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NATIONAL SENIOR CERTIFICATE EXAMINATION  
NOVEMBER 2022

## PHYSICAL SCIENCES: PAPER I

### MARKING GUIDELINES

Time: 3 hours

200 marks

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These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

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If answer is left as a fraction candidate penalized only ONCE per question (or in each part of a split question).

**QUESTION 1**

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

**QUESTION 2** if incorrect letter included: 0

2.1.1 A, D, G for all (1 mark if only 2 given; 1 mark if ONLY D given)

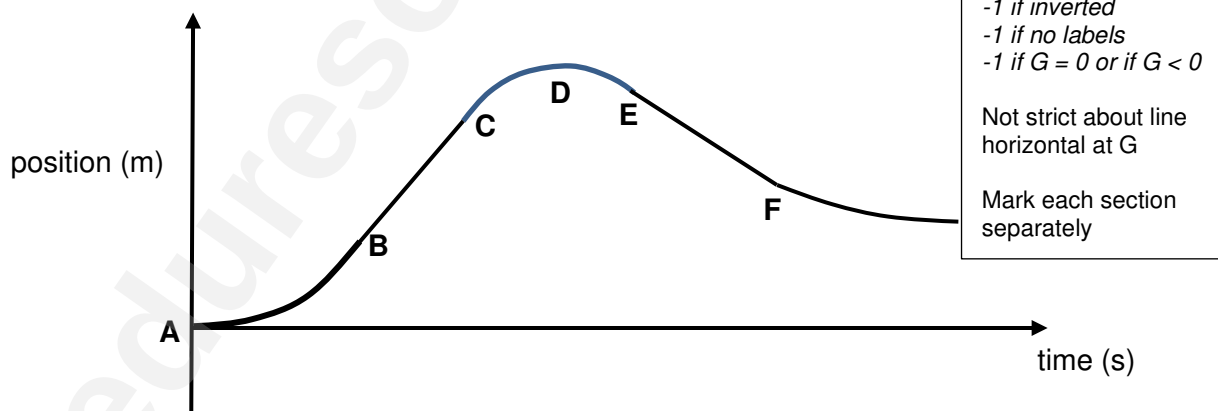
2.1.2 B–C

2.1.3 D–G OR D–E; E–F; F–G

2.1.4 Acceleration is the rate of change of velocity.  
Don't accept "over time" but ... "per unit time" is acceptable

2.1.5 C–E C–D (only 1); D–E (only 1)

2.1.6



2.2  $S_{\text{child}} + S_{\text{puppy}} = 100$   
 $2,0 t + 2,5 t = 100$   
 $t = 22,22 \text{ s}$

$S_{\text{child}} = 2,0(22,22)$   
 $S_{\text{child}} = 44,44 \text{ m}$

OR

$S_{\text{child}} = 2t$   
 $S_{\text{puppy}} = 2,5t$   
 $S_{\text{child}} + S_{\text{puppy}} = 100$   
 $2t + 2,5t = 100$   
 $4,5t = 100$   
 $t = 22,22 \text{ s}$   
 $S_{\text{child}} = 2t$   
 $= 2(22,22)$   
 $= 44,44 \text{ m}$

$S_{\text{child}} = 2t$   
 $S_{\text{puppy}} = 2,5t$   
 $\text{distance} = (100 - x)$   
 $\text{equating / substituting}$   
 $+ 44,44 \text{ m}$

$$t_{child} = \frac{s_{child}}{v_{child}}$$

$$= \frac{s_{child}}{2,0}$$

$$t_{puppy} = \frac{s_{puppy}}{v_{puppy}}$$

$$= \frac{(100 - s_{child})}{2,5}$$

$$\frac{s_{child}}{2,0} = \frac{(100 - s_{child})}{2,5}$$

$$2,5 s_{child} = 2,0(100 - s_{child})$$

$$s_{child} = 44,44 \text{ m}$$

$$2 : 2,5$$

$$44,44 : 55,56$$

$$= 44,44 \text{ m}$$

$$2,5 + 2 = 4,5 \text{ m.s}^{-1}$$

$$s = ut + \frac{1}{2}at^2$$

$$100 = 4,5t + 0$$

$$t = 22,22 \text{ s}$$

$$s_{child} = 2t$$

$$= 2(22,22)$$

$$= 44,44 \text{ m}$$

Approximation method – candidate repeats substitutions to approach the correct answer:

- Evidence must be clear (correct statements are given marks, e.g.  $\Delta x = 2t$ )
- If final answer is correct (44,44 m) then 5 marks
- If method shown and correct but final answer is e.g. 44,5 m, then 4/5 marks given.

### QUESTION 3

3.1  $v = u + at$

$$0 = u + (-9,8)(0,8)$$

$$u = 7,84 \text{ m.s}^{-1}$$

OR

$$s = ut + \frac{1}{2}at^2$$

$$0 = u(1,6) + \frac{1}{2}(-9,8)(1,6)^2$$

$$u = 7,84 \text{ m.s}^{-1}$$

Could choose down to be positive throughout.

3.2  $s = ut + \frac{1}{2}at^2$

$$= (7,84)(0,8) + \frac{1}{2}(-9,8)(0,8)^2$$

$$s = 3,14 \text{ m}$$

Carry over initial velocity from 3.1

OR

$$v^2 = u^2 + 2as$$

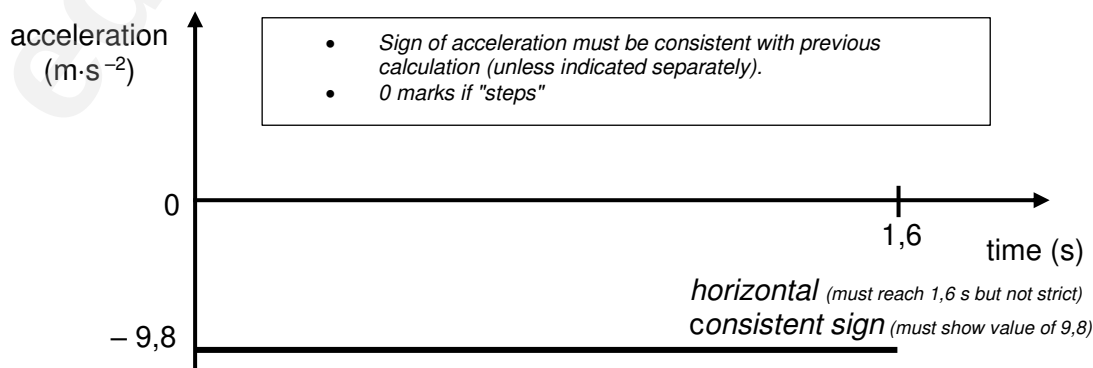
$$0^2 = (7,84)^2 + 2(-9,8)s$$

$$s = 3,14 \text{ m}$$

Must show "-" of  $a = +9,8$ , even though squared

If height left as a negative value, no mark for answers (max 2 marks)

3.3



3.4  $s = ut + \frac{1}{2}at^2$

$$s = (5)(1,2) + \frac{1}{2}(-9,8)(1,2)^2$$

$$s = -1,06 \text{ m}$$

$$\mathbf{s = 1,06 \text{ m}}$$

*If height left as a negative value, no mark for answer (max 2 marks)  
EXCEPT if already penalised in 3.2*

*Max height (1,28 m)*

*Correct distance*

*Answer*

OR  $v^2 = u^2 + 2as$   
 $0^2 = 5^2 + 2(9,8)s$   
 $S = 1,28 \text{ m}$

$$s = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2}(-9,8)(0,69)^2$$

$$= 2,34 \text{ m}$$

*If  $s = \frac{1}{2}(u + v)t$  is used with no other calculation, then 0/3 as there are 2 unknown for this equation and it will not produce a height without another calculation.*

$$V = u + at$$

$$0 = 5 + (-9,8)t$$

$$t = 0,51 \text{ s}$$

$$\text{Height} = 2,34 - 1,28$$

$$= 1,06 \text{ m}$$

3.5  $v = u + at$   
 $v = 5 + (-9,8)(1,2)$   
 $v = -6,76 \text{ m} \cdot \text{s}^{-1}$   
 $\mathbf{v = 6,76 \text{ m} \cdot \text{s}^{-1}}$

*Accept a positive or negative answer for 3.5*

*Don't carry through error of time from 3.4 (0,6 s)*

OR  $v = u + at$   
 $v = 5 + (-9,8)(1,2)$   
 $v = -6,76$   
 $\mathbf{= 6,76 \text{ m} \cdot \text{s}^{-1}}$

*For each option:  
-1 per error*

OR  $s = \frac{1}{2}(u + v)t$   
 $-1,05 = \frac{1}{2}(5 + v)(1,2)$   
 $-0,88 = \frac{1}{2}(5 + v)$   
 $\mathbf{v = 6,76 \text{ m} \cdot \text{s}^{-1}}$

OR  $v^2 = u^2 + 2as$   
 $= 5^2 + 2(-9,8)(-1,05)$   
 $= 45,58$   
 $\mathbf{v = 6,76 \text{ m} \cdot \text{s}^{-1}}$

*General "rules" for marking 3.5:*

- g and s need to have the same sign*
- u can be positive or negative if  $v^2 = u^2 + 2as$  used*
- if  $t = 1,2 \text{ s}$ , then u must be opposite sign to g.*
- if  $t = 0,18 \text{ s}$ , then u must be the same sign as g.*
- if using  $v = u + at$ :*
  - if  $t = 0,18 \text{ s}$   
 $v = +5 + (+9,8)(0,18)$*
  - if  $t = 0,69 \text{ s}$ :  
 $v = 0 + (+9,8)(0,69)$   
(u must be 0 and s and a must have the same sign)*

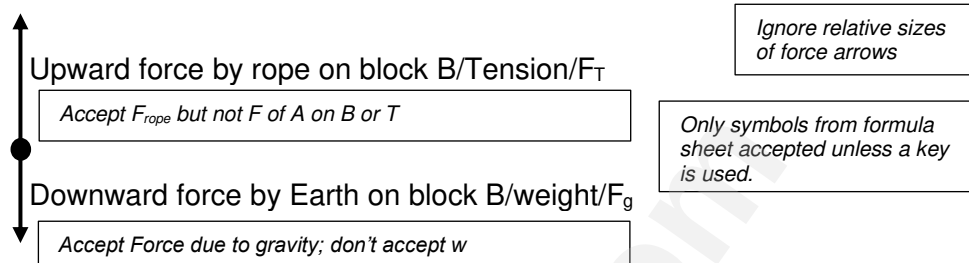
OR  $v = u + at$   
 $= 0 + (-9,8)(0,69)$   
 $= -6,76$   
 $\mathbf{= 6,76 \text{ m} \cdot \text{s}^{-1}}$

OR  $s = \frac{1}{2}(u + v)t$   
 $-2,34 = \frac{1}{2}(0 + v)(0,69)$   
 $-3,39 = \frac{1}{2}(v)$   
 $\mathbf{v = 6,76 \text{ m} \cdot \text{s}^{-1}}$

**QUESTION 4**

- 4.1 Weight is the gravitational force the Earth exerts on any object on or near its surface.

4.2



- 4.3 When a net force acts on an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass of the object.

NOT "indirectly"

**OR**Accept  
"resultant"  
instead of  
"net"

Don't accept "it" for acceleration

direction  
relationship  
[net force must be mentioned]

The net force acting on an object is equal to the rate of change of momentum.

4.4  $F_{net} = T - F_{g(B)} = m_B a$

OR  $F_{NET} = T + F_g = ma$ **OR**

Accept mass (6) or weight (58, 8) substituted

$$F_{net} = T - m_B g = m_B a$$

Accept symbols from Q4.2

- 4.5  $T + 6(-9,8) = (6)a$  for block B (anticlockwise is positive)  
 $-T + 8(9,8) = (8)a$  for block A (anticlockwise is positive)

Awarded for 8 kg expression with  
signage consistency with 6 kg  
expression taken into account.

$$8(9,8) - (8)a + 6(-9,8) = 6a$$

$$78,4 - 8a - 58,8 = 6a$$

$$14a = 19,6$$

$$a = 1,4 \text{ m}\cdot\text{s}^{-2}$$

Equating  
markIf both masses treated as one system:  
[Max 4/5]

$$F_{NET} = ma$$

$$F_{gA} - F_{gB} = (14)a \text{ (must use 14 kg)}$$

$$A = 1,4 \text{ m}\cdot\text{s}^{-2}$$

$$F_g + T = ma \text{ (must use single mass)}$$

$$T = 67,5 \text{ N}$$

$$T + 6(-9,8) = 6(1,4)$$

$$T = 67,2 \text{ N}$$

Substitution mark

Equating and substitution marks are stand alone  
Check for the equating of incorrect methods i.e.  $F_{NET(A)} = F_{NET(B)}$ 

4.6  $s = ut + \frac{1}{2}at^2$

$$0,6 = (0)t + \frac{1}{2}(1,4)t^2$$

$$t = 0,93 \text{ s}$$

Carry over  
acceleration from 4.5**OR** alternative methods

**OR**  $s_A + s_B = 1,2$  (method)  
 $\frac{1}{2}(1,4)t^2 + \frac{1}{2}(1,4)t^2 = 1,2$  (substitution – a must have same sign)  
 $t = 0,93 \text{ s}$

**OR**  $v^2 = u^2 + 2as$   
 $= 0^2 + 2(1,4)(0,6)$   
 $v = 1,3 \text{ m.s}^{-1}$

$$v = u + at$$

$$1,3 = 0 + 1,4t$$

$$t = 0,93 \text{ s}$$

**OR** BLOCK A:  
 $F_{\text{NET}} = -T + 78,4$   
 $= -67,2 + 78,4$   
 $= 11,2 \text{ N}$

$$v^2 = u^2 + 2as$$

$$= 0^2 + 2(1,4)(0,6)$$

$$v = 1,3 \text{ m.s}^{-1}$$

$$F_{\text{NET}} \cdot \Delta t = m \cdot \Delta v$$

$$(11,2) \cdot \Delta t = (8)(1,3) \text{ (substitution)}$$

$$t = 0,93 \text{ s}$$

**OR** BLOCK B:  
 $F_{\text{NET}} = T - 58,8$   
 $= 67,2 - 58,8$   
 $= 8,4 \text{ N}$

$$v^2 = u^2 + 2as$$

$$= 0^2 + 2(1,4)(0,6)$$

$$v = 1,3 \text{ m.s}^{-1}$$

$$F_{\text{NET}} \cdot \Delta t = m \cdot \Delta v$$

$$(8,4) \cdot \Delta t = (6)(1,3) \text{ (substitution)}$$

$$t = 0,93 \text{ s}$$

**OR**

If they use energy principles, they only get the mark for 0,6 m being used.

## QUESTION 5

5.1

$$(p_{total})_{before} = (p_{total})_{after}$$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$2(3) + 5(1,5) = 2v_1 + 5(2,5)$$

$$v_1 = 0,5 \text{ m} \cdot \text{s}^{-1} \text{ right}$$

NB Total or  $\Sigma$  for standalone formula mark

Independent mark

OR  $\Delta p_x = -\Delta p_y$  (not accepting formula if substitution error)

$$m_x v_x - m_x u_x = -(m_y v_y - m_y u_y)$$

$$2v - 2(3) = -5(2,5 - 1,5)$$

5.2

Both experience same force / neither / equal; NLIII  
Or explain using principle of conservation of momentum  
Rate of change of momentum is equal.

5.3

Neither / experience same change in momentum NL2  
Principle of conservation of momentum (equal change in momentum); equal impulse.  
If proved by calculation, they must draw a conclusion from values – i.e. mention a change in momentum  
Not accepting equal rate of change of momentum

5.4

The product of the net force and the time for which it acts.  
resultant the contact time

NOT just time

5.5

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

$$F_{net} = \frac{(5)(0) - 5(2,5)}{0,2}$$

$$F_{net} = -62,5$$

$$F_{net} = 62,5 \text{ N}$$

Accept a negative answer

OR

$$v = u + at$$

$$= 2,5 + a(0,2)$$

$$a = -12,5$$

formula for both

$$F_{NET} = ma$$

$$= 5(-12,5) \text{ (3 values)}$$

$$= -62,5$$

$$= 62,5 \text{ N}$$

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

$$= \frac{-5(2,5)}{0,2}$$

$$= 62,5 \text{ N}$$

Not marking sign

OR

$$v = u + at$$

$$0 = 2,5 + a(0,2)$$

$$a = -12,5$$

formula for both

$$V^2 = U^2 + 2as$$

$$0 = (2,5)^2 + 2(-12,5)s$$

$$S = 0,25 \text{ m}$$

$$W_{net} = \Delta E_k$$

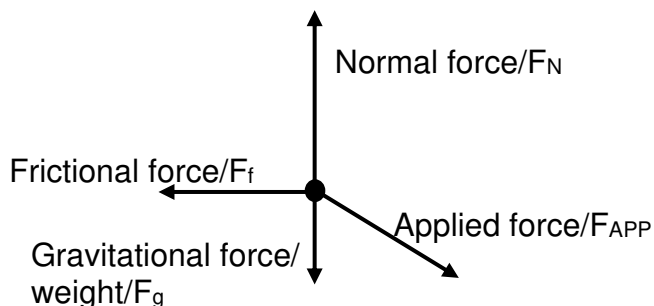
$$F_{NET}(0,25) = -\frac{1}{2}(5)(2,5)^2$$

$$F_{NET} = -62,5$$

$$= 62,5 \text{ N}$$

## QUESTION 6

6.1



Accept components instead of applied force OR accept if components given in addition to applied force, as long as they are dashed lines.

6.2

$$F_{\text{vert}} = F \cdot \sin \theta$$

$$F_{\text{vert}} = 25 \cdot \sin 15$$

$$F_{\text{vert}} = 6,47 \text{ N}$$

$$F_{\text{vert}} = F \cdot \cos \theta$$

$$F_{\text{vert}} = 25 \cdot \cos 75$$

$$F_{\text{vert}} = 6,47 \text{ N}$$

NB not just "force" perpendicular to surface

6.3 The perpendicular force exerted **by** a surface on an object in contact with it.

6.4

$$F_N = F_g + F_{\text{app,vert}} \text{ (as scalars)}$$

$$F_N = (0,01)(9,8) + 6,47$$

$$F_N = 6,57 \text{ N}$$

Independent mark

Carry over  $F_{\text{vert}}$  from 6.2

Watch out because  $6,47 - 0,098 = 6,37 \text{ N}$

6.5

$$F_{fk} = \mu F_N$$

$$F_{fk} = (0,6)(6,57)$$

$$F_{fk} = 3,94 \text{ N}$$

Carry over  $F_N$  from 6.5

Independent mark

6.6

$$F_{\text{net}} = F_{\text{app,hor}} - F_{fk} \text{ (as scalars)}$$

$$F_{\text{net}} = 25 \cos 15^\circ + (-3,94)$$

$$F_{\text{net}} = 20,21 \text{ N}$$

Formula must be correct to get this mark

Carry over  $F_{fk}$  from 6.5

Don't accept "net work done"...

6.7 The work done by a net force [on an object] is equal to the change in the kinetic energy of the object.

Object only needs to be mentioned once

6.8

$$F_{\text{net}} \cdot s = \Delta E_K$$

$$20,21(0,2) = \Delta E_K$$

$$\Delta E_K = 4,04 \text{ J}$$

$F \cdot s = \Delta E_K$  only allocated a formula mark if  $F_{\text{NET}}$  substituted

Carry over  $F_{\text{net}}$  from 6.6

$$W_{\text{NET}} = W_{\text{HOR}} + W_f$$

$$(20,21)(0,2) = 25 \cdot \cos 15(0,2) + W_f$$

$$W_f = 0,79 \text{ J}$$

6.9

$$\Delta E_{th} = F_f \cdot s$$

$$\Delta E_{th} = 3,94(0,2)$$

$$\Delta E_{th} = 0,79 \text{ J}$$

$W = F \cdot s$  only allocated a formula mark if  $F_f$  substituted

Carry over  $F_{fk}$  from 6.5

$$W_{\text{NET}} = W_{\text{HOR}} + W_f$$

$$(20,21)(0,2) = 25 \cdot \cos 15(0,2) + W_f$$

$$W_f = 0,79 \text{ J}$$

## QUESTION 7

particle / mass / object

Must say that this is an attractive force

- 7.1 7.1.1 Every particle with mass in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

7.1.2  $F = \frac{GM_1M_2}{r^2}$  *Check that they haven't substituted 6,4 here*

$$3,6 = \frac{(6,7 \times 10^{-11})(360)(6,0 \times 10^{24})}{r^2}$$

$$r^2 = \frac{(6,7 \times 10^{-11})(360)(6,0 \times 10^{24})}{3,6}$$

$$r = 200 \times 10^8 \text{ m}$$

OR

$$F = \frac{GM_1M_2}{r^2}$$

$$3,6 = \frac{(6,7 \times 10^{-11})(360)(6,0 \times 10^{24})}{(r + 6,4 \times 10^6)^2}$$

$$(r + 6,4 \times 10^6)^2 = \frac{(6,7 \times 10^{-11})(360)(6,0 \times 10^{24})}{3,6}$$

$$r + 6,4 \times 10^6 = 2,00 \times 10^8$$

$$r = 1,94 \times 10^8 \text{ m}$$

$$\text{height above surface} = 2,00 \times 10^8 \text{ m} - 6,4 \times 10^6$$

$$= 1,94 \times 10^8 \text{ m OR } 194 \times 10^6 \text{ m OR } 194 \times 10^3 \text{ km}$$

7.1.3  $g = \frac{F}{m}$

$$g = \frac{3,6}{360}$$

$$g = 0,01 \text{ m} \cdot \text{s}^{-2} \text{ OR } \text{N} \cdot \text{kg}^{-1}$$

Check working because 1,94 rounds to 2,00 – if method correct, this is acceptable!

OR

$$g = G \frac{M}{r^2}$$

$$g = (6,67 \times 10^{-11}) \frac{6,0 \times 10^{24}}{(200 \times 10^6)^2}$$

$$g = 0,01 \text{ m} \cdot \text{s}^{-2} \text{ OR } \text{N} \cdot \text{kg}^{-1}$$

- 7.2 7.2.1 Z

7.2.2 Y *Be careful of X vs Y!*

7.2.3  $F = \frac{kq_1q_2}{r^2}$

Check that not E =  
If all else correct, MAX 3/4

$$F = \frac{(9 \times 10^9)(2 \times 10^{-6})(6 \times 10^{-6})}{(5 \times 10^{-2})^2} \text{ (numerator)}$$

$$F = 43,2 \text{ N}$$

$$\begin{aligned} 7.2.4 \quad \text{charge per sphere} &= \frac{\text{total system charge}}{2} \\ &= \frac{(+6 \times 10^{-6} + +2 \times 10^{-6})}{2} \\ &= 4 \times 10^{-6} \text{ C OR } 4 \mu\text{C} \end{aligned}$$

$$\begin{aligned} 7.2.5 \quad \text{electrons transferred} &= \frac{\text{change in charge}}{\text{charge per electron}} \\ &= \frac{2 \times 10^{-6}}{1,6 \times 10^{-19}} \\ &= 1,25 \times 10^{13} \text{ electrons} \end{aligned}$$

|                   |
|-------------------|
| Ignore – if given |
|-------------------|

7.2.6 from A to B

**QUESTION 8**

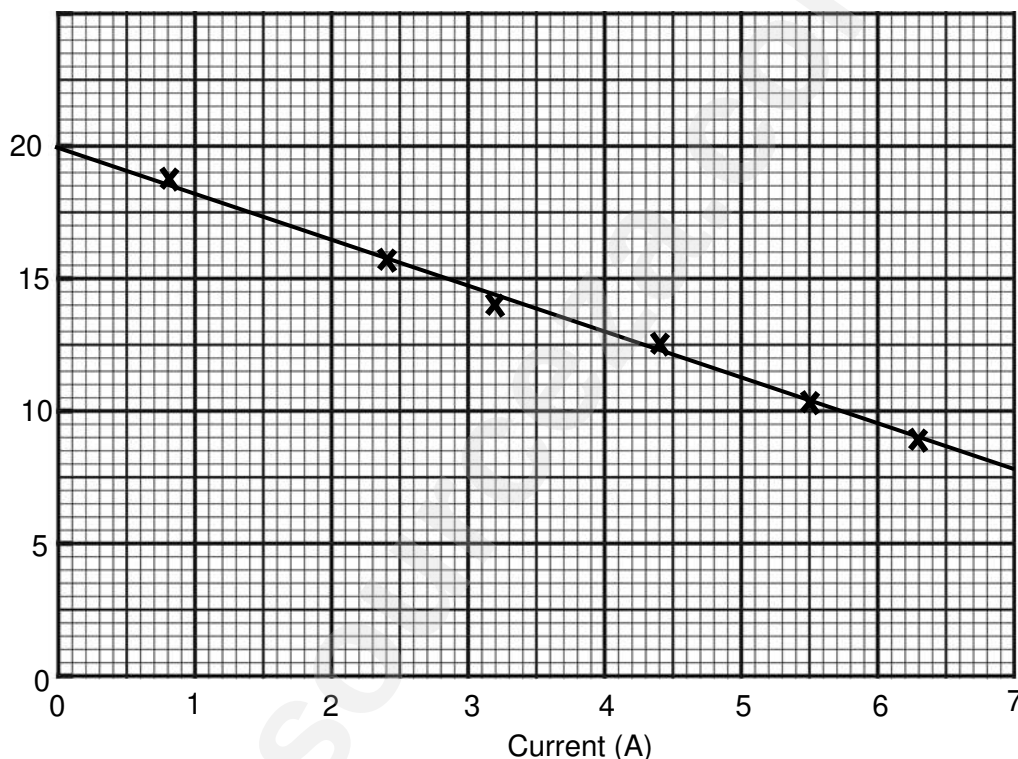
- 8.1 8.1.1 Heading  
 y-axis title and unit  
 y-axis scale (plotted points  $> \frac{1}{2}$  graph paper)  
 plotted points  
 line of best fit (line must extend beyond plotted points)

Non-linear scale MAX 2/6

Awful scale -1

Incorrectly labelled scale or inconsistent (e.g. 0 in wrong place)

Graph showing the reading on the voltmeter vs the current through the circuit.



- 8.1.2  $\text{gradient} = \frac{\Delta y}{\Delta x}$   
 $\text{gradient} = \frac{\text{values from y-axis}}{\text{values from x-axis}}$

-1 if points not shown

If points from table but not on LOBF:  
Formula

Unit

X even if in range

If on LOBF – full marks

(values must be from LOBF on graph – not data points)

 $\text{gradient} = -1,75 \Omega$  (accept 1,6 to 1,9)[unit must be given  $\Omega$  or  $V \cdot A^{-1}$ ]

- 8.1.3  $V_{\text{load}} = emf - Ir$   
**OR**  $V_{\text{term}} = -rI + emf$   
 $\text{gradient} = -r$   
 $r = 1,75 \Omega$

Equation must include  
 $V_{\text{LOAD}}$  or  $V_{\text{TERM}}$  and  $Ir$ Max 1/3 if -1,75  $\Omega$  only  
Max 2/3 if formula included

If no

- 8.1.4 **20 V** (y-intercept)

[carry over whatever]

They didn't have to cut the y axis –  
they could have used a ruler to  
get value.

8.1.5  $emf = (R + r)$   
 $20 = 4(R + 1,75)$   
 $R = 3,25 \Omega$

Carry over emf and r from 8.1.3 and 8.1.4 respectively

If 8.1.3 not answered, c.o. from 8.1.2

OR Read off  $V = 13 \text{ V}$

$$V = IR$$

$$13 = (4)R$$

$$R = 3,25 \Omega$$

[carry over from their LOBF]

If scale non-linear: MAX 2/3 (miss 1<sup>st</sup> mark)

If value matches graph – method mark can be given

8.2 8.2.1  $P = \frac{V^2}{R}$   
 $60 = \frac{12^2}{R}$   
 $R = 2,4 \Omega$

Watch out for v is proportional to I ... get 0

Accept "voltage", But not "emf"

8.2.2 Current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.

Provided resistance stays constant

8.2.3  $R_{TOTAL} = \frac{V}{I} = \frac{12}{6} = 2 \Omega$

If they stop here, no carry over to 8.2.4

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

Independent method mark

$$\frac{1}{2} = \frac{1}{R} + \frac{1}{2,4}$$

$$R = 12 \Omega$$

Carry over R from 8.2

OR

$$I_{bulb} = \frac{V_{bulb}}{R_{bulb}} = \frac{12}{2,4} = 5 \text{ A}$$

OR

$$I_{bulb} = \frac{P}{V_{bulb}} = \frac{60}{12} = 5 \text{ A}$$

$$\therefore I_R = 6 \text{ A} - 5 \text{ A} = 1 \text{ A}$$

$$R = \frac{V_R}{I_R} = \frac{12}{1}$$

$$R = 12 \Omega$$

8.2.4  $W = \frac{V^2 t}{R} = \frac{12^2}{12} (2 \times 60) = 1\,440 \text{ J}$

OR

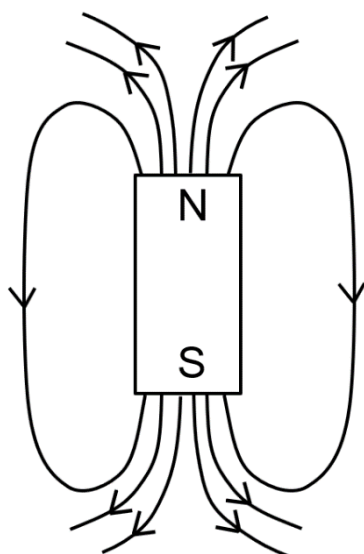
$$W = VIt = (12)(1) (2 \times 60) = 1\,440 \text{ J}$$

OR

$$W = I^2 R t = 1^2 (12) (2 \times 60) = 1\,440 \text{ J}$$

**QUESTION 9**

9.1 9.1.1



direction of arrows  
shape of field  
symmetry

(3)

9.1.2 The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic field.

2 or 0

flux

9.1.3 clockwise

9.1.4 Falling magnet causes strength of magnetic field in coil to (increase)/change. Coil experiences a change in flux. Change in flux induces an emf/electric current in the metal ring.

9.1.5 moving the magnet faster

**OR**

OR Throwing the magnet

OR Decreasing the temperature of the ring to reduce R

dropping the magnet from a greater height

9.1.6 The product of the number of turns on the coil and the flux through the coil.

9.1.7 The induced current would be much greater as a coil has more turns/loops.

greater flux linkage

9.2 9.2.1 into the page

- 9.2.2
- Move the loop into the magnetic field **OR** move the loop out of the magnetic field
  - With the loop in the field, change the shape of the wire loop
  - With the loop in the field, rotate the loop.

**Any 2**

**QUESTION 10**

10.1 The photons from the UV radiation have enough energy to eject electrons.

10.2 The minimum amount of energy needed to emit an electron from the surface of a metal.

eject / knock out

2 or 0

10.3  $4,3 \times 1,6 \times 10^{-19}$   
 $= 6,88 \times 10^{-19} \text{ J}$

10.4  $hf = W_0 + E_{K(\max)}$   
 $(6,6 \times 10^{-34})(15 \times 10^{14}) = 6,88 \times 10^{-19} + E_{K(\max)}$   
 $E_{K(\max)} = 3,02 \times 10^{-19} \text{ J}$

Carry over  $W_0$   
from 10.3

10.5  $E_{K(\max)} = \frac{1}{2}mv^2$   
 $3,02 \times 10^{-19} = \frac{1}{2}(9,1 \times 10^{-31})v^2$   
 $v = 8,15 \times 10^5 \text{ m} \cdot \text{s}^{-1}$

Carry over  
 $E_{K(\max)}$  from 10.4

10.6 When the electrons are ejected from the zinc disc, the electroscope becomes increasingly positive and the positively charged leaves repel one another.

**Total: 200 marks**