basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2010

MEMORANDUM

MARKS: 150

This memorandum consists of 23 pages.

NOTE: Marking rule 1.5 was changed according to decisions taken at the memorandum discussion, 17-18 November 2010.

Learning Outcomes and Assessment Standards		
LO 1	**LO 2**	**LO 3**
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables.	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge.	**AS 12.3.1:** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims.
AS 12.1.2: Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations.	**AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words.	**AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications.
AS 12.1.3: Select and use appropriate problem-solving strategies to solve (unseen) problems.	**AS 12.2.3:** Apply scientific knowledge in everyday life contexts.	**AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally.
AS 12.1.4: Communicate and defend scientific arguments with clarity and precision.		

GENERAL GUIDELINES

1. CALCULATIONS

1.1 **Marks will be awarded for**: correct formula, correct substitution, correct answer with unit.

1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark**.

1.5 When **no formula** is given, marks will be **forfeited** for **zero substitutions** not shown. Other substitutions and a correct answer will be credited.

1.6 **No penalisation if zero substitutions are omitted** in calculations where **correct formula** / principle is given correctly.

1.7 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

1.8 Marks are only awarded for a formula if a **calculation has been attempted**. i.e. substitutions have been made or a numerical answer given.

1.9 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

1.10 All calculations, when not specified in the question, must be done to two decimal places.

2. UNITS

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question or sub-question**.

2.2 Units are only required in the final answer to a calculation.

2.3 Marks are only awarded for an answer, and not for a unit *per se*. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

2.4 SI units must be used except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this.

3. GENERAL

3.1 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

3.2 For marking purposes, alternative symbols (s,u,t, etc.) will also be accepted

3.3 Separate compound units with a multiplication dot, not a full stop, for example, $m \cdot s^{-1}$.
For marking purposes $m.s^{-1}$ and m/s will also be accepted.

4. POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

4.1 **Sub-question to sub-question:** When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent sub-questions.

4.2 **A multi-step question in a sub-question**: If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

4.3 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

4.4 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

4.5 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

4.6 Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in question 3.2 the answer given to question 3.1, and 3.1 is incorrect, no marks can be awarded for question 3.2. However, if the answer for e.g. 3.1. is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.

SECTION A

QUESTION 1

1.1	Elastic ✓	[12.2.1]	(1)
1.2	Huygens' (principle) ✓	[12.2.1]	(1)
1.3	ohm / Ω ✓	[12.2.1]	(1)
1.4	(Split-ring) commutator ✓	[12.2.1]	(1)
1.5	Work function ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.3]	(2)
2.2	C ✓✓	[12.1.2]	(2)
2.3	D ✓✓	[12.2.3]	(2)
2.4	D ✓✓	[12.2.2]	(2)
2.5	D ✓✓	[12.2.1]	(2)
2.6	C ✓✓	[12.2.2]	(2)
2.7	C ✓✓	[12.2.2]	(2)
2.8	B ✓✓	[12.1.2]	(2)
2.9	C ✓✓	[12.2.1]	(2)
2.10	A ✓✓	[12.2.2]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

3.1 3 seconds / 3 s ✓ [12.1.2] (1)

3.2

Accept the equations:	
$v = u + at$	$s = ut + \frac{1}{2}at^2$
$s = \left(\frac{v+u}{2}\right)t$	$v^2 = u^2 + 2as$

OPTION 1

Area between graph and time axis

Δy = (area of triangle)/ ½ bh ✓

= $\underline{½\ (3)(29,4)}$ ✓

= 44,1 m

Maximum height above ground:

$\underline{100 +}$✓ 44,1 = 144,1 m ✓

OPTION 2

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$= \left(\frac{0 + 29,4}{2}\right)3$ ✓ $= \left(\frac{29,4 + 0}{2}\right)3$

= 44,1 m (43,22m)

Maximum height above ground:

$\underline{100 +}$✓ 44,1 = 144,1 m ✓(143,22m)

OPTION 3

From edge of cliff to max height

(Upward positive)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\therefore$ $\underline{0^2 = 29,4^2 + 2(-9,8)\Delta y}$ ✓

$\therefore$ Δy = 44,1 m

Maximum height above ground:

$\underline{100 +}$✓ 44,1 = 144,1 m✓

From edge of cliff to max height)

(Downward positive)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\therefore$ $\underline{0^2 = (-29,4)^2 + 2(9,8)\Delta y}$ ✓

$\therefore$ Δy = - 44,1 m

Maximum height above ground:

$\underline{100 +}$✓ 44,1 = 144,1 m✓

OPTION 4

From edge of cliff to max height
(Upward positive)

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= \underline{(29,4)(3) + ½(-9,8)(3)^2}$ ✓
$= 44,1$ m

Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m ✓(143,2 m)

From edge of cliff to max height)
(Downward positive)

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= \underline{(-29,4)(3) + ½(9,8)(3)^2}$ ✓
$= - 44,1$ m

Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m ✓

OPTION 5

From max height to edge of cliff
Downward positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{(29,4)^2 = 0^2 + 2(9,8)\Delta y}$ ✓
$\therefore \Delta y = 44,1$ m

Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m✓

OPTION 6

From max height to edge of cliff
Downward positive

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= \underline{(0)(3) + ½(9,8)(3)^2}$ ✓
$= 44,1$ m

Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m ✓

OPTION 7

$\left.\begin{array}{l} E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)} \\ (mgh + ½\ mv^2)_A = (mgh + ½\ mv^2)_B \\ m(gh + ½\ v^2)_A = m(gh + ½\ v^2)_B \end{array}\right\}$ ✓ any equation

$\underline{(9,8)(100\ ) + ½\ (29,4)^2}$ ✓$=$ $\underline{(9,8)h + 0}$ ✓
$h = 144,1$ m ✓

OPTION 8

$\left.\begin{array}{l} W_{net} = \Delta E_k \\ mgh\cos\theta = ½\ m(v_f^2 – v_i^2) \\ m(gh\cos\theta) = ½m(v_f^2 - v_i^2) \end{array}\right\}$ ✓any equation

$\underline{(9,8)h\cos180^o = ½\ (0^2\ - (29,4)^2)}$ ✓
$h = 44,1$ m (43,22m)

Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m ✓

OPTION 9

$\left.\begin{array}{l} E_{mech\ (edge\ of\ cliff)} = E_{mech\ (max\ height)} \\ (mgh + ½\ mv^2)_A = (mgh + ½\ mv^2)_B \\ m(gh + ½\ v^2)_A = m(gh + ½\ v^2)_B \end{array}\right\}$ any equation

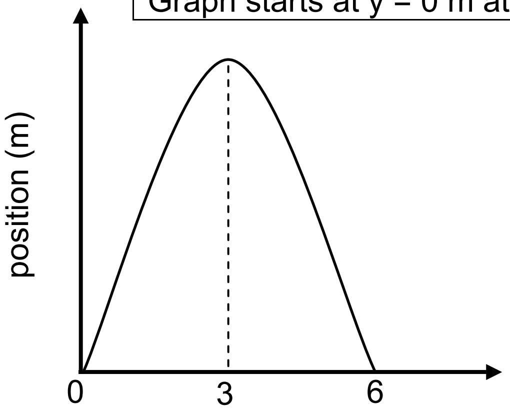
$\underline{0\ + ½\ (29,4)^2 = (9,8)h + 0}$ ✓
$h = 44,1$ m

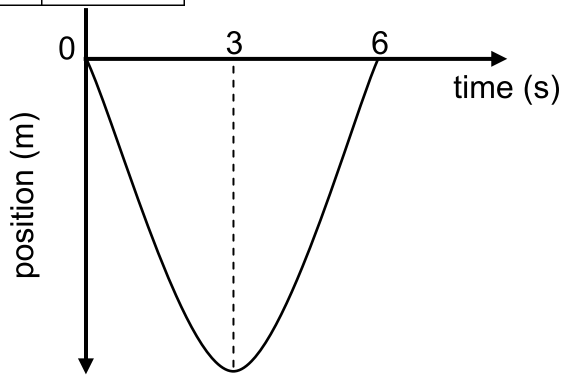
Maximum height above ground:
$\underline{100 +}$✓ 44,1 = 144,1 m ✓

[12.1.2]
[12.2.3] (4)

3.3

Checklist: Criteria for graph	Marks
Correct shape	✓
t = 3 s at maximum height	✓
t = 6 s at y = 0 m	✓
Graph starts at y = 0 m at t = 0 s	✓





[12.1.2] (4)

3.4.1

OPTION 1:
Upward positive:

$v_f = v_i + a\Delta t$ ✓
$= \underline{29{,}4}$✓ $+ \underline{(-9{,}8)(5{,}23)}$ ✓
$= -21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓
OR
$v_f = 21{,}85\ m{\cdot}s^{-1}$ ✓downwards✓

Downward positive:

$v_f = v_i + a\Delta t$ ✓
$= \underline{-29{,}4}$ ✓+ $\underline{(9{,}8)(5{,}23)}$ ✓
$= 21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓

OPTION 2

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 29{,}4\ (5{,}23) + ½\ (-9{,}8)(5{,}23)^2$
$= 19{,}73\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{29{,}4^2}$ ✓+ $\underline{2(-9{,}8)(19{,}73)}$ ✓
$\therefore v_f = 21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓

Downward positive:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (-29{,}4)(5{,}23) + ½\ (9{,}8)(5{,}23)^2$
$= -19{,}73\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{(-29{,}4)^2}$ ✓+ $\underline{2(9{,}8)(-19{,}73)}$ ✓
$\therefore v_f = 21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓

POSITIVE MARKING FROM 3.1

OPTION 3 (Downward motion only)
Downward positive:

Time for downward motion:
(5,23 – 3)✓ = 2,23 s

$v_f = v_i + a\Delta t$ ✓
$= \underline{0 + (9{,}8)(2{,}23)}$ ✓
$= 21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓

OPTION 4
Downward positive:

Time for downward motion:
(5,23 – 3)✓ = 2,23 s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{(0)(2{,}23) + ½\ (9{,}8)(2{,}23)^2}$
$= 24{,}36721\ m$

✓(for both formulae)

$v_f^2 = v_i^2 + 2a\Delta y$
$= \underline{(0)^2 + 2(9{,}8)(24{,}36721)}$ ✓
$\therefore v_f = 21{,}85\ m{\cdot}s^{-1}$ ✓downwards ✓

[12.2.3] (5)

3.4.2 **POSITIVE MARKING FROM QUESTION 3.4.1**

OPTION 1
Upward positive:

$\Delta t = (5{,}23 – 1)$ ✓ $= 4{,}23\ s$

$v_f = v_i + a\Delta t$ ✓
$= \underline{49 + (-9{,}8)(4{,}23)}$ ✓
$v_f = 7{,}55\ m{\cdot}s^{-1}$ upwards

$\Delta v_{XY} = v_X - v_Y$ (vector difference)
$= -21{,}85 - 7{,}55$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$✓ downwards✓

$v_{XY} = v_{XG} + v_{GY}$
$= -21{,}85 + (-7{,}55)$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$-21{,}85 = v_{XY} + (7{,}55)$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5{,}23 - 1)$ ✓ $= 4{,}23$ s

$v_f = v_i + a\Delta t$ ✓
$= \underline{-49 + (9{,}8)(4{,}23)}$ ✓
$= -7{,}55\ m{\cdot}s^{-1}$
$v_f = 7{,}55\ m{\cdot}s^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21{,}85 + (7{,}55)$
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21{,}85 - (-7{,}55)$
$= 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21{,}85 = v_{XY} + (-7{,}55)$
$= 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

<u>OPTION 2</u>

Upward positive:

$\Delta t = (5{,}23 - 1)$✓ $= 4{,}23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 49(4{,}23) + ½(-9{,}8)(4{,}23)^2$
$= 119{,}59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(49)^2 + 2(-9{,}8)(119{,}59)}$ ✓
$\therefore v_f = 7{,}55\ m{\cdot}s^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= -21{,}85 + (-7{,}55)$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= -21{,}85 - 7{,}55$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$-21{,}85 = v_{XY} + (7{,}55)$
$= -29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓
OR
$v_{XY} = 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

Downward positive:

$\Delta t = (5{,}23 - 1)$✓ $= 4{,}23$ s
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (-49)(4{,}23) + ½(9{,}8)(4{,}23)^2$
$= -119{,}59$ m (upwards)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both equations)
$= \underline{(-49)^2 + 2(9{,}8)(-119{,}59)}$ ✓
$\therefore v_f = 7{,}55\ m{\cdot}s^{-1}$ upwards

$v_{XY} = v_{XG} + v_{GY}$
$= 21{,}85 + (7{,}55)$
$= 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XY} = v_X - v_Y$ (vector difference)
$= 21{,}85 - (-7{,}55)$
$= 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

$v_{XG} = v_{XY} + v_{YG}$
$21{,}85 = v_{XY} + (-7{,}55)$
$= 29{,}40\ m{\cdot}s^{-1}$ ✓downwards✓

[12.1.3] (5)
[19]

QUESTION 4

4.1 The sum of the kinetic and (gravitational) potential energy is conserved / constant / remains the same / does not change✓ in an isolated / closed / system / no external work done / only conservative forces act on the system.✓

OR

The (total) mechanical energy is conserved/ constant✓ in an isolated system.✓

[12.2.1] (2)

4.2

OPTION 1	OPTION 2
$E_{mech} = U + K$ or $E_p + E_k$ $= mgh + ½ mv^2$ ✓(any formulae) $= (0,5)(9,8)(0,6)$ ✓ $+ ½ (0,5)(3)^2$ ✓ $= 5,19$ J ✓ (5,25 J)	$E_p = mgh = (0,5)(9,8)(0,6)$ ✓ $= 2,94$ J (3 J) $E_k = ½ mv^2 = ½ (0,5)(3)^2$ ✓ $= 2,25$ J $E_{mech} = E_p + E_k$ ✓ $= 2,94 + 2,25$ $= 5,19$ J✓

[12.2.3] (4)

4.3

Accepted formulae

$E_{mech(A)} = E_{mech(B)}$ / $E_{mech(i)} = E_{mech(f)}$ / $E_{mech(top)} = E_{mech(bottom)}$

$(E_p + E_k)_A = (E_p + E_k)_B$ / $(E_p + E_k)_{bottom} = (E_p + E_k)_{top}$

$(E_p + E_k)_i = (E_p + E_k)_f$ / $(U + K)_{bottom} = (U + K)_{top}$

$(U + K)_i = (U + K)_f$ / $(U + K)_A = (U + K)_B$ / $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$

OPTION 1	OPTION 2
$(U + K)_B = (U + K)_C$ ✓ $mgh_B + ½ m v_B^2 = mgh_C + ½ m v_C^2$ $5,19$ ✓ $= 0 + ½ (0,5)v^2$ ✓ $\therefore v = 4,56$ m·s^{-1}	$W_{net} = \Delta E_k$ ✓ $mg\Delta y\cos\theta = ½ m(v_f^2 – v_i^2)$ $(0,5)(9,8)(0,6)(1)$✓$= ½ (0,5)(v_f^2 – 3^2)$ ✓ $\therefore v_f = 4,56$ m·s^{-1}

$\Sigma p_{before} = \Sigma p_{after}$ ✓

$(0,5)(4,56) + 0$ ✓ $= (0,5)v_{f2} + (0,1)(3,5)$ ✓

$\therefore v_{f2} = 3,86$ m·s^{-1} ✓(to the right) (3,88 m·s^{-1})

Other formulae:

$p_{t\ before} = p_{t\ after}$ or $m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$

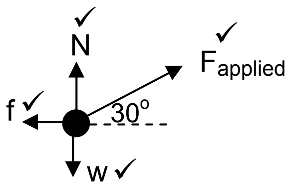
or $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

[12.1.3] (7)
[12.2.3] **[13]**

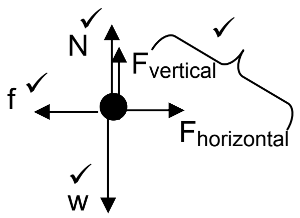
QUESTION 5

Accepted Labels	
N	Normal / Force of surface on crate / F_N / 269 N / 275 N
w	F_g / force of Earth on crate / weight / 294 N /300 N mg / gravitational force
$F_{applied}$	F / force of worker on crate / 50 N / F_A
f	$F_{friction}$ / 20 N / F_f / friction
$F_{horizontal}$ / F_x / $F_{//}$	43,30 N
$F_{vertical}$ / F_y / $F_\perp$	25 N

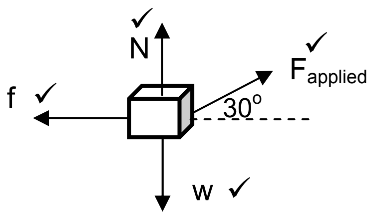
5.1



OR



Accept: Force diagram



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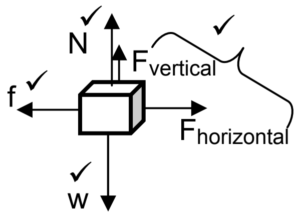


[12.1.2] (4)

5.2 $W = F\Delta x \cos 90^o$ ✓✓ $= 0$

OR

They (normal force and the gravitational force) are <u>perpendicular</u> /at 90^o to the (direction of the) <u>displacement / motion / Δx</u> ✓✓of the crate.

OR

The angle between the force and <u>displacement / motion / Δx</u> is 90^o.✓✓

OR

The crate moves horizontally and the forces act vertically.✓✓ [12.2.2] (2)

5.3

Accepted symbols for applied force: F_{appl} / F / F_A Accepted symbols for frictional force: f / F_f / $F_{friction}$ Accepted symbols for gravitational force: w / F_g / $F_{force\ of\ Earth\ on\ crate}$ / gravitational force

OPTION 1

$$\left.\begin{aligned} W_{net} &= W_{appl} + W_f \\ &= F_{app}\Delta x\cos\theta + f\Delta x\cos\theta \end{aligned}\right\}\checkmark \text{ For either formula}$$

$= \underline{(50)(6)(\cos30°)}\checkmark + \underline{(20)(6)(\cos180°)}\checkmark$

$= 259{,}81 + (-120)$

$W_{net} = 139{,}81\ \text{J}\ \checkmark$

OPTION 2

$W_{applied} = F_{app}\Delta x\cos\theta$

$= \underline{(50)(6)(\cos30°)}\checkmark$

$= 259{,}81\ \text{J}$

$W_f = f\Delta x\cos\theta$

$= \underline{(20)(6)(\cos180°)}\checkmark$

$= -120\ \text{J}$

$W_{net} = W_{applied} + W_f\ \checkmark$ OR $F_{app}\Delta x\cos\theta + F\Delta x\cos\theta$

$= 139{,}81\ \text{J}\ \checkmark$

OPTION 3

$$\left.\begin{aligned} W_{net} &= W_{appl\ //} + W_f \\ &= F_{app//}\Delta x\cos\theta + f\Delta x\cos\theta \end{aligned}\right\}\checkmark \text{ For either formula}$$

$= \underline{(50)(\cos30°)(6)\cos0°}\checkmark + \underline{(20)(6)(\cos180°)}\checkmark$

$= 259{,}81 + (-120)$

$W_{net} = 139{,}81\ \text{J}\ \checkmark$

OPTION 4

$F_{net} = F_{horizontal} + f$

$= \underline{(50)(\cos30°) + (-20)}\checkmark$

$= 23{,}30\ \text{N}$

$W_{net} = F_{net}\Delta x\cos\theta\ \checkmark$

$= \underline{(23{,}30)(6)(\cos0°)}\checkmark$

$= 139{,}81\ \text{J}\checkmark$

OPTION 5

$F_{net} = F_{horizontal} + f$

$ma = \underline{(50)(\cos30°) + (-20)}\checkmark$

$(30)a = (50)(\cos30°) + (-20)$

$a = 0{,}776...\ \text{m·s}^{-2}$

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

$= (0)^2 + 2(0{,}78...)(6)$

$v_f = 3{,}052...\ \text{m·s}^{-1}$

✓one mark for all three formulas

$W_{net} = \Delta K = ½\,m(v_f^2 - v_i^2)$

$= \underline{½\,(30)(3{,}052...^2 - 0^2)}\checkmark$

$= 139{,}81\ \text{J}\checkmark$

[12.1.3] (4)

5.4

$W_{net} = \Delta K$ / $W_{net} = \Delta E_k$ ✓
$= ½ mv_f^2 - ½ mv_i^2$
$\underline{139,81 = ½ (30)v_f^2 - 0}$ ✓
$v_f = 3,05 \text{ m·s}^{-1}$ ✓

If: W instead of W_{net} max($\frac{2}{3}$)
No marks for any other method

[12.2.3] (3)

5.5 Greater than ✓

The horizontal component (of the force) / force in direction of motion will now be greater / F_{net} will now be greater.✓

OR
As θ decreases cos θ increases✓

OR
For θ smaller than 30°, cos θ > cos 30°.✓ (2)
[12.3.2] **[15]**

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ / $f_L = \frac{v + v_L}{v} f_s$ ✓

$\therefore$ 1 000 ✓$= \frac{340 + v_L}{340}(960)$ ✓

$\therefore v_L = 14,17 \text{ m·s}^{-1}$ ✓

[12.2.3] (4)

6.3 Higher than ✓ [12.2.2] (1)
[6]

QUESTION 7

7.1 When two waves pass through the same region of space at the same time✓,
resulting in the superposition of waves. ✓ [12.2.1] (2)

7.2 Constructive (interference)✓

- The waves crossing each other are in phase. ✓/ Two troughs meet./
The path difference is an integer number of λ. [12.1.2] (2)

7.3 Dark band ✓

- It lies on the line combining all the points where crests and troughs overlap ✓ resulting in destructive interference. ✓

OR
It lies on the (nodal) line✓ where destructive interference occurs. ✓ (3)
[12.1.2] **[7]**

QUESTION 8

8.1 The ability of a wave to bend / spread out (in wave fronts)✓ as they pass through a (small) aperture / opening or around a (sharp) edge/ points /corners / barrier. ✓ (2)

8.2 8.2.1 Angle of / (Degree of) diffraction ✓
Position of minima
α or β [12.1.1] (1)

8.2.2 (Slit) width / a ✓ [12.1.1] (1)

8.3 (Slit) 1 ✓
-
Slit 1 represents the most diffraction. ✓

OR
Diffraction /Angle / sin θ / θ is inversely proportional to slit width. ✓

OR
$\sin\theta \;\alpha \frac{1}{a}$ or $\theta \;\alpha \frac{1}{a}$ ✓

OR
Larger angle at which first minimum for slit 1 is obtained. ✓

OR
Smaller angle at which first minimum for slit 2 is obtained.✓

OR
Actual calculations showing slit 1 is narrower than slit 2. ✓ [12.1.2] [12.2.2] (2)

8.4

OPTION 1

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 5° = \frac{(1)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = $4,70 \times 10^{-6}$ m ✓ (0,0000047 m / 4,7 μm)

OPTION 2

$\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 10° = \frac{(2)(410 \times 10^{-9})}{a}$ ✓ ✓

$\therefore$ a = $4,72 \times 10^{-6}$ m ✓ (0,00000472 m / 4,72 μm)

OPTION 3

Allocated full marks if calculation shown correctly in QUESTION 8.3. [12.1.3] (4)

[10]

QUESTION 9

9.1 The ratio of the (amount of) charge (transferred) ✓ to the (resulting) potential difference. ✓

[12.2.1] (2)

9.2 $C = \frac{\varepsilon_0 A}{d}$ ✓ or $C = \frac{K\varepsilon_0 A}{d}$ ✓ where $K = 1$

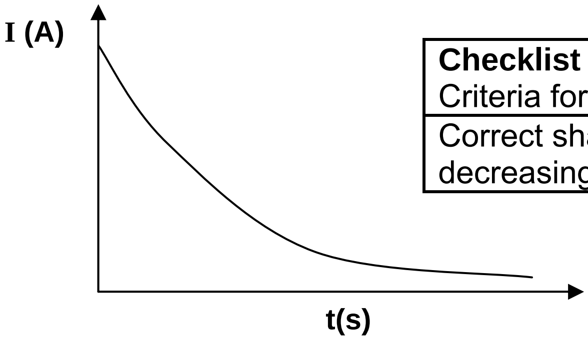
$= \frac{(8{,}85\times10^{-12})(2\times10^{-2})(1{,}5\times10^{-2})}{1{,}5\times10^{-3}}$ ✓ ✓

3 x 10^{-4}

$\therefore C = 1{,}77 \times 10^{-12}$ F ✓ (1,77 pF)

[12.2.3] (5)

9.3



Checklist Criteria for graph:	Mark/ *Punt*
Correct shape of graph showing decreasing current with time.	✓✓

[12.1.2] (2)

9.4 $C = \frac{Q}{V}$ ✓

$\therefore 1{,}77 \times 10^{-12} = \frac{Q}{12}$ ✓

$\therefore Q = 2{,}12 \times 10^{-11}$ C ✓

[12.2.3] (3)

9.5

OPTION 1	OPTION 2
$F = \frac{Vq}{d}$ ✓✓ $= \frac{(12)(3{,}2\times10^{-19})}{1{,}5\times10^{-3}}$ ✓ ✓ $= 2{,}56 \times 10^{-15}$ N ✓	$E = \frac{V}{d}$ ✓ $= \frac{12}{1{,}5\times10^{-3}}$ ✓ $= 8 \times 10^{3}\ \text{V·m}^{-1}$ $E = \frac{F}{q}$ ✓ $8 \times 10^{3} = \frac{F}{3{,}2\times10^{-19}}$ ✓ $\therefore F = 2{,}56 \times 10^{-15}$ N ✓

(5)

[12.1.3] **[17]**

QUESTION 10

10.1 The <u>current in a conductor is directly proportional to the potential difference</u> ✓
across its ends at <u>constant temperature</u>. ✓

OR
The <u>ratio of potential difference to current is constant</u>✓
at <u>constant temperature</u> ✓ [12.2.1] (2)

10.2.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ = $\frac{1}{1,4} + \frac{1}{1,4}$ ✓ $\therefore$ R_p = 0,7 Ω ✓

OR

$R_p = \frac{R_1 R_2}{R_1 + R_2}$ ✓ = $\frac{1,4 \times 1,4}{1,4 + 1,4}$ ✓= 0,7 Ω ✓ [12.2.3] (3)

10.2.2

<u>OPTION 1:</u>
emf = I(R + r) ✓
$\therefore$ <u>12 = I(0,7 + 0, 1)</u> ✓
$\therefore$ I = 15 A

R = $\frac{V}{I}$

0,7 = $\frac{V}{15}$ ✓

$\therefore$V = 10,5 V ✓

<u>OPTION 2:</u>
I = $\frac{V}{R}$ ✓ = $\frac{12}{0,8}$ ✓ = 15 A

V = IR
= (15)(0,7) ✓
= 10,5 V ✓

emf = I(R + r)
12 = $V_{external}$ + (15)(0,1) ✓
$V_{external}$ = 12 – (15)(0,1)
= 10,5 V ✓

$V_{\text{"lost"}}$ = Ir = (15)(0,1) ✓= 1,5 V
$V_{external}$ = 12 – 1,5 V = 10,5 V✓

$I_{headlight}$ = $\frac{15}{2}$ = 7,5 A✓
V = IR = (7,5)(1,4) = 10,5 V✓

<u>OPTION 3</u>
Voltage divides 0,7: 0,1 / 7:1
$\therefore V_{headlight}$ = $\frac{7}{8}$ ✓✓x 12 ✓
= 10,5 V ✓

[12.2.3] (4)

10.2.3

OPTION 1

$P = \frac{V^2}{R}$ ✓

$= \frac{10,5^2}{1,4}$ ✓

$= 78,75$ W ✓

OPTION 2

I(light) = 7,5 A

P = VI ✓

= (10,5)(7,5) ✓

= 78,75 W ✓

OPTION 3

I(light) = 7,5 A

$P = I^2R$ ✓

$= (7,5)^2(1,4)$ ✓

= 78,75 W ✓

OPTIONS ACCEPTED ONLY BECAUSE BULBS ARE IDENTICAL:

$P_{total} = \frac{V^2}{R}$ ✓

$= \frac{(10,5)^2}{0,7}$

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

P_{total} = VI ✓

= (10,5)(15)

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

$P_{total} = I^2R$ ✓

$= (15)^2(0,7)$

= 157,5 W

$P_{headlight} = \frac{157,5}{2}$ ✓

= 78,75 W ✓

[12.2.3] (3)

10.3 Decreases ✓

-

(Effective/ total) resistance decreases. ✓

(Total) current increases. ✓

"Lost volts" / $V_{internal}$ / Ir increases, thus potential difference / V (across headlights) decreases.✓

$P = \frac{V^2}{R}$ decreases.

[12.1.3] (4)

[16]

QUESTION 11

11.1 11.1.1

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ $= \frac{311,13}{\sqrt{2}}$ ✓ $= 220$ V ✓

[12.2.3] (3)

11.1.2

OPTION 1

$P_{ave} = V_{rms}I_{rms}$ ✓ $\therefore$ $100 = (220)I_{rms}$ ✓ $\therefore$ $I_{rms} = 0,45$ A

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max} = 0,45\sqrt{2}$ ✓ $= 0,64$ A ✓

OPTION 2

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$100 = \frac{(220)^2}{R}$ ✓ $\therefore R = 484\ \Omega$

$R = \frac{V_{max}}{I_{max}}$ ✓

$484 = \frac{311,13}{I_{max}}$ ✓

$I_{max} = 0,64$ A ✓

OPTION 3

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \frac{V_{max}}{\sqrt{2}} \times \frac{I_{max}}{\sqrt{2}} = \frac{V_{max}I_{max}}{2}$ ✓

100 ✓ $= \frac{311,13 \times I_{max}}{2}$ ✓

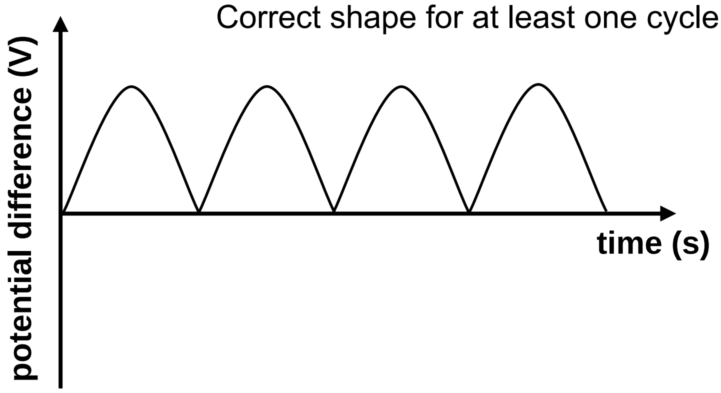
$I_{max} = 0,64$ A ✓

[12.1.3]

(5)

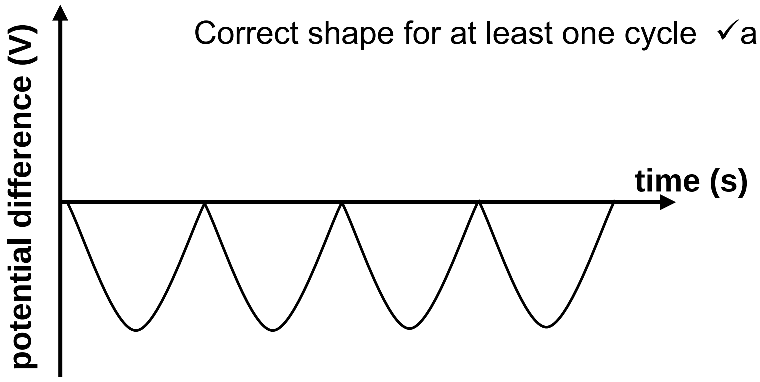
11.2

Correct shape for at least one cycle✓ and loops of equal height. ✓



OR

Correct shape for at least one cycle ✓and loops of equal height. ✓



[12.1.2] (2)
[10]

QUESTION 12

12.1 Any ONE: ✓
Damage to skin./Causes (skin) cancer.
Damage to eyes./Increased occurrence of cataracts.
Damage to crops resulting in food shortages. [12.3.2] (1)

12.2 Kills bacteria / germs / Sterilises/ sanitises / disinfects equipment.✓ [12.3.2] (1)

12.3

OPTION 1

$E = \frac{hc}{\lambda}$ ✓

$= \frac{(6,63 \times 10^{-34})(3 \times 10^{8})}{200 \times 10^{-9}}$ ✓ ✓

$= 9,95 \times 10^{-19}$ J ✓

OPTION 2

$c = f\lambda$

$3 \times 10^{8} = f(200 \times 10^{-9})$ ✓

$f = 1,5 \times 10^{15}$ Hz

✓ for both formulae

$E = hf$

$= (6,63 \times 10^{-34})(1,5 \times 10^{15})$ ✓

$= 9,95 \times 10^{-19}$ J ✓

[12.2.3] (4)

12.4

OPTION 1

$\left.\begin{array}{l} E = W_o + E_k \\ hf = hf_o + \frac{1}{2} mv^2 \end{array}\right\}$ ✓ For either formula

$9,95 \times 10^{-19}$ ✓ $= \underline{3,84 \times 10^{-19} + \frac{1}{2}(9,11 \times 10^{-31})v^2}$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1} ✓ (1157583,69 - 1158180,94 m·s^{-1})

OPTION 2

$E = W_o + E_k$ ✓

$E_k = \underline{9,95 \times 10^{-19} – 3,84 \times 10^{-19}}$ ✓

$= 6,11 \times 10^{-19}$ J

$E_k = \frac{1}{2} mv^2$

$\underline{6,11 \times 10^{-19} = \frac{1}{2}(9,11 \times 10^{-31})v^2}$ ✓

$\therefore v = 1,16 \times 10^{6}$ m·s^{-1} ✓ (1157583,69 - 1158180,94 m·s^{-1})

Other symbols:

E: hf

W_o: hf_o

K: E_k: $\frac{1}{2} mv^2$

[12.2.3] (4)

12.5 Yes✓
\-
(Photons of) X rays have a <u>higher frequency / shorter wavelength / energy</u> (than ultraviolet radiation). ✓

OR
UV light has lower frequency than X-rays. [12.2.2] (2)

[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150