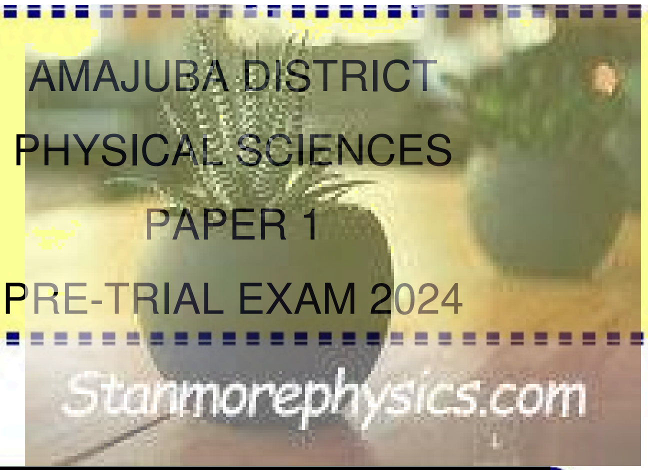
KwaZulu-Natal Department of Education
REPUBLIC OF SOUTH AFRICA

AMAJUBA DISTRICT

PHYSICAL SCIENCES

PAPER 1

PRE-TRIAL EXAM 2024



NATIONAL
SENIOR CERTIFICATE

GRADE 12

TIME: 3 hours

MARKS: 150

This question paper consists of 17 pages including data sheets

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK.**

2. This question paper consists of TEN 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 between two subsections, 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.

QUESTION 1: MULTIPLE-CHOICE QUESTION

1.1 Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

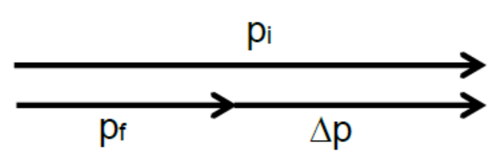
A body is moving at CONSTANT VELOCITY. The net force acting on it is ...

A zero
B constant
C increasing
D decreasing (2)

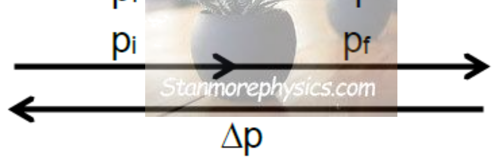
1.2 A ball has a mechanical energy E when it is at rest h metres above the ground. The ball is then dropped from this rest position. What is the kinetic energy of the ball when it is $\frac{1}{3}$ h metres above the ground?

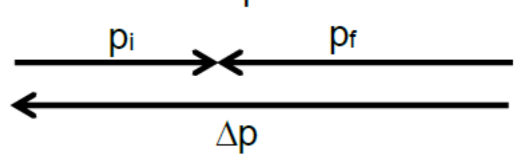
A $\frac{1}{3}$ E
B $\frac{2}{3}$ E
C E
D $\frac{3}{2}$ E (2)

1.3 A car of mass **m** is travelling at a constant velocity and has momentum **p**. The driver notices an object ahead of him and applies the brakes so that the momentum of the car changes to $\frac{1}{2}$ **p**.
Which ONE of the diagrams below correctly shows the relationship between **pi**, **pf** and **Δp**?

A


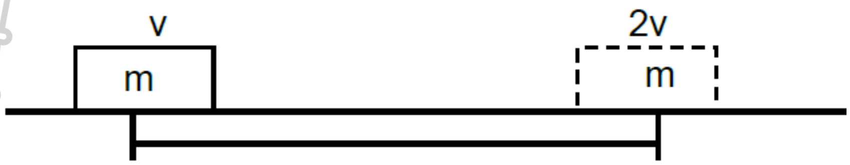
B


C


D


(2)

1.4 An object of mass m is accelerated from a velocity v to a velocity 2v, as shown in the diagram below.



What is the net work done on the object?

A mv^2

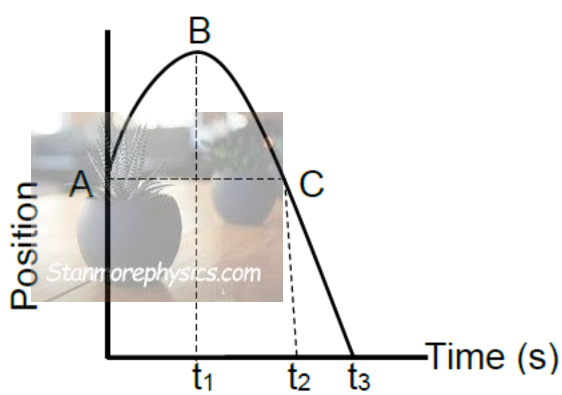
B $\frac{1}{2}mv^2$

C $\frac{3}{2}mv^2$

D $2\ mv^2$

(2)

1.5 A ball is thrown vertically upwards with velocity **v**, from the top of building, h metres above the ground. A, B and C are the positions of the ball during its motion as shown in the position-time graph below.



Which ONE of the following is correct for the VELOCITY and DISPLACEMENT of the ball when it is at point C?

	Velocity ($m \cdot s^{-1}$)	**Displacement (m)**
A	v	2h
B	v	0
C	0	2h
D	-v	0

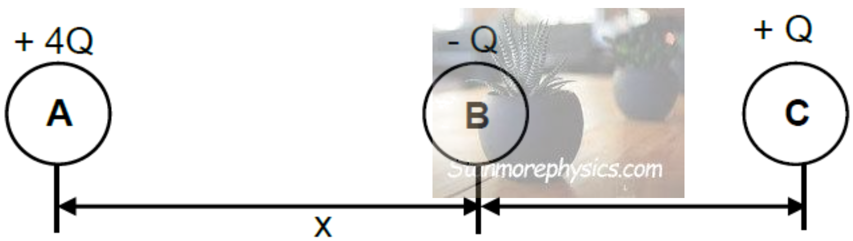
(2)

1.6 Astronomers observed that light from a distant star undergoes a red shift.
Which ONE of the following combinations is correct for the OBSERVED WAVELENGTH and the OBSERVED FREQUENCY when compared to the wavelength and frequency of the light source?

	OBSERVED WAVELENGTH	OBSERVED FREQUENCY
A	Lower than	Lower than
B	Higher than	Lower than
C	Lower than	Higher than
D	Higher than	Higher than

(2)

1.7 Three small identical spheres **A**, **B** and **C** carry charges as shown in the diagram below. The distance between spheres **A** and **B** is **x**.



For sphere **B** to experience a ZERO net electrostatic force, what must the distance between spheres **B** and **C** be?

A $\frac{1}{4}$ X

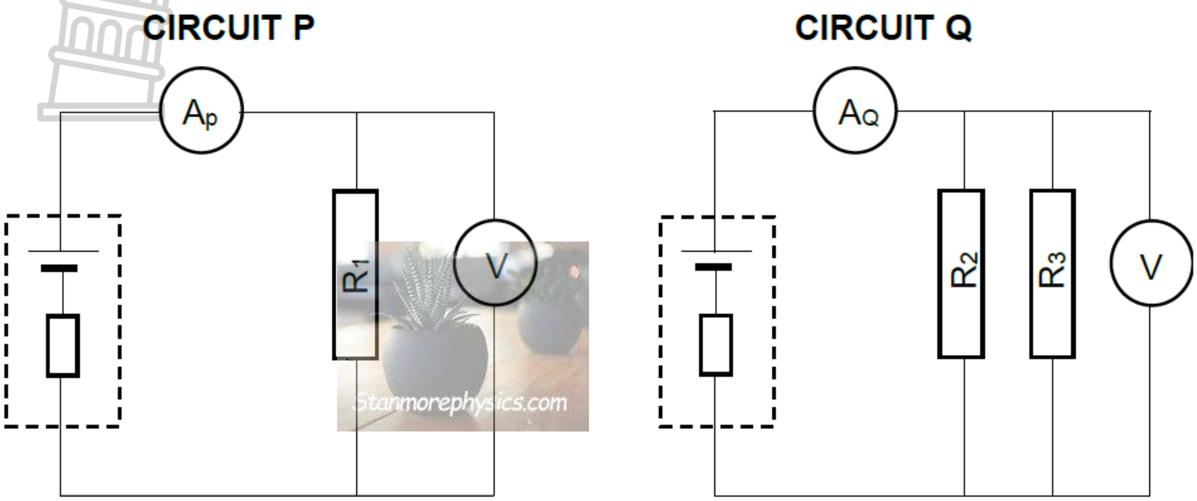
B $\frac{1}{2}$ X

C 2 X

D 4 X

(2)

1.8 The batteries in CIRCUITS P and Q are identical. Resistors R1, R2 and R3 are identical. The ammeters and conducting wires have negligible resistance, the voltmeters have very high resistance, while the resistance of the batteries CANNOT be ignored.



Which ONE of the following combinations is correct for the VOLTMETER READING and the AMMETER READING in circuits P and Q?

	VOLTMETER READING	AMMETER READING
A	$V_P > V_Q$	$A_P > A_Q$
B	$V_P < V_Q$	$A_P > A_Q$
C	$V_P > V_Q$	$A_P < A_Q$
D	$V_P < V_Q$	$A_P < A_Q$

(2)

1.9 Which ONE of the energy conversions below takes place when a DC motor is in operation?

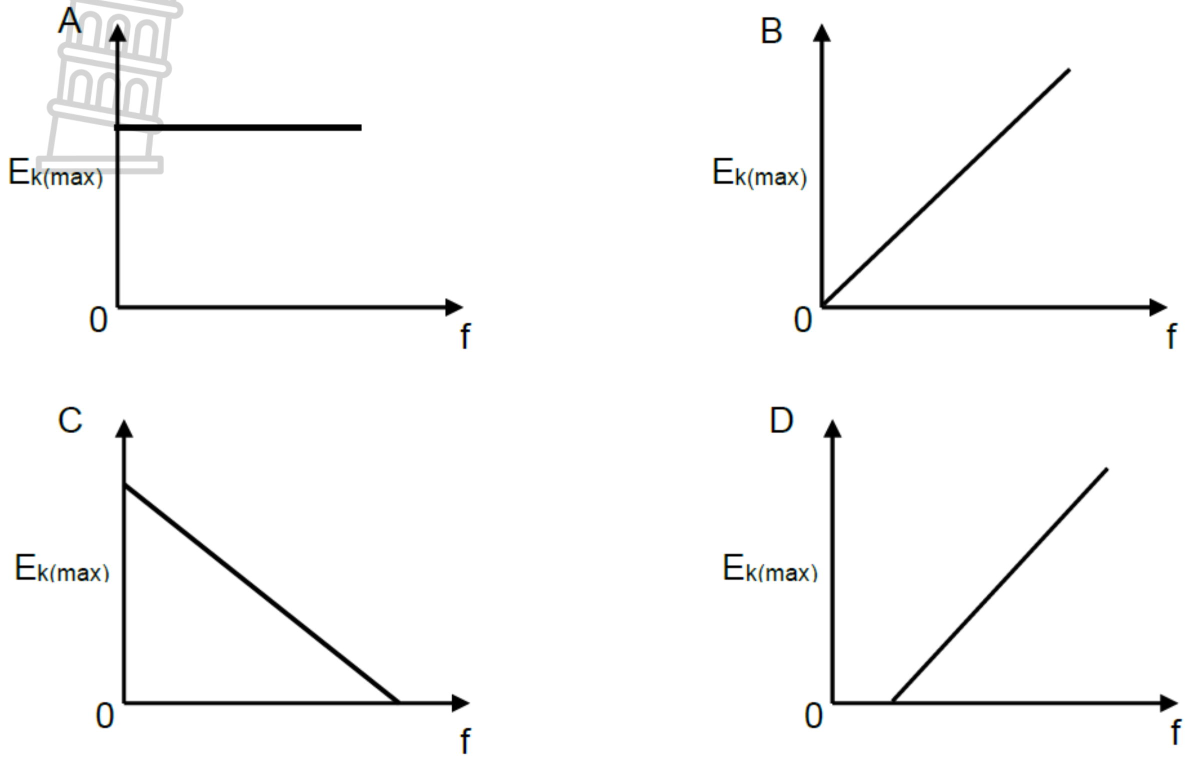
A Kinetic energy to Electrical energy.

B Electrical energy to Kinetic energy.

C Potential energy to Electrical energy.

D Electrical energy to Potential energy. (2)

1.10 Which ONE of the following graphs correctly illustrates the relationship between maximum kinetic energy (Ek(*max*)) of the emitted electrons from a metal surface and frequency (*f*) of the incident light?



(2)

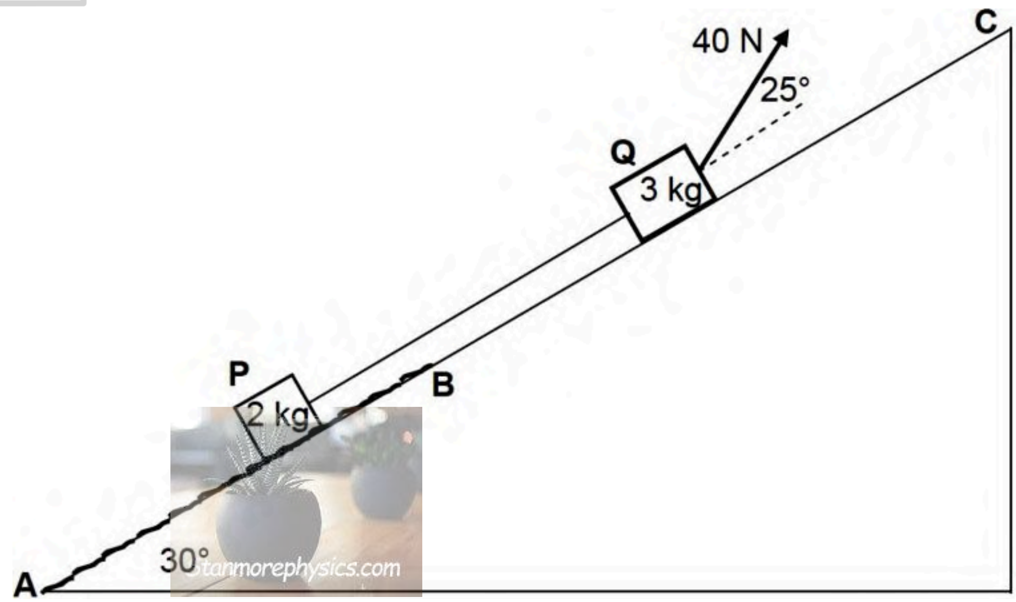
[20]

QUESTION 2

Block **P**, of mass 2 kg, is connected to block **Q**, of mass 3 kg, by a light inextensible string. Both blocks are on a plane inclined at an angle of 30° to the horizontal. Block **Q** is pulled by a constant force of 40 N at an angle of 25° to the incline.

Block **P** moves on a rough section, **AB**, of the incline, while block **Q** moves on a frictionless section, **BC**, of the incline. See diagram.

An average constant frictional force of 2,5 N acts on block **P** as it moves from **A** to **B** up the incline.



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

2.2 Draw a labelled free-body diagram for block **P**. (4)

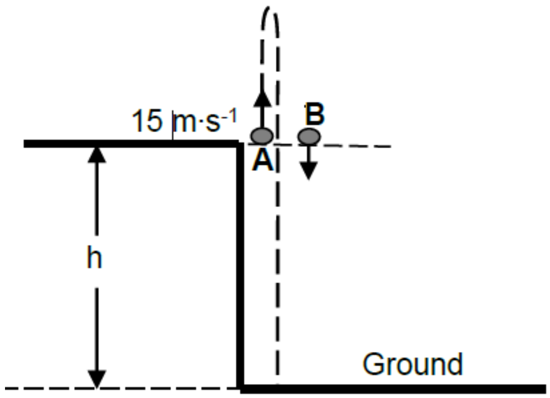
2.3 Calculate the magnitude of the acceleration of block **P** while block **P** is moving on section **AB**. (8)

2.4 If block **P** has now passed point **B**, how will its acceleration compare to that calculated in QUESTION 15.3? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (2)

[16]

QUESTION 3

A ball, **A**, is thrown vertically upward from a height, h, with a speed of 15 m·s-1. AT THE SAME INSTANT, a second identical ball, **B**, is dropped from the same height as ball **A** as shown in the diagram below. Both balls undergo free fall and eventually hit the ground.



3.1 Explain the term *free fall.* (2)

3.2 Calculate the time it takes for ball **A** to return to its starting point (4)

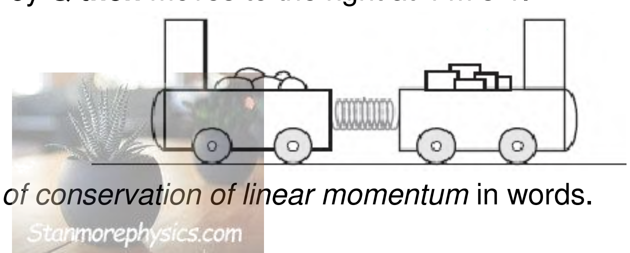
3.3 Calculate the distance between ball **A** and ball **B** when ball **A** is at its maximum height. (7)

3.4 Sketch a velocity-time graph in the ANSWER BOOK for the motion of ball **A** from the time it is projected until it hits the ground. Clearly show the following on your graph:
- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point (4)

[17]

QUESTION 4

The diagram 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.



4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the:

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

4.2.2 Magnitude of the average force exerted by the spring on trolley Q (4)

4.2 Is this an elastic collision? Only answer YES or NO. (1)

[11]

QUESTION 5

A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to **P** as shown below. It then moves along a frictionless horizontal portion **PQ** and finally moves up a second rough inclined plane. It comes to a stop 3 m above the horizontal at point **R**.

The frictional force, a non-conservative force, between the surface and the block is 18 N.

5.1 Using ENERGY PRINCIPLES only, calculate the speed of the block at point P. (4)

5.2 Explain why the kinetic energy at point **P** is the same as that at point Q. (2)

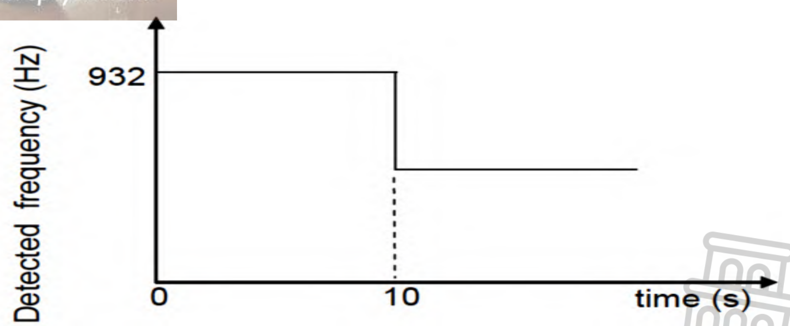
5.3 Explain the term non-conservative force. (2)

5.4 Calculate the angle (θ) of the slope QR. (7)

[15]

QUESTION 6

6.1 A patrol car is moving at a constant speed towards a stationary observer. The driver switches on the siren of the car when it is 300 m away from the observer.
The observer records the detected frequency of the sound waves of the siren as the patrol car *approaches*, *passes* and *moves away* from him.
The information obtained is shown in the graph.



6.1.1 Calculate the speed of the patrol car. (2)

6.1.2 State the *Doppler effect*. (2)

6.1.3 The detected frequency suddenly changes at t = 10 s. Give a reason for this change.
Take the speed of sound in air as 340 $m\cdot s^{-1}$. (2)

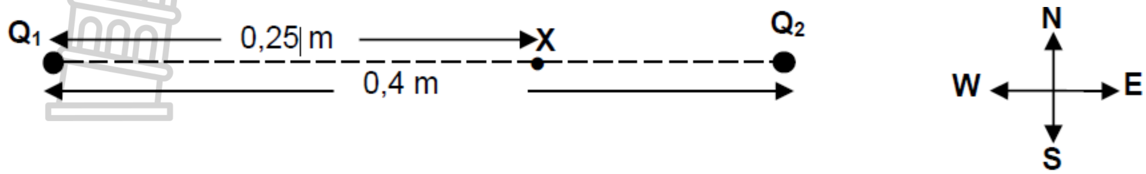
6.1.4 Calculate the frequency of the sound emitted by the siren. (4)

6.2 State TWO applications of the Doppler effect. (2)

[12]

QUESTION 7

Two charged particles, **Q1** and **Q2**, are placed 0,4 m apart along a straight line. The charge on **Q1** is + 2 x 10-5 C, and the charge on **Q2** is – 8 x 10-6 C. Point **X** is 0,25 m **east** of **Q1**, as shown in the diagram below.



Calculate the:

7.1 Net electric field at point **X** due to the two charges (6)

7.2 Electrostatic force that a – 2 x 10-9 C charge will experience at point **X** (4)

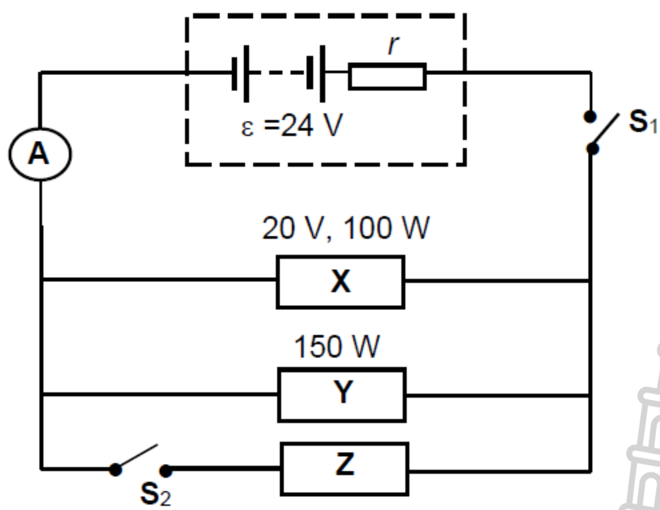
The – 2 x 10-9 C charge is replaced with a charge of – 4 x 10-9 C at point **X**.

7.3 Without any further calculation, determine the magnitude of the force that the – 4 x 10-9 C charge will experience at point **X**. (1)

[11]

QUESTION 8

Three electrical devices, **X**, **Y** and **Z**, are connected to a 24 V battery with internal resistance *r* as shown in the circuit diagram. The power rating of each of the devices **X** and **Y** are indicated in the diagram.



8.1 With switch **S1** closed and **S2** open, the devices function as rated. Calculate the:

8.1.1 Current in X (3)

8.1.2 Resistance of Y (3)

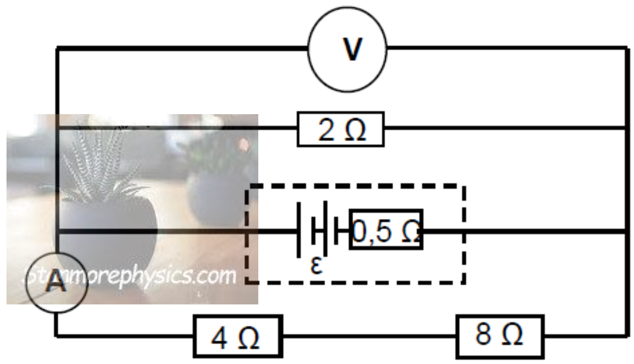
8.1.3 Internal resistance of the battery (5)

8.2 Now switch **S2** is also closed.

8.2.1 Identify device **Z** which, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged. (1)

8.2.2 Explain how you arrived at the answer to QUESTION 8.2.1 (2)

A battery of an unknown emf and an internal resistance of 0,5 Ω is connected to three resistors, a high-resistance voltmeter and an ammeter of negligible resistance, as shown. The reading on the ammeter is 0,2 A.



8.3 Calculate the:

8.3.1 Reading on the voltmeter (2)

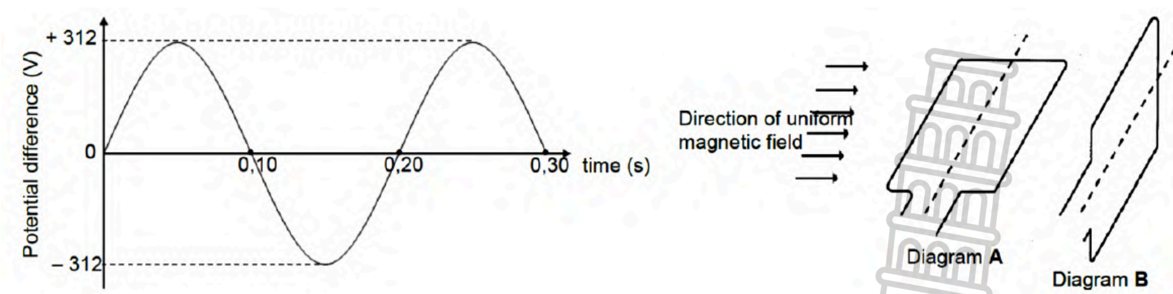
8.3.2 Total current supplied by the battery (4)

8.3.3 Emf of the battery (5)

[25]

QUESTION 9

The graph shows the voltage output of a generator. Diagrams **A** and **B** show the position of the generator at different times.



9.1 Does this generator have split rings or slip rings? (1)

9.2 Which ONE of the diagrams above, **A** or **B**, shows the position of the generator's coil at time = 0,10 s? (1)

9.3 Calculate the root mean square (rms) voltage for this generator. (3)

9.4 A device with a resistance of 40 Ω is connected to this generator. Calculate the:

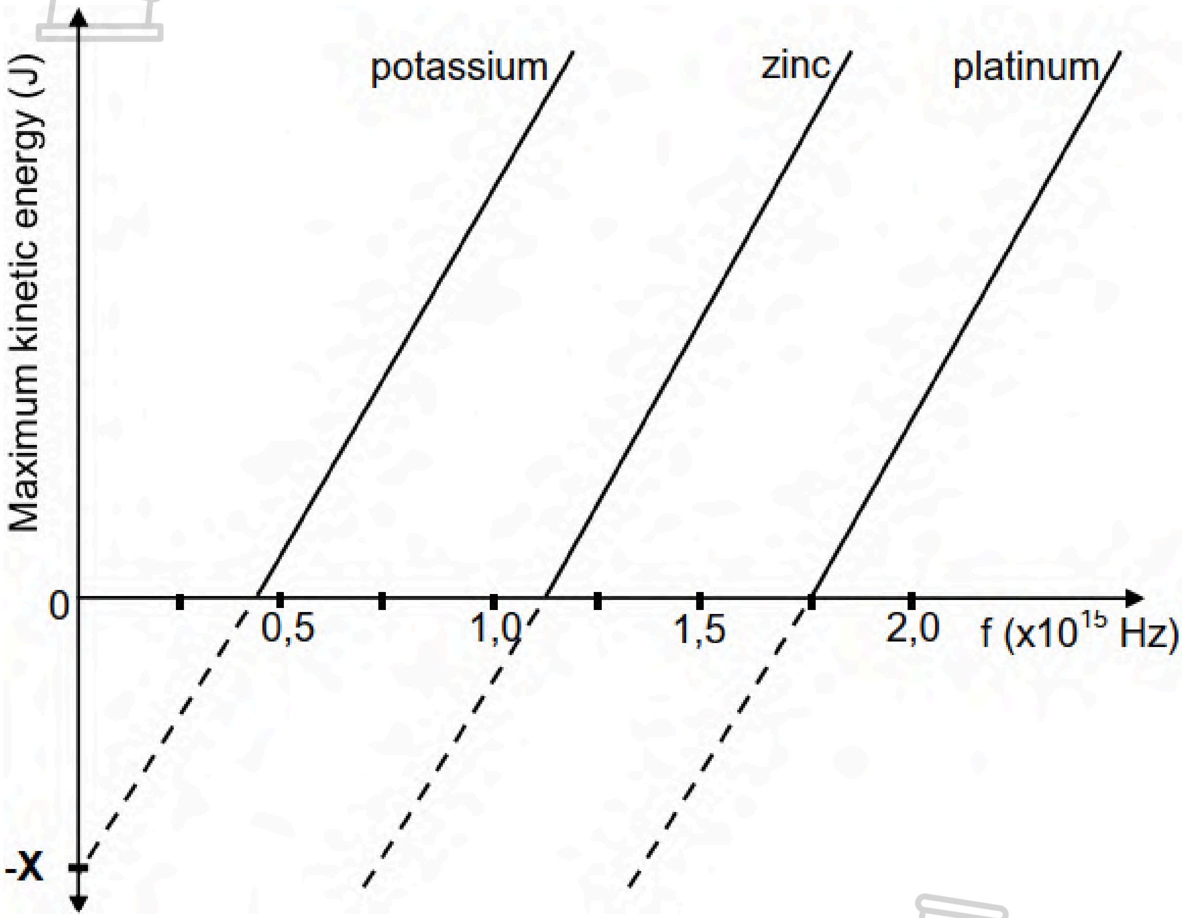
9.4.1 Average power delivered by the generator to the device (3)

9.4.2 Maximum current delivered by the generator to the device (4)

[12]

QUESTION 10

An experiment is conducted to investigate the relationship between the frequency 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. The graph represents the results obtained.



10.1 Name the phenomenon on which this experiment is based. (1)

10.2 Name the physical quantity represented by **X** on the graph. (1)

10.3 Which ONE of the three metals needs incident light with the *largest wavelength* for the emission of electrons? Give a reason for the answer. (2)

10.4 Define the term *work function* in words.

10.5 Calculate the:

10.5.1 Work function of **platinum** (3)

10.5.2 Frequency of the incident light that will emit electrons from the surface of **platinum** with a maximum velocity of 5,60 x 105 $m \cdot s^{-1}$ (4)

[11]

DATA SHEET

PHYSICS :

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m \cdot s^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11}\ N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^8\ m \cdot s^{-1}$
Planck's constant	h	$6,63 \times 10^{-34}\ J \cdot s$
Coulomb's constant	k	$9,0 \times 10^9\ N \cdot m^2 \cdot C^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$
Mass of the Earth	M	$5,98 \times 10^{24}\ kg$
Radius of the Earth	R_E	$6,38 \times 10^6\ m$

TABLE 2: FORMULAE

MOTION

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

FORCE

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

TABLE 2: FORMULAE

MOTION

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

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1m_2}{d^2}$ or $F = G\frac{m_1m_2}{r^2}$	$g = G\frac{M}{d^2}$ or $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ OR $E_P = mgh$
$K = \frac{1}{2}mv^2$ OR $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ OR $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ OR $E = W_o + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv^2_{max}$ OR $K_{max} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

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

ELECTRIC CIRCUITS

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

ALTERNATING CURRENT

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

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PAPER 1

PRE-TRIAL EXAM MARKING GUIDELINE (2024)

NATIONAL
SENIOR CERTIFICATE

GRADE 12

MARKS: 150

QUESTION 1

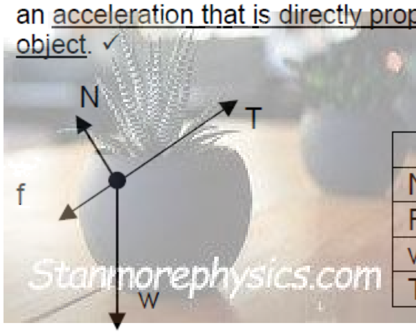
1.1 A
1.2 B
1.3 B
1.4 C
1.5 D
1.6 B
1.7 B
1.8 C
1.9 B
1.10 D

[20]

QUESTION 2

2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force with an <u>acceleration that is directly proportional to the force</u> ✓ and <u>inversely proportional to the mass of the object</u>. ✓ (2)

2.2



	Accept the following symbols
N ✓	F_N/Normal/Normal force
F ✓	F_f/f_k/frictional force/kinetic frictional force
w ✓	F_g,/mg/weight/$F_{\text{Earth on block}}$/19,6 N/gravitational force
T ✓	Tension/F_T/F_A/F

(4)

2.3 For the 2 kg block:

$F_{net} = ma$
$T + (-w_{II}) + (-f_k) = ma$
$T - (w_{II} + f_k) = ma$
} ✓Any one

$T - (2)(9,8)\sin 30°$ ✓ $- 2,5$ ✓ $= 2a$ ✓
$T - 9,8 - 2,5 = 2a$
$T - 12,3 = 2a$ ……….(1)

For the 3 kg block:
$F_x + (-T) + (-w_{II}) = ma$
$F_x - (T + w_{II}) = ma$
$[40 \cos 25°$ ✓ $- T - (3)(9,8)\sin 30°$ ✓$]$ ✓ $= 3a$
$36,25 - T - 14,7 = 3a$
$21,55 - T = 3a$ ………….(2)
$9,25 = 5a$ $\therefore a = 1,85 \text{ m·s}^{-2}$ ✓ (8)

2.4 Greater than ✓
F_{net} increases. ✓ (2)

[16]

QUESTION 3

3.1 Motion under the influence of the gravitational force/weight ONLY. ✓✓ (2)

3.2

OPTION 1	
Upwards positive: $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ 0 ✓ = $\underline{15\ \Delta t + \frac{1}{2}(-9{,}8)\ \Delta t^2}$ ✓ Δt = 3,06 s ∴ It takes 3,06 s ✓	**Downwards positive:** $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓ 0 ✓ = $\underline{-15\ \Delta t + \frac{1}{2}(9{,}8)\ \Delta t^2}$ ✓ Δt = 3,06 s ∴It takes 3,06 s ✓
OPTION 2 **Upwards positive:** $v_f = v_i + a\Delta t$ ✓ 0 ✓ = $\underline{15 + (-9{,}8)\Delta t}$ ✓ Δt = 1,53 s It takes (2)(1,53) = 3,06 s ✓	**Downwards positive:** $v_f = v_i + a\Delta t$ ✓ 0✓ = $\underline{-15 + (9{,}8)\Delta t}$ ✓ Δt = 1,53 s It takes (2)(1,53) = 3,06 s ✓

(4)

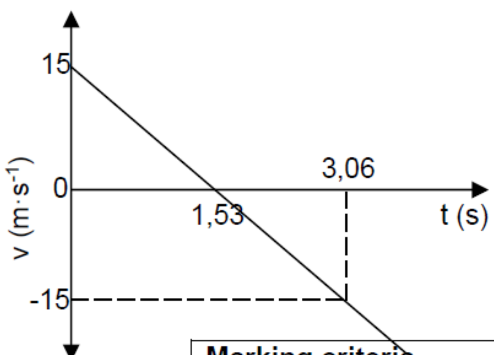
3.3

Upwards positive: $v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A 0 = $(15)^2$✓ + 2 (-9,8)Δy ✓ ∴ Δy_A = 11,48 m <u>When A is at highest point:</u> $\Delta y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$ = 0 + $\underline{\frac{1}{2}(-9{,}8)\ (1{,}53)^2}$ ✓✓ Δy_B = -11,47 m ∴ Δy_B = 11,47 m downward Distance = $y_A + y_B$ = 11,47 + 11,48 ✓ = 22,95 m ✓	**Downwards positive:** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ For ball A 0 = $(-15)^2$✓ + 2 (9,8)Δy✓ ∴ Δy_A = -11,48 m <u>When A is at highest point:</u> $\Delta y_B = v_i\Delta t + \frac{1}{2} a\Delta t^2$ = 0 + $\underline{\frac{1}{2}(9{,}8)\ (1{,}53)^2}$ ✓✓ Δy_B = 11,47 m ∴ Δy_B = 11,47 m downward Distance = $y_A + y_B$ = 11,48 + 11,47 ✓ = 22,95 m ✓

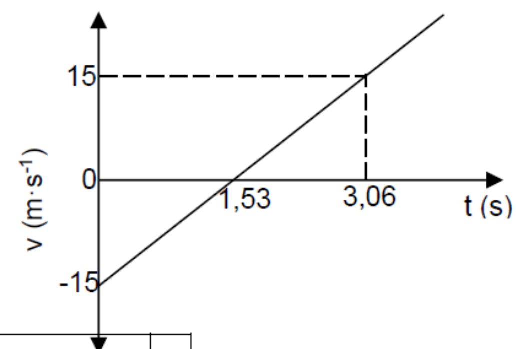
(7)

3.4

UPWARD AS POSITIVE



DOWNWARD POSITIVE



Marking criteria	
Graph starts at correct initial velocity shown.	✓
Time for maximum height shown (1,53 s).	✓
Time for return shown (3,06 s)	✓
Shape: Straight line extending beyond 3,06 s	✓

(4)

QUESTION 4

4.1 The <u>total (linear) momentum of an isolated/(closed system</u> ✓ <u>is constant/conserved.</u> ✓ (2)

4.2.1 $\sum p_i = \sum p_f$✓ (4)

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$

0✓ = $\underline{(0{,}4)v_{1f} + 0{,}6\ (4)}$✓

v_{1f} = - 6 m·s^{-1}

= 6 m·s^{-1} to the left/*na links*✓

4.2.2 (4)

OPTION 1	OPTION 2	OPTION 3
$\Delta p = F_{net}\Delta t$✓ $[(0,6)(4) - 0]$✓ $= F_{net}\ (0,3)$✓ $F_{net} = 8\ N$✓ **OR/OF** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,6(4 - 0)$✓$= F_{net}(0,3)$✓ $F_{net} = 8\ N$✓	$v_f = v_i + a\Delta t$ $4 = 0 + a(0,3)$ $a = 13,33\ m{\cdot}s^{-2}$ $F_{net} = ma$ $= 0,6(13,33)$ $F_{net} = 8\ N$✓	$\Delta p = F_{net}\Delta t$✓ $[(0,4)(6) - 0]$✓ $= F_{net}\ (0,3)$✓ $F_{net} = 8\ N$✓ **OR/OF** $m(v_f - v_i) = F_{net}\Delta t$✓ $0,4(6 - 0)$✓$= F_{net}(0,3)$✓ $F_{net} = 8\ N$✓

4.3 NO (1)

[11]

QUESTION 5

5.1 (4)

$\Delta U + \Delta K = 0$✓

$(5)(9,8)(5) + 0$✓ $+ (0 + \frac{1}{2}(5v_f^2))$✓ $= 0$

$v_f = \sqrt{2 \times 9,8 \times 5}$

$= 9,90\ m{\cdot}s^{-1}$✓ $(9,899\ m{\cdot}s^{-1})$

5.2 No friction/zero resultant force ✓ and thus no loss in energy. ✓ (2)
OR Only conservative forces are present. **OR** Mechanical energy is conserved.

5.3 The force for which the work done is path dependent. ✓✓ (2)

5.4 (7)

OPTION 1

$W_{nc} = \Delta U + \Delta K$ ✓

$F\ \Delta x \cos\theta = \Delta U + \Delta K$

$(18\ \Delta x \cos 180$✓$) = (5)(9,8)(3 - 0)$✓ $+ \frac{1}{2}(5)(0 - 9,90^2)$✓

$\Delta x = 5,4458\,m$✓

$\theta = \sin^{-1}\frac{3}{5,4458}$✓

$\theta = 33,43°$✓

[15]

QUESTION 6

6.1.1 (2)

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ **OR** $v = \frac{d}{t} = \frac{300}{10}$ ✓ $= 30\,m{\cdot}s^{-1}$ ✓

$300 = v_i\,(10)$ ✓

$v_i = 30\ m{\cdot}s^{-1}$ ✓

6.1.2 The change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (2)

6.1.3 Car/source (just) passes observer. ✓✓ (2)

6.1.4 (4)

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR** $f_L = \frac{v}{v - v_s} f_s$

932✓ $= \frac{340}{340 - 30}$✓ f_s $\therefore f_s = 849,76\ Hz$ ✓

6.2 (2)

ANY TWO:

Doppler / Blood flow meter/Measuring the heartbeat of a foetus/Radar/Sonar/Used to determine whether stars are receding or approaching earth.

[12]

QUESTION 7

7.1 (6)

$E_x = E_2 + E_{(-8)}$ ✓ $= \frac{kQ_2}{r^2} + \frac{kQ_{-8}}{r^2}$ ✓ correct equation

$$= \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2} ✓ + \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2} ✓$$

$= 2,88 \times 10^6 + 3,2 \times 10^6 = 6,08 \times 10^6\ N\cdot C^{-1}$ ✓ to the east/right ✓

OR

$E = \frac{kQ}{r^2}$ ✓

$E_2 = \frac{(9\times10^9)(2\times10^{-5})}{(0,25)^2}$ $= 2,88 \times 10^6\ NC^{-1}$ to the east/right

$E_{-8} = \frac{(9\times10^9)(8\times10^{-6})}{(0,15)^2}$ $= 3,2 \times 10^6\ N\cdot C^{-1}$ to the east/right

$E_x = E_2 + E_{(-8)} = (2,88 \times 10^6 + 3,2 \times 10^6)$ ✓ = $\underline{6,08 \times 10^6\ N\cdot C^{-1}}$ ✓ to the east/right ✓

7.2 (4)

OPTION 1

$F_E = QE$ ✓
$= (-2 \times 10^{-9})(6,08 \times 10^6)$ ✓
$= -12,16 \times 10^{-3}\ N$
$F_E = 1,22 \times 10^{-2}\ N$ ✓ to the west/left ✓

OPTION 2

$F_{(-2)Q1} = qE_{(2)}$ ✓
$= (2 \times 10^{-9})(2,88 \times 10^6)$
$= 5,76 \times 10^{-3}\ N$ to the west/left

$F_{(-2)Q2} = qE_{(8)}$
$= (2 \times 10^{-9})(3,2 \times 10^6)$
$= 6,4 \times 10^{-3}\ N$ to the west/left

$F_{net} = \underline{5,76 \times 10^{-3} + 6,4 \times 10^{-3}}$ ✓
$= 1,22 \times 10^{-2}\ N$ ✓ to the west/left

7.3 $2,44 \times 10^{-2}\ N$ ✓ / twice / double (1)

[11]

QUESTION 8

8.1.1 $P = VI$ ✓ $\therefore$ $100 = 20(I)$ ✓ $\therefore I = 5\ A$ ✓ (3)

8.1.2 $P = \frac{V^2}{R}$ ✓ $\therefore R = \frac{(20)^2}{150}$ ✓ $= 2,67\ \Omega$ ✓ (3)

8.1.3 $P = VI$ **OR** $P = I^2R$ (5)

$\therefore I_{150W} = \frac{150}{20}$ ✓ $= 7,5\ A$ $\therefore I_{150W} = \sqrt{\frac{150}{2,67}}$ ✓ $= 7,5\ A$

$I_{tot} = (5 + 7,5)$ ✓
$\varepsilon = I(R + r)$ ✓ $\therefore$ $24 = 12,5(R + r)$
$24 = V_{ext} + V_{ir}$ $\therefore$ $24 = 20 + 12,5(r)$ ✓ $\therefore r = 0,32\ \Omega$ ✓

8.2.1 Device Z is a voltmeter. ✓ (1)

8.2.2 Device **Z** should be a voltmeter (or a device with very high resistance) because it has a very high resistance✓ and will draw very little current. ✓ The current through **X** and **Y** will remain the same hence the device can operate as rated. (2)

8.3.1 $V = IR$ ✓
$= (0,2)(4+8)$ ✓
$= 2,4$ V ✓ (2)

8.3.2 (4)

$V = IR$ $2,4 = I_2(2)$ ✓ $I_{2\Omega} = 1,2$ A ✓ $I_T = I_2 + 0,2$ A ✓ $= 1,4$ A ✓	OR $I_2 = 6 \times 0,2$ ✓ $I_2 = 1,2$ A ✓ $I_T = I_2 + 0,2$ ✓ $= 1,4$ A ✓

8.3.3 (5)

OPTION 1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $\frac{1}{R_p} = \frac{1}{12} + \frac{1}{2}$ $R_P = 1,72\ \Omega$ ✓ $\varepsilon = I(R+r)$ ✓ $= 1,4(1,72 + 0,5)$ ✓ $= 3,11$ V ✓	**OPTION 2** $V_{int} = Ir$ ✓ $= (1,4)(0,5)$ $= 0,7$ V ✓ $\varepsilon = V_{ext/eks} + V_{int}$ ✓ $= 2,4 + 0,7$ ✓ $= 3,1$ V ✓

[11]

QUESTION 9 (Q 14)

9.1 Slip rings ✓ (1)

9.2 B ✓ (1)

9.3 $V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓ $= \frac{312}{\sqrt{2}}$ ✓ $= 220,62$ V ✓ (3)

9.4.1 **OPTION 1** (3)

$P_{aver/gemid} = \frac{V^2_{rms/wgk}}{R}$ ✓ $= \frac{(220,62)^2}{40}$ ✓ $= 1216,83$ W ✓

OPTION 2

$I_{rms} = \frac{V_{rms/wgk}}{R}$

$= \frac{(220,62)}{40}$

$= 5,515$

$P_{ave} = I^2_{rms}R$

✓ any one

$= (5,515)^2(40)$ ✓

$= 1216,61$ W ✓

OR

$P_{ave} = V_{rms}I_{rms} = (220,62)(5,515)$ ✓ $= 1216,72$ W ✓

9.4.2 (4)

OPTION 1

$I_{max} = \frac{V_{max/maks}}{R}$ ✓

$= \frac{312}{40}$ ✓✓

$= 7,8$ A ✓

OPTION 2

$P_{ave} = V_{rms}I_{rms}$ } ✓ Any one

$\underline{1\ 216,83 = 220,62\ I_{rms}}$ ✓

$I_{rms} = 5,515$ A

$I_{rms} = \frac{I_{max/maks}}{\sqrt{2}}$ } ✓ Any one

$5,515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓ ∴ $I_{max} = 7,8$ A ✓

[12]

QUESTION 10

10.1 Photoelectric effect ✓ (1)

10.2 Work function (of potassium) ✓ (1)

10.3 Potassium ✓ It has the lowest work function / threshold frequency / highest threshold wavelength. ✓ (2)

10.4 The work function of a metal is the minimum energy that an electron (in the metal) needs ✓ to be emitted/ejected from the metal / surface. ✓ (2)

10.5.1 (3)

$W_o = hf_o$ ✓

$= (6,63 \times 10^{-34})(1,75 \times 10^{15})$ ✓

$= 1,160 \times 10^{-18}$ J ✓

OR/OF

$E = W_o + E_{k(max)}$
$hf = W_o + E_{k(max)}$ } ✓ Any one

$(6,63 \times 10^{-34})(1,75 \times 10^{15}) = W_o + 0$ ✓

$W_o = 1,160 \times 10^{-18}$ J ✓

10.5.2 (4)

$E = W_o + E_{k(max)}$
$hf = hf_o + \frac{1}{2}mv^2_{max}$ } ✓ Any one/

$(6,63 \times 10^{-34})f$ ✓ $= 1,160 \times 10^{-18} + \frac{1}{2}(9,11 \times 10^{-31})(5,60 \times 10^5)^2$ ✓

∴ $f = 1,97 \times 10^{15}$ Hz ✓

[11]