JENN

Training and Consultancy

The path to enlightened education

SUBJECT: PHYSICAL SCIENCES

GRADE 12

LAST PUSH

CONTENT MANUAL SOLUTION BOOK

Topic(s)

1. Newton's Laws of Motion
2. Vertical Projectile Motion
3. Momentum and Impulse
4. Work Energy and Power
5. Electrostatics
6. Electric Circuits
7. Doppler Effect
8. Electrodynamics
9. Optical Phenomena

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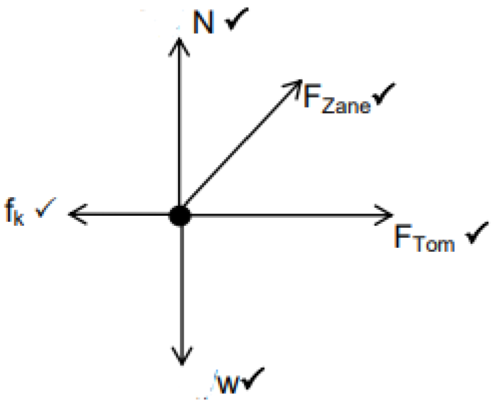
QUESTION 1

1.1

1.1.1 Tension is a (pulling) force acting in a string or rope✓✓ (3)
Force applied by Zane (F_{Zane})/160 N✓

1.1.2 Decrease (2)

1.1.3 (5)



1.2

OPTION 1	OPTION 2
Choose east to be positive $F_{net} = F_x + F_{Tom} + f_k$ $F_{net} = F_{Zane} \text{Cos } 65° + F_{Tom} + f_k$ ✓ 205 = 200✓ + 160 Cos 65°✓ + f_k f_k = - 62,62 N $f_k = \mu_k N$ $f_k = \mu_k (F_g - F_{Zane} \text{Sin } 65°)$ Any one $f_k = \mu_k (mg - F_{Zane} \text{Sin } 65°)$ 62,62 = μ_k (350 x 9,8 – 160 Sin 65°) ✓ 62,62 = μ_k (3284,99) μ_k = 0,019/ 0,02 ✓	$F_{net} = F_x + F_{Tom} + f_k$ $F_{net} = F_{Zane} \text{Cos } 65° + F_{Tom} + f_k$ ✓ 205 = 200✓ + 160 Cos 65°✓ + f_k f_k = - 62,62 N N = $F_g - F_{Zane}$ Sin 65) = $mg - F_{Zane}$ Sin 65°) = 350 x 9,8 – 160 Sin 65° ✓ = 3284,99 N $f_k = \mu_k N$ ✓ 62,62 = μ_k (3284,99) μ_k = 0,019/ 0,02 ✓

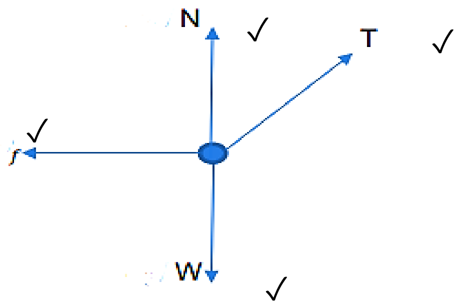
(6)

[16]

QUESTION 2

2.1 An object continues in a state of rest or uniform (moving with constant) velocity unless it is acted upon by a net (resultant) force. ✓✓ (2)

2.2



(4)

2.3

$F_X = T\cos\theta$ ✓
$F_X = 5\cos 25°$
$F_X = 4{,}532\ N$ to the right ✓

(2)

2.4 That single force that has the same effect as all the other forces combined. ✓✓

OR

The vector sum of all the forces acting on an object✓✓ (2)

2.5

$F_{net} = ma$ (to the right is positive)
$F_{p_x} + (-f_k) + (F_{Qx}) + (-f_k) + F_{app} = 0$
} any one of the equations ✓

$4.532 - 2{,}5 - 4.532 - 1 + F_{app} = 0$
$F_{app} = 3{,}5N$ (to the right) ✓

(2)

2.6 Acceleration is to the right. ✓
Mass of system decreases while applied force remains constant. ✓
Thus, block Q will accelerate in the direction of the applied force (F). ✓ (3)

2.7 Increase✓ (1)

[17]

QUESTION 3

3.1

3.1.1 The crate will slide✓ to the right. ✓
Accept: The crate will move forward (2)

3.1.2 Newton's First Law of Motion. ✓ An object will continue in a state of rest or uniform velocity ✓ unless acted upon by a non-zero resultant / net force ✓ (3)

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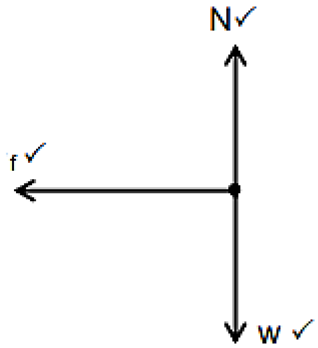
3.1.3



(3)

3.1.4

OPTION 1	OPTION 2
$a = \frac{\Delta v}{\Delta t}$ $a = \frac{v_f - v_i}{t}$ ✓ $= \frac{(17{,}22 - 29{,}17)}{7}$ ✓ ✓ $= -1{,}71\ m \cdot s^{-2}$ = $1{,}71\ m \cdot s^{-2}$ to the left / opposite direction✓	$F_{net}\Delta t = m\Delta v$ ✓ $F_{net}(7) = 4910(17{,}22 - 29{,}17)$ ✓ $F_{net} = -8382{,}07$ N $F_{net} = ma$ $-8382{,}07 = 4910a$ ✓ a = $1{,}71\ m \cdot s^{-2}$ to the left / opposite direction✓

(4)

3.1.5

OPTION 1	OPTION 2
$F_{net} = ma$✓ = (4910) (- 1,71) ✓ = - 8396,10 = 8 396,10 N✓ to the left✓	$F_{net} = \frac{m(v_f - v_i)}{\Delta t} = \frac{\Delta P}{\Delta t}$ ✓ $= \frac{(4910)(17{,}22 - 29{,}17)}{7}$ ✓ = 8382, 07 N ✓to the left✓
Range : 8382, 07 N - 8 396,10 N	

(4)

3.2

3.2.1 When a net force, F_{net}, is applied on an object of mass (m), it accelerates the object in the direction of the net force. ✓✓ This acceleration is directly proportional to the net force and inversely proportional to the mass of the object (2)

3.2.2 (4)

OPTION 1	OPTION 2
m_1 $F_{net} = ma$✓ $F_{applied} + (-F) = ma$ $6,5 - F = 0,75a$ .... (1) ✓ m_2 $F_{net} = ma$ $F = ma$ $F = 0,8a$ .....(2) ✓ (1) + (2) $6,5 = 0,75a + 0,8a$ ∴ a = 4,19 m·s^{-2} to the right✓	$F_{net} = ma$✓ 6,5 ✓ = 1,55a ✓ $\frac{6,5}{1,55} = a$ a = 4,19 m·s^{-2} = 4,19 m·s^{-2} to the right✓

3.2.3 (3)

OPTION 1	OPTION 2
$F_{net} = ma$ F = 0,8 x 4,19 ✓ = 3,35 N ✓ to the right✓	$F_{net} = ma$ $F_{applied} - F = ma$ 6,5 – F = 0,75(4,19) ✓ – F= – 3,35 N F = 3,36 N✓ to the right✓

[25]

VERTICAL PROJECTILE MOTION

QUESTION 1

1.1

1.1.1 Upwards✓ (1)

1.1.2 Downwards✓ (1)

1.2 Q✓ Weight is the only force acting on the rocket. ✓ (2)

1.3 **Upwards positive**

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓

$\therefore$ -225,6 ✓ = (112,8)Δt ✓ + ½(-9,8)Δt^2 ✓

$\therefore$ Δt = 24,87 s

Total time

4 + ✓ 24,87 = 28,87 s ✓

Downwards positive

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓

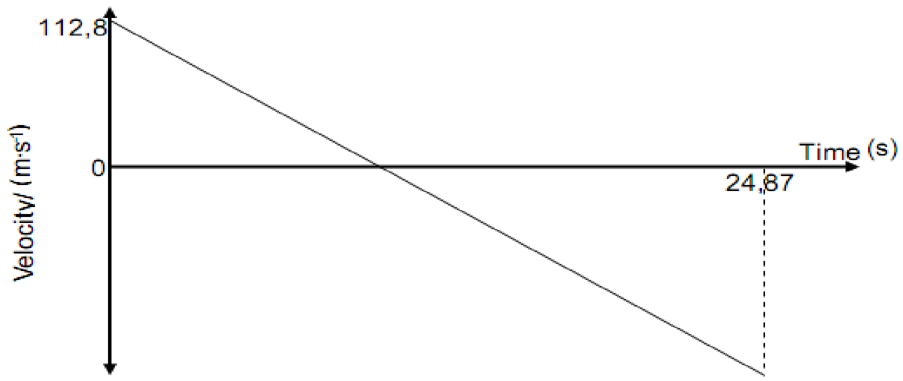
$\therefore$ 225,6 ✓ = (-112,8)Δt ✓ + ½(9,8)Δt^2 ✓

$\therefore$ Δt = 24,87 s

Total time

4 + ✓ 24,87 = 28,87 s ✓ (6)

1.4



Criteria for graph	Marks
Graph starts at (0; 112,8).	✓
Graph is a straight line with a gradient.	✓
Graph has a negative gradient.	✓

(3)

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QUESTION 2

2.1

2.1.1 0 N✓ (1)

2.1.2 Downwards✓ (1)

2.2

2.2.1

Upwards positive:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
-21✓ $= \underline{v_i(2,88) + \frac{1}{2}(-9,8)(2,88)^2}$✓
$v_i = 6,82\ m\cdot s^{-1}$ ✓

Downwards positive:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
21✓ $= \underline{v_i(2,88) + \frac{1}{2}(9,8)(2,88)^2}$✓
$v_i = -6,82$
$v_i = 6,82\ m\cdot s^{-1}$ ✓

(4)

2.2.2

Upwards positive:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{0^2 = (6,82)^2 + 2(-9,8)\Delta y}$ ✓
$\Delta y = 2,37$ m

Max height= $\underline{2,37 + 21 + 0,6}$✓ = 23,97 m✓

Downwards positive:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{0^2 = (-6,82)^2 + 2(9,8)\Delta y}$ ✓
$\Delta y = -2,37$ m

Max height= $\underline{2,37 + 21 + 0,6}$✓ = 23,97 m✓

(4)

2.5

Upwards positive:

$v_f = v_i + a\Delta t$
$= \underline{6,82 + (-9,8)(2,88)}$ ✓
$= -21,40\ m\cdot s^{-1}$

Both formulae ✓

$F_{net}\Delta t = mv_f - mv_i$
$\underline{(N - F_g)(0,1)}$ ✓ $= \underline{0,5(18) - 0,5(-21,40)}$ ✓
$N - (0,5)(9,8) = 197$
$N = 201,9$ N ✓

Downwards positive:

$v_f = v_i + a\Delta t$
$= -6,82 + (9,8)(2,88)$ ✓
$= 21,40\ m\cdot s^{-1}$

Both formulae ✓

$F_{net}\Delta t = mv_f - mv_i$
$\underline{(F_g - N)(0,1)}$✓ $= \underline{0,5(-18) - 0,5(21,40)}$ ✓
$(0,5)(9,8) - N = -197$
$N = 201,9$ N ✓

(5)

[15]

QUETION 3

3.1 An object which has been given an initial velocity and then it moves under the influence of the gravitational force only. ✓✓ (2)

3.2.1

$$v_f^2 = v_i^2 + 2a\Delta y$$

$= 0 + 2(9{,}8)(19{,}6)$ ✓ (3)

$v_f = 19{,}6\ m\cdot s^{-1}$ ✓

3.2.2

$$\Delta x_A = v_i\Delta t + \frac{1}{2}a\Delta t^2$$

$$19{,}6 = 0 + \frac{1}{2}(9{,}8)\Delta t^2 \checkmark$$

$$\Delta t = 2\ s$$

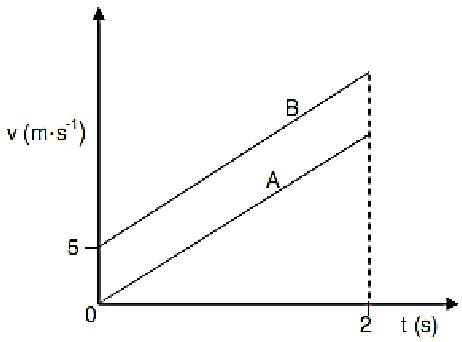
$$\Delta t_A = \Delta t_B$$

$$\Delta x_B = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$29{,}6 \checkmark = v_i(2) + \frac{1}{2}(9{,}8)(2^2) \checkmark$$

$$v_i = 5\ m\cdot s^{-1} \checkmark$$ (4)

3.3



Marking criteria	Marks
A starts at 0 m·s⁻¹ with positive gradient.	✓
Graphs for A and B stop at 2s.	✓
B starts at -5 m·s⁻¹ with positive gradient.	✓
Lines parallel to each other.	✓

(4)

[13]

QUESTION 4

4.1

4.1.1 (3)

Downwards positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$v_f^2 = (2)^2 + 2(9{,}8)(45)$ ✓

$v_f = 29{,}76\ m{\cdot}s^{-1}$ ✓ ($29{,}77\ m{\cdot}s^{-1}$)

4.1.2 (3)

$v_f = v_i + a\Delta t$ ✓

Ball/*Bal* **A**

$-29{,}76 = -2 + (-9{,}8)\ \Delta t$`

$\Delta t = 2{,}83\ s$ ✓

∴ for ball/*vir bal* **B**

$\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$

∴ for ball/*vir bal* **B**

$\Delta t_B = 2{,}83 - 1 = 1{,}83\ s$ ✓

4.1.3 (5)

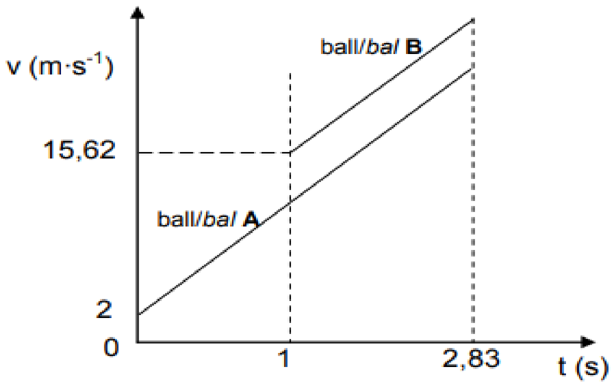
$\Delta t_B = 1.83s$ ✓

$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓

-45 ✓ $= v_i\ (1{,}83) + ½\ (-9.8)(1{,}83)^2$ ✓

$v_i = -15{,}62\ m{\cdot}s^{-1}$ ✓

4.3



CRITERIA FOR MARKING/*KRITERIA VIR NASIEN*	
1 mark for each initial velocity shown/*1 punt vir elke beginsnelheid aangedui* (For/*Vir* A 2 $m{\cdot}s^{-1}$ for/*vir* B 15,62 $m{\cdot}s^{-1}$)	✓✓
Time of release of ball/*Tyd van vrystelling van bal* **B** t= 1s	✓
Time of flight for both balls must be indicated as same on time axis/*Vlugtyd van beide balle moet op dieselfde tydas aangetoon word* (2,83 s)	✓
Shape: Lines must be parallel or nearly so/*Vorm: Lyne moet parallel of amper parallel wees*	✓

(5)

[16]

QUESTION 5

5.1 0.5✓ (1)

5.2 (5)

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (-2)^2 + 2(-9,8)(-1,8)$ ✓

$v_f = -6,27\ m\cdot s^{-1}$ ✓

✓Both equations/*Beide vergelykings*

$v_f = v_i + a\Delta t$

$-6,27 = -2 + (-9,8)\Delta t$ ✓

$\Delta t = 0,44\ s$ ✓

5.3 (4)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = v_i^2 + 2(-9,8)(0,9)$ ✓

$v_i = 4,2\ m\cdot s^{-1}$ ✓ upwards/*opwaarts* ✓

5.4 (4)

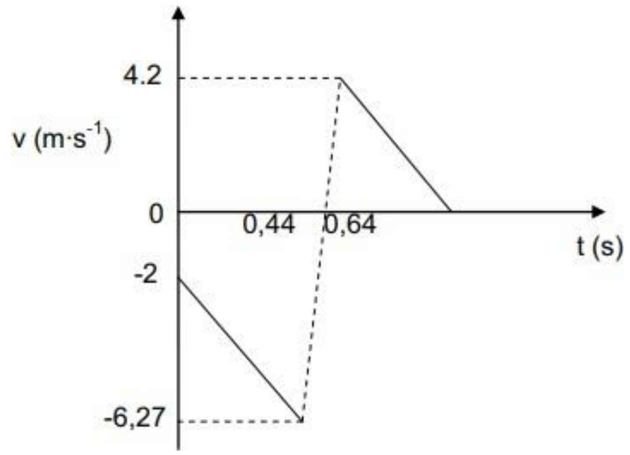
$F_{net}\Delta t = m\Delta v$ ✓

$F_{net}(0,2)$ ✓ $= (0,5)[(-4,2 - (6,27)]$ ✓

$F_{net} = -26,175\ N$

$F_{net} = 26,175\ N$ ✓

5.5 ✓✓✓



(3)

[15]

MOMENTUM AND IMPULSE

ACTIVITY 1

1.1 $P_A = 6 \times 10^3$ kg.m·s^{-1} East ✓✓ (2)

1.2 **East as positive**

$\Sigma p_i = \Sigma p_f$

$(mv_i)_1 + (mv_i)_2 = (mv_f)_1 + (mv_f)_2$✓

$\underline{6 \times 10^3 + (1500)(v_i)}$ ✓ = $\underline{1 \times 10^3 + 2 \times 10^3}$✓

$v_i = -2$ m·s^{-1}

$v_i = 2$ m·s^{-1}West✓

West as positive

$\Sigma p_i = \Sigma p_f$

$(mv_i)_1 + (mv_i)_2 = (mv_f)_1 + (mv_f)_2$✓

$\underline{(-6 \times 10^3) + (1500)(v_i)}$ ✓ = $- \underline{1 \times 10^3 + (-2 \times 10^3)}$ ✓

$v_i = 2$ m·s^{-1} (4)

Magnitude and direction of the velocity of truck B before collision = 2 m·s^{-1} west✓

1.3 **Total Kinetic Energy Before Collision:**

$E_{ktotal} = \frac{1}{2} m_1 v_{i1}^2 + \frac{1}{2} m_2 v_{i2}^2$ ✓

$= \frac{1}{2}(2000)(3)^2 + \frac{1}{2}(1\,500)(-2)^2$✓ = 9 000 + 3 000 = $\underline{12\,000 \text{J}}$✓

Total Kinetic Energy After Collision:

$E_k = \frac{1}{2} m_1 v_{f1}^2 + \frac{1}{2} m_2 v_{f2}^2$

$= \frac{1}{2}(2\,000)(0,5)^2 + \frac{1}{2}(1\,500)\left(\frac{2000}{1500}\right)^2$✓ = 1583,33 J ✓

E_{ktotal} before collision not equal to E_{ktotal} after collision – thus the collision is inelastic✓ (6)

[12]

Sol 2

2.1.1 $Principle\ of\ conservation\ of\ mechanical\ energy.$ ✓ (1)

2.1.2 $m_1v_{i1} + m_2vi_2 = m_1v_{f1} + m_2v_{f2}$ ✓

$(1084 \times 33) + (3437 \times -28)$ ✓ $= (1084 \times -5) + 3437v_{f2}$ ✓

$v_{f2} = 16{,}02 m.s^{-1} West$ ✓ (4)

2.1.3 **POSITIVE MARKING FROM 4.1.2**

$$\sum E_{ki} = \tfrac{1}{2}m_1{v_{i1}}^2 + \tfrac{1}{2}m_1{v_{i2}}^2 \checkmark$$

$$= \tfrac{1}{2} \times 1084 \times 33^2 + \tfrac{1}{2} \times 3437 \times 28^2 \checkmark$$

$$= 1\,937\,542\ \text{J} \quad \textbf{Or} \quad 1{,}94 \times 10^6\text{J}$$

$$\sum E_{kf} = \tfrac{1}{2} \times 1084 \times 5^2 + \tfrac{1}{2} \times 3437 \times 16{,}02^2 \checkmark$$

$$= 454\,586{,}53\ \text{J} / 4{,}55 \times 10^5\text{J}$$

$$\sum E_{ki} \neq \sum E_{ki} \checkmark \therefore the\ collision\ is\ inelastic \checkmark$$ (5)

2.2.1 Product of the resultant/net force acting on an object and the time the net force acts on the object. ✓✓ (2)

2.2.2 $F_{net} = \frac{\Delta p}{\Delta t}$ ✓

$-2{,}1 \times 10^5$ ✓ $= \frac{1200(-8-20)}{\Delta t}$ ✓

$\Delta t = 0{,}16 s$ ✓ (4)

$F_{net}\ and\ \Delta v\ must\ have\ the\ same\ sign$

2.3.1 $p = mv$ ✓

$5 = \frac{500}{100}v_i$ ✓

$v_i = 10 m.s^{-1}$ East ✓ (3)

2.3.2 $\sum p_i = \sum p_f$

$p_{iX} + p_{iY} = p_{fX} + p_{fY}$ ✓

$5 + p_{iY}$ ✓ $= 2 + 4$ ✓

$p_{iY} = 1 kg.m.s^{-1} east$ ✓ (4)

2.3.3 Net force. ✓ (1)

4.3.4 $F_{net} = \frac{\Delta p}{\Delta t}$ ✓

$= \frac{2-5}{2{,}4-1}$ ✓ (3)

$F_{net} = -2{,}1428 = 2{,}14\text{N}$✓

4.3.5 ON✓ (1)

Activity 3

3.1.1 The energy an object has as a result of its motion. ✓✓ (2)

3.1.2 $E_k = \frac{1}{2}mv^2$✓

$= \frac{1}{2}(40)(0{,}5)^2$✓

= 5 J✓ (3)

3.1.3 $E_p + E_{k\ at\ A} + W_f = E_p + E_{K\ at\ B}$✓

40(9,8)(20✓) + 5 (c/o) ✓+ W_f = ½ (40)(19,24)^2 ✓

W_f = –441,45 J✓ (5)

3.1.4 The product of the net force and the time over which it acts. ✓✓ (2)

3.1.5 F_{net} △t = △p✓

F_{net} =1,4 = mv_f mv_i✓

= 40(0 – 19,24) ✓

F_{net} = 549,71✓ N left✓ (5)

3.2.1 The total linear momentum of an isolated system remains constant. ✓✓ (2)

3.2.2 $m_t v_{it} + m_{board} v_{board}$ ✓= $(m_t + m_{board})v_f$✓

45(1,5) + 5(–3,0) = 50 v_f✓

v_f = 1,05 m·s^{-1} ✓right✓ (5)

[24]

ELECTROSTATICS

ACTIVITY 1

1.1 For object N

$n = \frac{Q}{q_e}$

$Q = (5 \times 10^{6})(-1,6 \times 10^{-19})$ ✓

$= -8 \times 10^{-13}$ C ✓ (2)

ACCEPT NEGATIVE

1.2 ***POSITIVE MARKING FROM 8.1***

Charge on / M (Q_M) is $+8 \times 10^{-13}$ C ✓(2 or0)✓ (2)

1.3 The electric field at a point is the (electrostatic) force experienced per unit✓ positive charge placed at that point (1)

1.4 **POSITIVE MARKING FROM 3.1 AND 3.2**

$E = \frac{kQ}{r^2}$ ✓

$E_{PM} = \frac{(9 \times 10^{9})(8 \times 10^{-13})}{(0,25)^2}$ ✓ ← Q from 3.2

$= 0,12$ N.C^{-1} to the right

$E_{PN} = \frac{(9x10^{9})(8x10^{-13})}{(0,1)^2}$ ✓ ← Q from 3.1

$= 0,72$ N.C^{-1} to the left

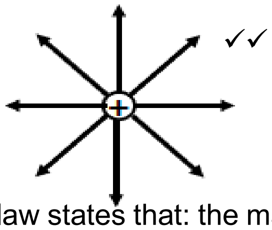
Enet= EPM - EPN = 0, 12 – 0, 72 = - 0, 60 N.C^{-1}

= 0, 60 N.C^{-1} to the left✓ (4)

ACTIVITY 2

2.1

2.1.1



- pattern
- direction

(2)

2.1.2 Coulomb's law states that: 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)

2.1.3 $F_{up} = F_{down}$

$\frac{kq_1q_2}{r^2} = mg$ ✓

$\frac{(9 \times 10^9)(30 \times 10^{-9})(100 \times 10^{-9})}{h^2}$ ✓✓ $= (1,5 \times 10^{-3})(9,8)$ ✓

h = 0, 043 m ✓ (5)

2.2 2.2.1 $E_{6\mu C} = \frac{kQ}{r^2}$ ✓

$E_{6\mu C} = \frac{(9 \times 10^9)(6 \times 10^{-6})}{(0,09)^2}$ ✓✓

$\mathbf{E_{6\mu C} = 6,67 \times 10^6\ N.C^{-1}}$ ✓ (4)

2.2.2 $E_{-2\mu C} = \frac{kQ}{r^2}$

$E_{-2\mu C} = \frac{(9 \times 10^9)(2 \times 10^{-6})}{(0,04)^2}$ ✓

$E_{-2\mu C} = 1,125 \times 10^7\ N.C^{-1}$ ✓

$E_{net} = 1,125 \times 10^7 - 6,67 \times 10^6$ ✓

$\mathbf{E_{net} = 4,58 \times 10^6}$ ✓ **N. C^{-1} towards charges or right** ✓ (5)

[18]

ACTIVITY 3

3.1 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)

3.2 $$F = \frac{kQ_1Q_2}{r^2}\ ✓$$

$$7,2 \times 10^{-6} = \frac{9 \times 10^9 \times Q \times 16 \times 10^9}{(0,4)^2}\ ✓$$

QA = -8 nC. ✓ (3)

3.3 Electric field at P due to A

$$E = \frac{kQ}{r^2}\ ✓$$

$$= \frac{9 \times 10^9 \times 8 \times 10^{-9}}{(0,3)^2}\ ✓ = 800\ N.C^{-1}\ ✓$$

Electric field at P due to B

$$E = \frac{9 \times 10^9 \times 16 \times 10^{-9}}{(0,7)^2}\ ✓ = 293,88\ N \cdot C^{-1}$$

Net electric field at P 800 + 293,88 ✓= 1 093,88 $N \cdot C^{-1}$. ✓ (6)

3.4 **B TO A**✓ (1)

3.5 $$\frac{8nC + 16nC}{2} = 12nC\ ✓✓$$

4 nC electrons were transferred from B to A

$$\frac{4 \times 10^{-9}}{1,6 \times 10^{-19}}\ ✓ = 2,5 \times 10^{10}\ ✓ \text{electrons}$$ (4)

[16]

DOPPLER EFFECT

ACTIVITY 1

1.1 Doppler Effect ✓

Doppler Effect is 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.✓ ✓ (3)

OR

The change in the observed frequency when there is relative motion between the source and the observer.

1.2 $f_l = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s$ ✓ OR $f_l = \left(\frac{v}{v \pm v_s}\right) f_s$

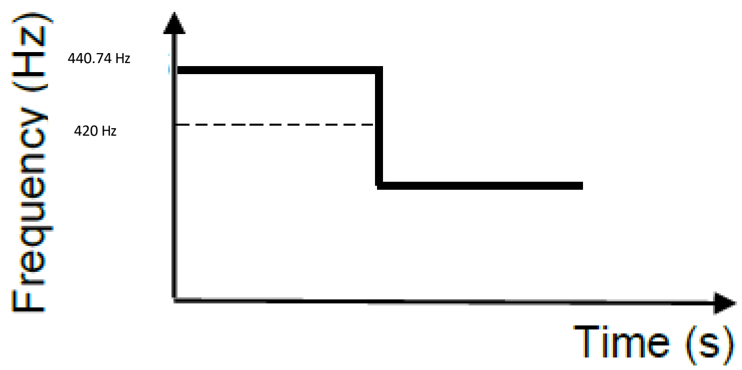
$f_L = \frac{340 ✓}{(340-16) ✓}(420)$✓

$f_L = 440{,}74\ Hz$✓ (5)

1.3.1 Smaller than✓ (1)

1.3.2 Increases ✓ (1)

1.4



CRITERIA FOR GRAPH

Both axis correctly labelled with SI units	✓
Horizontal line at 440,74 Hz	✓
Horizontal line below 420 Hz	✓
420 Hz correctly indicated	✓

(4)

[14]

ACTIVITY 2

2.1 It is the (apparent) 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. ✓

OR

An (apparent) change in(observed/detected) frequency (pitch),(wavelength) ✓ as a result of the relative motion between a source and an observer ✓ (listener).

(2)

2.2

OPTION 1

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

$3\,650 = \left(\frac{340}{340 - 240}\right) f_s$ ✓✓✓

$f_s = 1\,073{,}52$ Hz

$v = f\lambda$ ✓

$340 = (1\,073{,}52)\lambda$ ✓

$\lambda = 0{,}32$ m ✓

OPTION 2

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

$3\,650 = \left(\frac{340}{340 - 240}\right)\left(\frac{340}{\lambda_s}\right)$ ✓✓✓

$\lambda = 0{,}32$ m ✓

(7)

2.3 Greater than✓ (1)

[10]

Activity 3

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 propagation. ✓ **OR**

3.1 An (apparent) change in (observed/detected) frequency (pitch), as a result of the relative motion between a source and an observer (listener). (2)

3.2 Towards (1)

3.3

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark$$

$$3\,148 \checkmark = \frac{340 + 0}{340 - v_s} f_s \checkmark$$

$$2\,073 \checkmark = \frac{340 - 0}{340 + v_s} f_s \checkmark$$

Solve for v_s: ∴ $v_s = 70\ m \cdot s^{-1}$ ✓

(5)

3.4

OPTION 1	**OPTION 2**	**OPTION 3**
$\Delta t = \frac{\Delta x}{v}$ $\Delta t = \frac{350}{70}$ ✓ $\Delta t = 5\ s$ ✓	$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $350 = 70\Delta t + 0$ ✓ $\Delta t = 5\ s$ ✓	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ $350 = \left(\frac{70 + 70}{2}\right)\Delta t$ ✓ $\Delta t = 5\ s$ ✓

(2)

ELECTRODYNAMICS

Activity 1

1.1.1 Electrical energy to kinetic (mechanical) energy√√ (2)

1.1.2 Flemmings left hand motor rule√ (1)

1.1.3 Anti-clockwise√ (1)

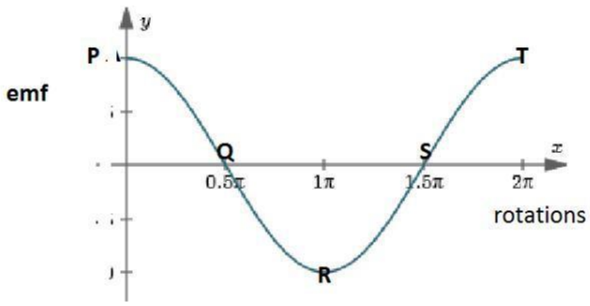
1.1.4 Split ring commutator√ – it allows the armature/coil to continue to turn/rotate in one direction√

It does this by changing the direction of current in the coil every half turn. √ (3)

1.2.1 There is a changing magnetic flux linkage through the coil. √√ (2)

1.2.2 Cos Shape (may start with negative emf) P Q R S T correct axes labeled√√√

(one mark only if sine graph)



(3)

1.2.3 **Option 1**

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$✓

$V_{rms} = \frac{24}{\sqrt{2}}$✓

$V_{rms} = 16,97\ V$

$I_{rms} = \frac{V_{rms}}{R}$✓

$I_{rms} = \frac{16,97}{265}$✓

$I_{rms} = 0,064\ A$✓

Option 2

$I_{rms} = \frac{V_{rms}}{R}$✓ OR $I_{rms} = \frac{V_{max}}{\sqrt{2}\,R}$✓

$I_{rms} = \frac{24✓}{\sqrt{2}(265)✓}$

$I_{rms} = 0,064\ A$✓ (5)

1.3.4 **POSITIVE MARKING FROM QUESTIONS 8.2.3**

Option 1

$P_{ave} = V_{rms}I_{rms}$✓

$P_{ave} = 16,97x0,064$✓

$P_{ave} = 1,09\ V$✓

Option 2

$P_{ave} = I^2_{rms}R$✓

$P_{ave} = (0,064)^2 265$✓

$P_{ave} = 1,09\ V$✓

Option 3

$P_{ave} = \frac{V^2_{rms}}{R}$✓

$P_{ave} = \frac{(16,97)^2}{625}$✓

$P_{ave} = 1,09\ V$✓ (3)

[20]

QUESTION 2

2.1.1 Electrical (energy) to mechanical / kinetic (energy) ✓

2.1.2 Mechanical / kinetic (energy) to electrical (energy) ✓

2.1.3 Motor effect ✓

2.1.4 Electromagnetic induction ✓ (4)

2.2 DC generator (dynamo)✓ (1)

2.3 **X** Armature **OR** Coil✓ (1)

2.4.1 (**Y**) Carbon brushes ensure that the coil is connected to the external circuit. ✓✓ (2)

2.4.2 ***Z****) Split ring or commutator ensures that the direction of the current in the external circuit remains the same.* ✓✓ (2)

2.5.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$✓

$= \frac{12{,}73}{\sqrt{2}}$ ✓

= 9,00 V ✓ (3)

2.5.2 **Positive marking from 9.5.1**

<table>
<tr><td>OPTION 1</td><td rowspan="2">$R = \frac{V_{rms}}{I_{rms}}$
$25 = \frac{9}{I_{rms}}$
I_{rms} = 0,36 A</td><td>OPTION 2
Pave = $V_{rms}I_{rms}$ ✓
= 9(0,36)✓
= 3,24 W✓</td></tr>
<tr><td>$P_{ave} = \frac{V_{rms}^2}{R}$ ✓
$= \frac{(9)^2}{25}$ ✓
$= 3{,}24\ W$ ✓</td><td>OPTION 3
$\boldsymbol{P_{ave} = I_{rms}^2 R}$✓
$\boldsymbol{= (0{,}36)^2(25)}$✓
$\boldsymbol{= 3{,}24\ W}$✓</td></tr>
</table>

(3)

[16]

OPTICAL PHENOMENON

ACTIVITY 1 [SOLUTIONS]

1.1 ±11, 8 x 10^{-19} J (Accept any value from 1,8 to 12 × 10^{-19} J) ✓ (1)

1.2 As the wavelength of the incident radiation increases the maximum kinetic energy of the emitted electrons decreases. ✓

Do not accept an answer which states that these variables are inversely proportional to one another.

Also the candidates cannot state that 'As the maximum kinetic energy of the emitted electrons decreases, the wavelength of the incident radiation increases.'✓

(2)

1.3 The longer the wavelength of the incident radiation the lower the frequency and **the lower the energy of the photons** ✓therefore the emitted electrons will have less kinetic energy since $E_k = E_{light} – W_o$= (W_o =constant for a particular metal.)✓

The **manipulated** formula must be shown to obtain full marks✓ (2)

1.4 Alternative 1

λ= 4, 9 x 10^{-7} m (x-intercept)

$f_o = \frac{c}{\lambda}$ ✓

$= \frac{3 \times 10^8}{4,9 \times 10^{-7}}$ ✓

= **6, 12 x 10^{14} Hz**✓ (3)

1.5 $W_o = h.f_o$✓

= 6,6x 10^{-34} x 6, 12 x 10^{14} (c.o.e. from 2.4)

W_o = 4, 04 x 10^{-19} J✓ (3)

[11]

ACTIVITY 2

2.1 The work function is the minimum amount of energy needed to emit an electron from the surface of a metal. √√ (2)

2.2 frequency of incident radiation√ (1)

2.3 Gradient = $\frac{\Delta y}{\Delta x} \equiv \frac{J}{s^{-1}}$ √= J.s √= N.m.s (2)

Note: the gradient of the line (m) is equal to *Planck's constant*, h

$\therefore E_k = hf - (hf_0)$

(y = mx + c where m is equal plank's constant)

2.4 $W_o = hf_o$ √

$= (6,6 \times 10^{-34})(1,05 \times 10^{15})$ √√

$= 6,93 \times 10^{-19}$ J√

therefore zinc√ (5)

2.5 $E_k = hf - W_o$√

$\frac{1}{2} m_e v_e^2 = h\frac{c}{\lambda} - W_o$√

$(0,5)(9,1 \times 10^{-31})(2,77 \times 10^5)^2$ √√$= (6,6 \times 10^{-34})(3 \times 10^8)/(475 \times 10^{-9})$ √ – Wo

$3,49 \times 10^{-20} = 4,17 \times 10^{-19} - W_o$

$W_o = 3,82 \times 10^{-19}$ J√

Hence metal is sodium√. (6)

[16]

QUESTION 3

3.1 The process whereby electrons are ejected from a metal surface ✓ when light of suitable frequency is incident/shines on the surface. ✓ (2)

3.2 $7,48 \times 10^{-19}$ (J) ✓

3.3 $E = W_0 + E_{kmax}$ ($= W_0 + \frac{1}{2}mv^2_{max}$) ✓

When $E_k = 0$, $E = W_0$✓ (3)

3.4 Mass (of photo-electron) ✓ (1)

3.5

OPTION 1
Gradient = ½m ✓ $\frac{11,98 \times 10^{-19} - 7,48 \times 10^{-19}}{X - 0}$ ✓ ✓ $= \frac{1}{2}(9,11 \times 10^{-31})$ ✓   X = 0,9868 ✓
OPTION 2
$E = W_0 + \frac{1}{2}mv^2_{max}$ ✓ $11,98 \times 10^{-19}$ ✓ $= 7,48 \times 10^{-19}$✓ $+ \frac{1}{2}(9,11 \times 10^{-31})v^2$✓ [or $\frac{1}{2}(9,11 \times 10^{-31})$X] $4,5 \times 10^{-19} = 4,56 \times 10^{-31}v^2$ $v^2 = 0,9868 \times 10^{12}$ X = 0,9868 ✓ (0,99)

(5)

3.6 Remains the same ✓ (1)

3.7 Increases ✓ (1)

[13]