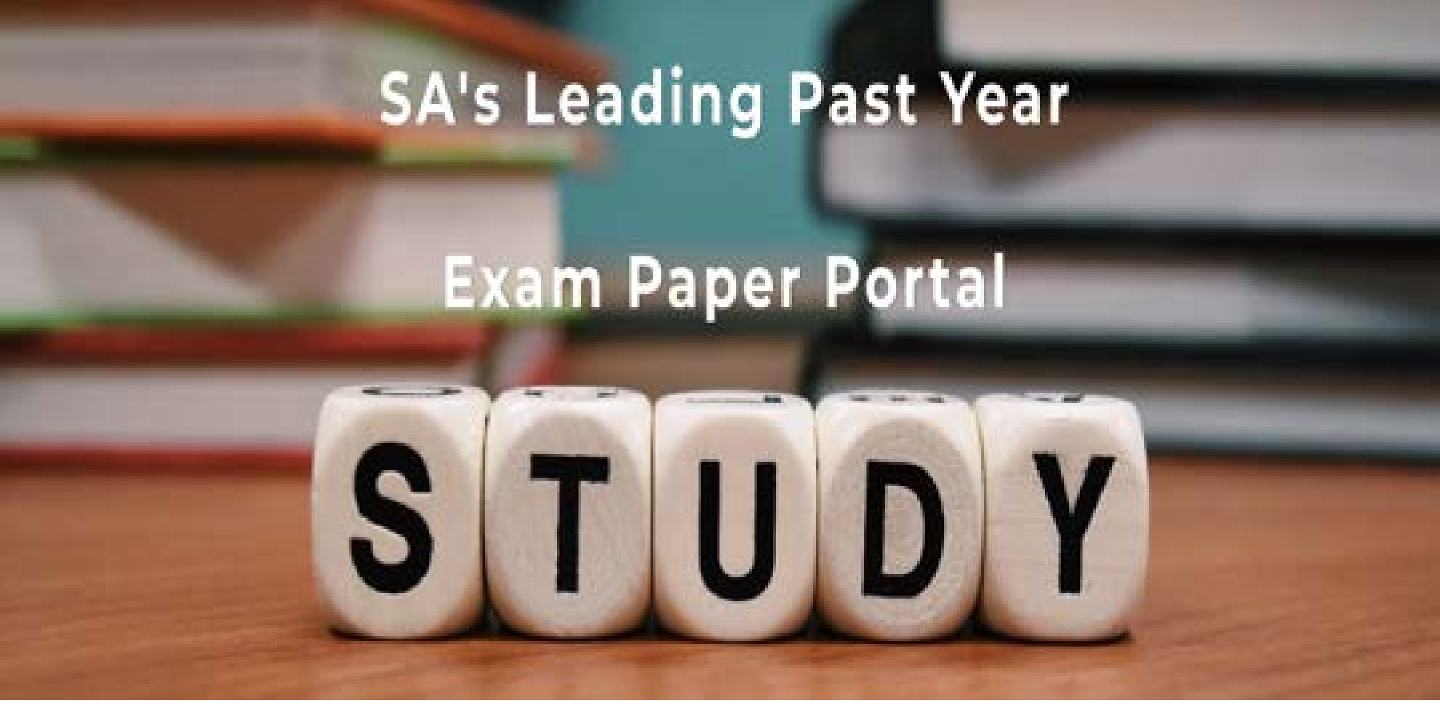
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STUDY

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

PREPARATORY EXAMINATIONS

MARKING GUIDELINE

SEPTEMBER 2021

MARKS : 150

TIME: 3 hours

This marking guideline consists of 15 pages.

QUESTION 1: MULTIPLE CHOICE

1.1	A✓✓	(2)
1.2	D✓✓	(2)
1.3	C✓✓	(2)
1.4	D✓✓	(2)
1.5	D✓✓	(2)
1.6	B✓✓	(2)
1.7	B✓✓	(2)
1.8	A✓✓	(2)
1.9	A✓✓	(2)
1.10	C✓✓	(2)
		[20]

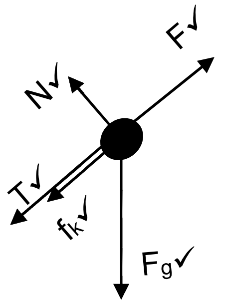
QUESTION 2

2.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object✓✓.

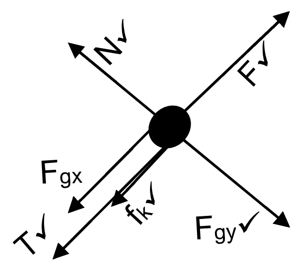
OR

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

2.2



ACCEPT



	Accept the following symbols
F	F_A/F_{app}/$F_{Applied}$
N	F_N/Normal/Normal force
fk	Kinetic friction force/f/F_f/f_r
T	Tension force/F_T
F_g	W/58,8N

Notes
- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with body/dot : *Max:4/*5
- If arrows missing but labels are there: *Max:4/*5

(5)

2.3 **For the 4 kg crate**

$F_{net} = ma$

T – f – Fg// = ma

T – 1 – (9,8)(4)sin30° ✓= 4(2,5)

T = 30,6 N upwards

For the 6 kg crate

$F_{net} = ma$

F – f – T – Fg// = ma

F–1,5– 30,6 – (9,8)(6)sin 30° ✓= 6(2,5)

F = 76,5 N ✓

✓ Any of the two

(5)

2.4.1 INCREASES✓ (1)

2.4.2 The 4 kg block will move upwards/forward (for a brief moment)✓, stop✓ and then slide down the plane / backward✓. (3)

[16]

QUESTION 3

3.1.1 Zero✓ (1)

3.1.2 9,8 m·s^{-2} ✓downwards ✓ (2)

3.2.1 **OPTION 1**

UPWARD POSITIVE	**UPWARD NEGATIVE**
$\Delta y = v_i\Delta t + ½a\Delta t^2$✓ Δy= (4,9)(0,5) + ½(-9,8)(0,5)^2✓ Δy = 1,225 m Height after 0,5 s = 80 +✓ 1,225 = 81,23 m✓ ∴The ball is 81,23 m above the ground	$\Delta y = v_i\Delta t + ½a\Delta t^2$✓ Δy= (-4,9)(0,5) + ½(9,8)(0,5)^2✓ Δy = -1,225 m Height after 0,5 s = 80 +✓ 1,225 = 81,23 m✓ ∴The ball is 81,23m above the ground

OPTION 2

UPWARD POSITIVE	UPWARD NEGATIVE
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$v_f = 4,9 + (-9,8)(0,5)$	$v_f = -4,9 + (9,8)(0,5)$
$v_f = 0\ m{\cdot}s^{-1}$	$v_f = 0\ m{\cdot}s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{0 = 4,9^2 + 2(-9,8)\Delta y}$ ✓	$\underline{0 = -4,9^2 + 2(9,8)\Delta y}$ ✓
$\Delta y = 1,225$ m	$\Delta y = -1,225$ m
Height after 0,5 s = $\underline{80 +}$ ✓ 1,225 = 81,23 m ✓	Height after 0,5 s = $\underline{80 +}$ ✓ 1,225 = 81,23 m ✓
∴The ball is 81,23 m above the ground	∴The ball is 81,23 m above the ground

OPTION 3

UPWARD POSITIVE	UPWARD NEGATIVE
$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$v_f = 4,9 + (-9,8)(0,5)$	$v_f = 4,9 + (-9,8)(0,5)$
$v_f = 0\ m{\cdot}s^{-1}$	$v_f = 0\ m{\cdot}s^{-1}$
$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓	$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓
$[\Delta y = \frac{0 + 4,9}{2}\ 0,5]$ ✓	$[\Delta y = \frac{0 - 4,9}{2}\ 0,5]$ ✓
$\Delta y = 1,225$ m	$\Delta y = -1,225$ m
Height after 0,5 s = $\underline{80 +}$ ✓ 1,225 = 81,23m ✓	Height after 0,5 s = $\underline{80 +}$ ✓ 1,225 = 81,23 m ✓
∴The ball is 81,23 m above the ground	∴The ball is 81,23 m above the ground

OPTION 4

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$ ✓

$\underline{\frac{1}{2}m(4,9)^2 + m(9,8)(80)}$ ✓ = $\underline{\frac{1}{2}m(0)^2 + m(9,8)h_f}$ ✓

$h_f = 81,225$ m ✓

OPTION 5

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$ ✓

$\underline{\frac{1}{2}m(4,9)^2 + m(9,8)(0) = \frac{1}{2}m(0)^2 + m(9,8)h_f}$ ✓

$h = 1,225$ m

Height after 0,5 s = $\underline{80 +}$✓ 1,225
= 81,23 m✓
∴The ball is 81,23 m above the ground

(4)

3.2.2 **OPTION 1**

UPWARDS POSITIVE	**UPWARDS NEGATIVE**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
-80 ✓ $= \underline{(4,9)\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓	80 ✓ $= \underline{(-4,9)\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$\Delta t = 4,57$ s ✓	$\Delta t = 4,57$ s ✓

OPTION 2

UPWARDS POSITIVE	**UPWARDS AS NEGATIVE**
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
$v_f^2 = \underline{(4,9)^2 + 2(-9,8)(-80)}$ ✓	$v_f^2 = \underline{(-4,9)^2 + 2(9,8)(80)}$ ✓
$v_f = -39,9\ m\cdot s^{-1}$	$v_f = 39,9\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ ✓	$v_f = v_i + a\Delta t$ ✓
$\underline{-39,9 = 4,9 + (-9.8)\Delta t}$ ✓	$\underline{39,9 = -4,9 + (9.8)\Delta t}$ ✓
$\Delta t = 4,57$ s ✓	$\Delta t = 4,57$ s ✓

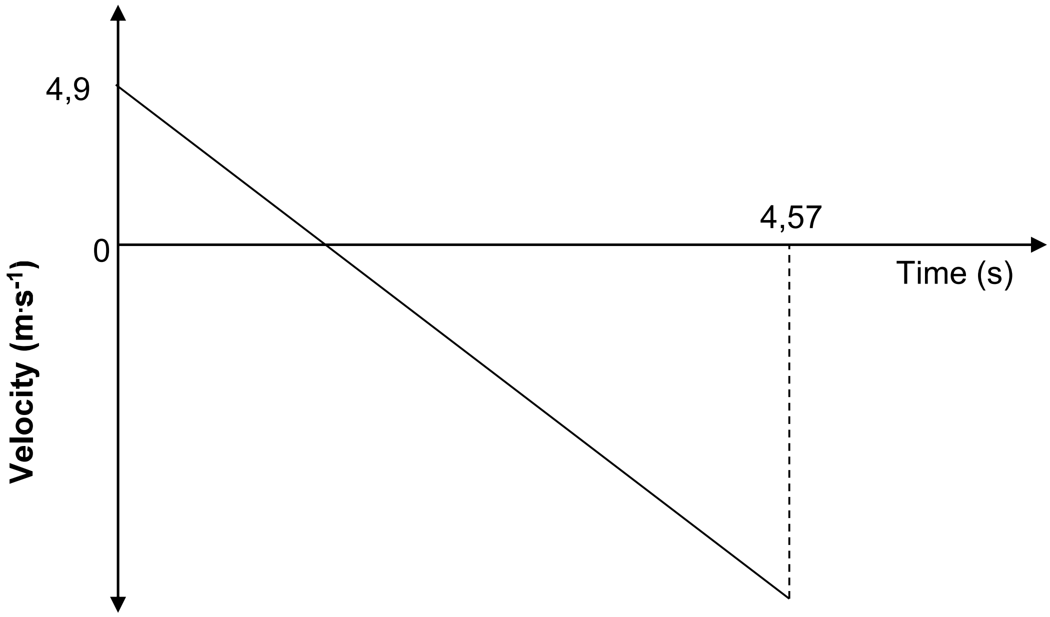
OPTION 3: POSITIVE MARKING FROM QUESTION 3.2.1

Considering ball from the maximum height

UPWARDS POSITIVE	**UPWARDS AS NEGATIVE**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$\underline{-81,23 = (0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓	$\underline{81,23 \checkmark = (0)\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$\Delta t = 4,07$ s	$\Delta t = 4,07$ s
Time to reach ground = $\underline{0,5 +}$ ✓4,07 = 4,57 s ✓	Time to reach ground = 0,5 + 4,07 = 4,57 s ✓

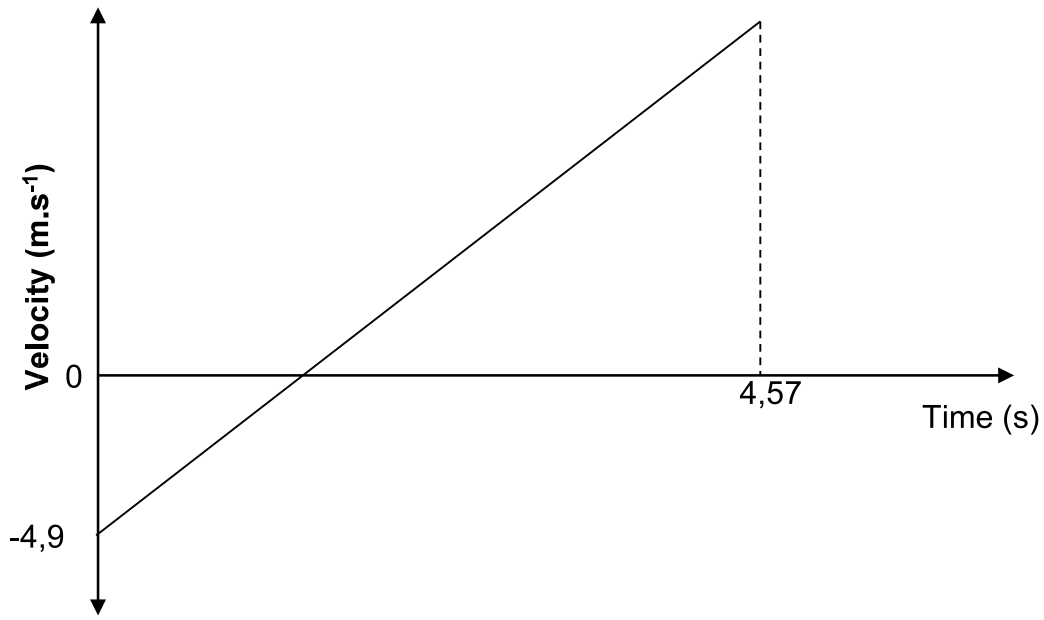
3.3 POSITIVE MARKING FROM Q3.2.2

UPWARD POSITIVE



OR

UPWARD NEGATIVE



CRITERIA FOR MARKING OF GRAPH	
Correct shape	✓
Indication of initial velocity	✓
Indication of the time for the entire motion	✓

(3)
[14]

QUESTION 4

4.1 The total linear momentum in an isolated system is conserved✓✓

(accept "closed" instead of "isolated")

OR

In an isolated system, the total linear momentum before a collision is equal to the total linear momentum after the collision.✓✓ (2)

4.2 p_{total} (before) = p_{total} (after)

$\Sigma p_i = \Sigma p_f$ ✓

$m_1 v_{i1} + m_2 v_{i2} = (m_1 + m_2)v$

1200 (25) + 1800 (0)✓ = (1200 + 1800)v ✓

v = 10 m·s^{-1}✓.

∴ Speed of the cars after is 10 m·s^{-1} (4)

4.3

$\Sigma K_f = ½ (m_1 + m_2)v^2$✓ = ½ (1200 + 1800) 10 ^{2}✓ = 150 000 J	$\Sigma K_i = ½ m_1 v_{i1}^2 + ½ m_2 v_{i2}^2$ = ½ (1200)(25)^2 + ½(1800)(0)^2✓ = 375 000 J

$\Sigma K_f \neq \Sigma K_i$✓

∴Collision is Inelastic ✓ (5)

NOTE: If it is assumed that $\Sigma K_f = \Sigma K_i$ at the outset, *Max:2/5*

4.4 POSITIVE MARKING FROM QUESTION 4.2

OPTION 1	**OPTION 2**
$v_f^2 = v_i^2 + 2a\Delta y$✓ $0^2 = (10)^2 + 2a(20)$ ✓ a = - 2,5 m·s^{-2}	$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓ $20 = \left(\frac{0+10}{2}\right)\Delta t$ ✓ Δt = 4 s $v_f = v_i + a\Delta t$ 0 = 10 + a(4) a = - 2,5 m·s^{-2}

$F_{net} = ma$✓

$F_f = ma$

F_f = 3000(-2,5) ✓

F_f = -7500 N

∴ Magnitude of frictional force is 7500 N✓ (5)

[16]

OPTION 3

$\Delta y = \frac{v_f + v_i}{2}\Delta t$ ✓

$20 = \left(\frac{0+10}{2}\right)\Delta t$ ✓ $\therefore \Delta t = 4$ s

$F_{net} = f = \frac{\Delta p}{\Delta t}$

$f = \frac{m(v_f - v_i)}{\Delta t}$ ✓

$= \frac{3000(0-10)}{4}$

$= -7500$ N

∴ Magnitude of f is 7500 N✓

OPTION 4

$W_{net} = \Delta E_k$
$f\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$ } ✓

f (20) cos 180º ✓ = ½(3000)(0)² - ½(3000)(10)²✓

f = 7500 N ✓

(4)

[16]

QUESTION 5

5.1.1 **OPTION 1**

W = FΔxcosθ✓
$W_{gravity}$ = mgΔycosθ
= (1 300)(9,8)(60)cos180º✓
= - 764 400 J✓ ($-7,64 \times 10^5$ J)

OPTION 2

W = - ΔEp✓
= -(1300)(9,8)(60 -0) ✓
= - 764 400 J✓ ($-7,64 \times 10^5$ J)

-1 mark if either negative is omitted

(3)

5.1.2 $W_{counterweight}$ = mgΔycosθ
= (900)(9,8)(60)cos0º ✓
= 529 200 J ($5,29 \times 10^5$ J) ✓ (2)

5.2 **OPTION 1**
POSITIVE MARKING FROM 5.1.1 AND 5.1.2

$W_{net} = \Delta E_K$
$W_{gravity} + W_{countweight} + W_{motor} = 0$ ✓
$W_{motor} = -(W_{gravity} + W_{countweight})$

$-764\ 400 + 529\ 200$✓ $+ W_{motor} = 0$
$\therefore W_{motor} = 235\ 200$ J

OPTION 2
$F_{motor} = T_{right} - T_{left}$
$= 1300(9,8) - 900(9,8)$
$= 3920$ N
$W_{motor} = F_{motor}\,\Delta y \cos 0$ ✓
$= (3920)(60)\cos 0$ ✓
$= 235\ 200$ J

$P_{ave\ motor} = \frac{W}{\Delta t}$ ✓

$P_{ave\ motor} = \frac{235200}{120}$ ✓

$= 1960$ W✓ (5)

[10]

QUESTION 6

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

6.2 $v = \frac{d}{\Delta t}$ $v = \frac{45}{3}$ ✓ $\therefore v_L = 15\ m \cdot s^{-1}$

$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ / $f_L = \frac{v - v_L}{v} f_S$

$f_L = (\frac{340 - 15}{340 + 0})755$ ✓ ✓

$f_L = 721,69$ Hz✓ (5)

6.3 Any two✓✓
- Ultrasound waves (to measure the heartbeat of a foetus in the womb).
- Doppler flowmeter (to measure the rate of blood flow)
- Traffic management systems, (especially speed control)
- Radar, (allowing for the tracking of weather systems)
- Astronomy, (where the application of the red-shift and blue-shift of light from the stars has revolutionised our understanding of the universe) (2)

6.4.1 The spectral lines (light) from the star are shifted towards longer wavelengths. ✓✓ (2)

6.4.2 Decrease✓ (1)

[12]

QUESTION 7

7.1.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them✓✓ (2)

NB DO NOT MARK QUESTION 7.1.2. MAX MARK FOR QUESTION 7 WILL BE 13. CONVERT THIS MARK TO 21 USING THE CONVERSION TABLE PROVIDED AT THE END OF THESE GUIDELINES

7.1.2 $F = k\frac{q_1q_2}{r^2}$ ✓

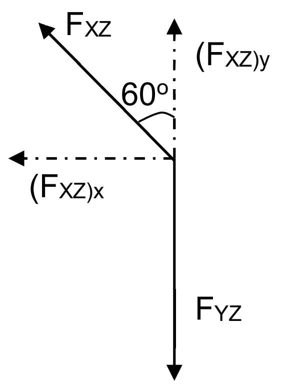
$F_{YZ} = 9\times10^9\left(\frac{1{,}5\times10^{-6}\times1{,}8\times10^{-6}}{(3\times10^{-2})^2}\right)$✓

$F_{YZ} = 27$ N downwards.

$F_{XZ} = 9\times10^9\left(\frac{2{,}1\times10^{-6}\times1{,}8\times10^{-6}}{(6\times10^{-2})^2}\right)$✓

$F_{AC} = 9{,}45$ N at 60° to the vertical
But F_{XZ} has two perpendicular components i.e. F_{XZx} and F_{XZy}

Vector diagram



$F_{YZx} = F_{YZ}\sin60°$

$F_{YZx} = 9{,}45\sin60°$✓

$F_{ACx} = 8{,}184$ N to the left

$F_{YZy} = F_{YZ}\cos60°$

$F_{YZy} = 9{,}45\cos60°$✓

$F_{ACy} = 4{,}725$ N upwards

$F_{net\ x} = 8{,}814$ N to the left

$F_{net\ y}$ = 27 – 4,725✓ = 22,275 N downwards

$(F_{net})^2 = (F_{net\ x})^2 + (F_{net\ y})^2$

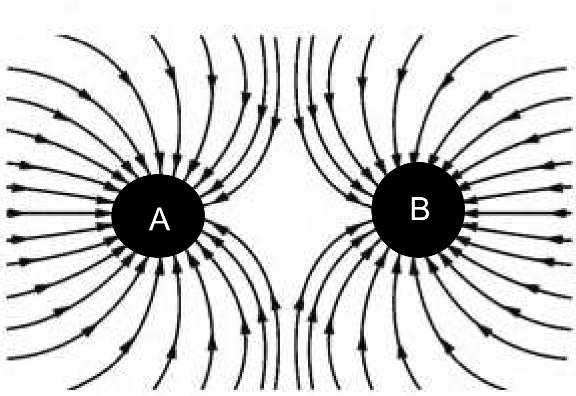
$(F_{net})^2 = (8{,}814)^2 + (22{,}275)^2$✓

$F_{net} = \sqrt{(8{,}814^2 + 22{,}275^2)}$

$F_{net} = 23{,}73$ N✓ (8)

7.2.1 The electric field at a point is the (electrostatic) force experienced per unit positive charge placed at that point. ✓✓ (2)

7.2.2



CRITERIA FOR MARKING THE ABOVE ELECTRIC FIELD PATTERN	
Correct direction of field lines	✓
Shape of the electric field lines (At least 4 lines on each sphere)	✓
No field lines crossing each other/No field lines inside the spheres	✓

(3)

7.2.3 $Q = \frac{Q_1+Q_2}{2}$

$Q = \frac{5\times10^{-6} + (-10 \times10^{-6})}{2}$ ✓

$= -2,5 \times 10^{-6}$ C (-2,5 μC)

$E = k\frac{Q}{r^2}$ ✓

$E_{AP} = 9\times10^9 \left(\frac{2,5\times10^{-6}}{0,045^2}\right)$ ✓

$E_{QP} = 1,11 \times 10^7 N{\cdot}C^{-1}$ to the left

$E_{BP} = 9\times10^9 \left(\frac{2,5\times10^{-6}}{0,015^2}\right)$ ✓

$E_{BP} = 1,00 \times 10^8 N{\cdot}C^{-1}$ to the left

$E_{net} = E_{AP} + E_{BP}$

$E_{net} = 1,11 \times 10^7 +$ ✓ $1,00 \times 10^8$

$E_{net} = 1,11 \times 10^8 N{\cdot}C^{-1}$ ✓ (6)

[21]

QUESTION 8

8.1 (Maximum) <u>energy provided (work done)</u> by a battery <u>per coulomb/unit charge</u> passing through it ✓✓ (2)

8.2.1

OPTION 1	OPTION 2
$P = I^2R$✓ $40 = 2^2R_3$✓ $R_3 = 10\ \Omega$	$P_s = V_3I$✓ $40 = V_3(2)$ $V_3 = 20$ V $\therefore R_3 = \frac{V_3}{I} = \frac{20}{2}$ ✓ $= 10\ \Omega$

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R_P} = (\frac{1}{10} + \frac{1}{10})$✓ $R_P = 5\ \Omega$ $R_{EXT} = R_P + R_s$ $R_{EXT} = \underline{5 + 10}$✓ $R_{EXT} = 15\ \Omega$✓	$R_P = (\frac{1}{R_1} + \frac{1}{R_2})^{-1}$ $R_P = (\frac{1}{10} + \frac{1}{10})^{-1}$✓ $R_P = 5\ \Omega$ $R_{EXT} = R_P + R_s$ $R_{EXT} = \underline{5 + 10}$✓ $R_{EXT} = 15\ \Omega$✓	$R_P = \frac{R_1R_2}{R_1 + R_2}$ $R_P = \frac{(10)(10)}{10+10}$✓ $R_P = 5\ \Omega$ $R_{EXT} = R_P + R_s$ $R_{EXT} = \underline{5 + 10}$✓ $R_{EXT} = 15\ \Omega$✓

(5)

8.2.2 POSITIVE MARKING FROM QUESTION 8.2.1

$\mathcal{E} = I(R + r)$ ✓

$\mathcal{E} = 2(15 + 0,1)$ ✓

$\mathcal{E} = 30,2$ V ✓

(3)

8.2.3

OPTION 1	OPTION 2 (Positive marking from Q8.2.1)
$W = P \times t$✓ $W = 40 \times 20 \times 60$✓ $W = 48000$ J✓	$W = I^2Rt$✓ $W = (2)^2(10)(20 \times 60)$✓ $W = 48000$ J✓

(3)

[13]

QUESTION 9

9.1.1 AC (generator) ✓ (1)

9.1.2 Slip rings✓ (1)

9.1.3 (Faraday's Law of) Electromagnetic induction✓ (1)

9.2.1 The rms value of AC is the DC potential difference which dissipates the same amount of energy as AC. ✓✓ (2 OR 0) (2)

9.2.2 **OPTION 1**

$V_{RMS} = \frac{V_{Max}}{\sqrt{2}}$ ✓

$V_{RMS} = \frac{311,13}{\sqrt{2}}$ ✓

$V_{RMS} = 220,00$ V

$P_{ave} = \frac{V_{RMS}^2}{R}$ ✓

$P_{ave} = \frac{220^2}{807}$ ✓

$P_{ave} = 59,98$ W✓

OPTION 2

$I_{max} = \frac{V_{Max}}{R}$ ✓

$= \frac{311,13}{807}$ ✓

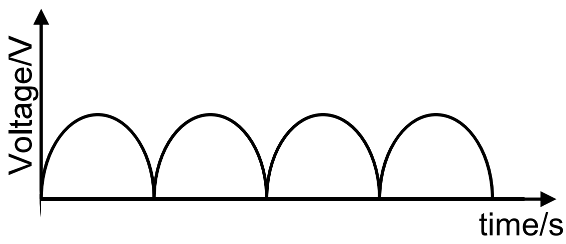
$= 0,3855$ A

$P_{ave} = \frac{I_{max} V_{max}}{2}$ ✓

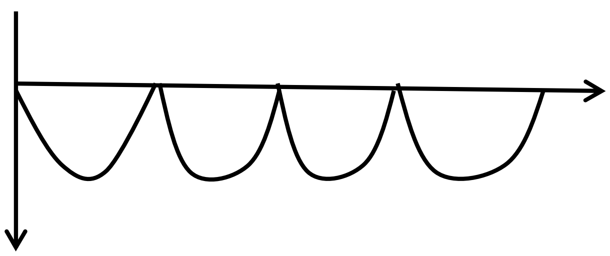
$P_{ave} = \frac{311,13 \times 0,3855}{2}$ ✓

$P_{ave} = 59,97$ W✓ (5)

9.3.1



OR



CRITERIA FOR MARKING THE ABOVE GRAPH	
Correct shape	✓
At least one complete cycle	✓

(2)

9.3.2 (Commutator) allows the induced current to flow in the same direction / in one direction in the external circuit✓✓ (2)

[14]

QUESTION 10

10.1 Threshold frequency, f_o, is the minimum frequency of light needed to emit electrons from a certain metal surface. ✓✓ (2 or 0) (2)

10.2 $Q = nq_e$

$Q = 2,01 \times 10^9 \times 1,6 \times 10^{-19}$ ✓

$Q = 3,22 \times 10^{-10}$ C

$I = \frac{Q}{\Delta t}$ ✓

$I = \frac{3,22 \times 10^{-10}}{1}$ ✓

$I = 3,22 \times 10^{-10}$ A ✓ (4)

10.3 Decreases ✓

When the intensity of the light is decreased, the number of photons per second will decrease ✓ (2)

10.4 $E = W_o + K_{max}$
$E = hf_o + K_{max}$ ✓

$2,12 \times 10^{-18}$ ✓ $= (6,63 \times 10^{-34})(2,21 \times 10^{15})$ ✓ $+ K_{max}$

$K_{max} = 6,55 \times 10^{-19}$ J ✓ (4)

10.5 Decreases ✓

More energy is used to release the electrons. ✓

OR

Work function is greater. ✓ (2)

[14]

TOTAL: 150

CONVERSION OF MARKS FOR QUESTION 7

MARK OBTAINED OUT OF 13	CONVERTED MARK OUT OF 21
0	0
1	2
2	3
3	5
4	6
5	8
6	10
7	11
8	13
9	15
10	16
11	18
12	19
13	21