Physics 12

January 2004 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

	Organizers	Sub-Organizers
1.	Vector Kinematics in Two Dimensions	A, B
	and	
	Dynamics *and* Vector Dynamics	C, D
2.	Work, Energy and Power	E
	and	
	Momentum	F, G
3.	Equilibrium	H
4.	Circular Motion	I
	and	
	Gravitation	J
5.	Electrostatics	K, L
6.	Electric Circuits	M, N
7.	Electromagnetism	O, P

PART A: Multiple Choice (each question worth TWO marks)

Q	K	C	S	CO	PLO	Q	K	C	S	CO	PLO
1.	D	K	2	1	A1	16.	B	U	2	4	I5
2.	B	U	2	1	A2	17.	B	U	2	4	I4
3.	B	U	2	1	B8	18.	A	H	2	4	I4; C8
4.	A	K	2	1	C3	19.	C	K	2	5	J1
5.	B	U	2	2	C3, 7; D5	20.	A	K	2	5	K4, 6
6.	A	U	2	2	D5; C4	21.	C	U	2	5	K5
7.	A	U	2	2	E2, 7	22.	D	U	2	6	L4
8.	C	K	2	2	F4, 5; C3	23.	C	U	2	6	M7
9.	D	U	2	2	F4; A10	24.	D	U	2	7	N2; M6
10.	B	U	2	3	G3	25.	D	K	2	7	O2
11.	C	H	2	3	F4, 7; A8	26.	B	U	2	7	O3
12.	A	K	2	3	H7	27.	A	U	2	7	O4; M5
13.	C	U	2	4	H5	28.	B	U	2	7	P1
14.	B	H	2	4	H5	29.	D	U	2	7	P2
15.	A	K	2	4	I3	30.	A	U	2	7	P11; N2

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	7	1	D6, 4; C4
2.	2	U	7	2	E3, 7
3.	3	U	7	3	H11, 5
4.	4	U	7	4	J7, 10
5.	5	U	7	5	L2
6.	6	U	7	6	M5, 11
7.	7	H	9	7	O8, 6, 7
8	8	H	5	1, 7	A10; O6
9.	9	H	4	4	J3

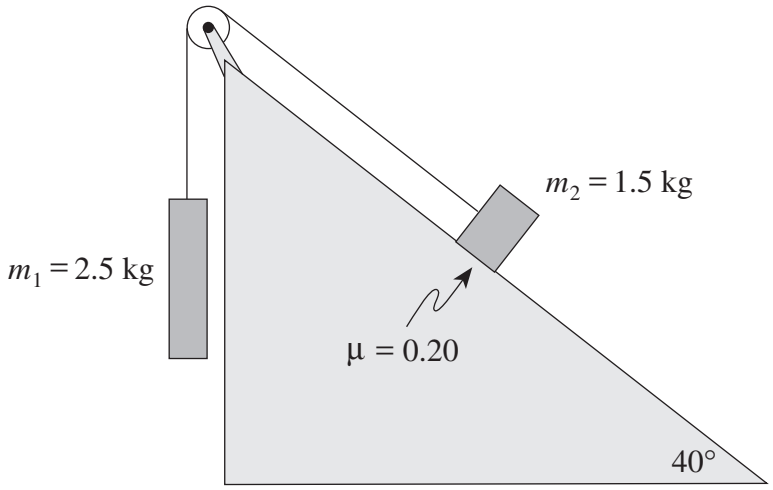
Written Response = 60 marks

Multiple Choice = 60 (30 questions)
Written Response = 60 (9 questions)
EXAMINATION TOTAL = 120 marks

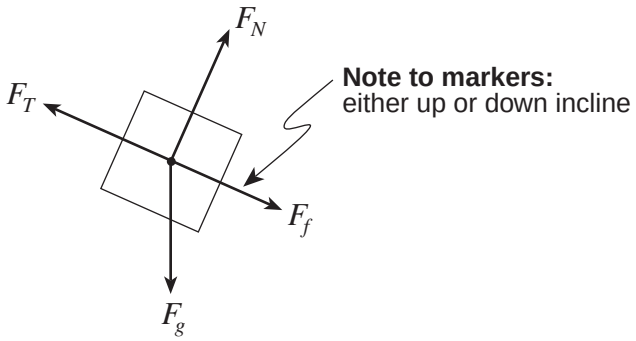
LEGEND:

Q = Question Number **B** = Score Box Number **C** = Cognitive Level
CO = Curriculum Organizer **K** = Keyed Response **S** = Score
PLO = Prescribed Learning Outcome

1. A system of masses is connected by a light cord passing over a pulley as shown in the diagram.



a) Draw a labelled free body diagram for mass m_2. **(2 marks)**



← **2 marks** for diagram

b) What is the magnitude of the acceleration of the system of masses? **(5 marks)**

$$F_{net} = m_T a$$

$$a = \frac{F_{net}}{m_T}$$

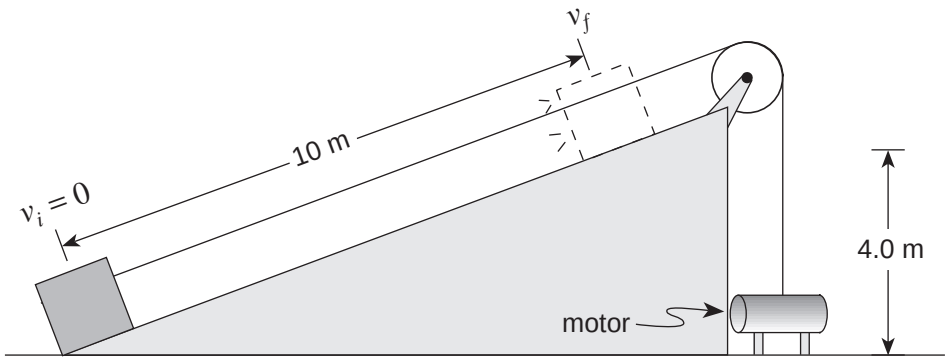
$$= \frac{F_{1_g} - F_{2_{fr}} - F_{2_{g_x}}}{(m_1 + m_2)} \quad \leftarrow \textbf{2 marks}$$

$$\left.\begin{array}{l} \dfrac{= m_1 g - \mu m_2 g \cos\theta - m_2 g \sin\theta}{m_1 + m_2} \\ \dfrac{2.5 \cdot 9.8 - 0.20 \cdot 1.5 \cdot 9.8 \cdot \cos 40 - 1.5 \cdot 9.8 \cdot \sin 40}{2.5 + 1.5} \end{array}\right\} \leftarrow \textbf{2}\,\tfrac{\mathbf{1}}{\mathbf{2}}\ \textbf{marks}$$

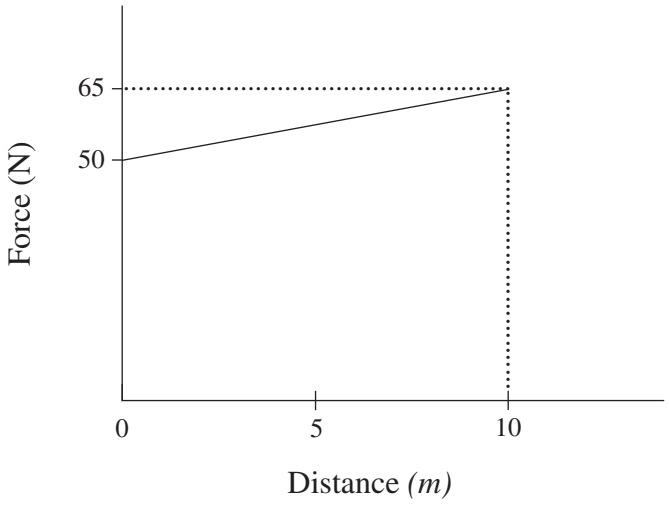
$$\frac{24.5 - 2.25 - 9.45}{2.5 + 1.5}$$

$$= 3.2\ \mathrm{m/s^2} \qquad \leftarrow \tfrac{\mathbf{1}}{\mathbf{2}}\ \textbf{mark}$$

2. An electric motor and a rope are used to pull a 10 kg crate of car parts up an inclined plane as shown below. The crate starts out from rest on the ground and ends up with speed v_f at a height of 4.0 m above the ground.



The graph below shows the force exerted on the crate by the motor as it is pulled 10 m up the inclined plane.



a) How much work is done on the crate by the electric motor from $d = 0$ m to $d = 10$ m?
(3 marks)

$W = F_{av} \cdot d$ ← **1 mark**

$W = (65 + 50) / 2 \cdot 10 = 575$ J ← **2 marks**

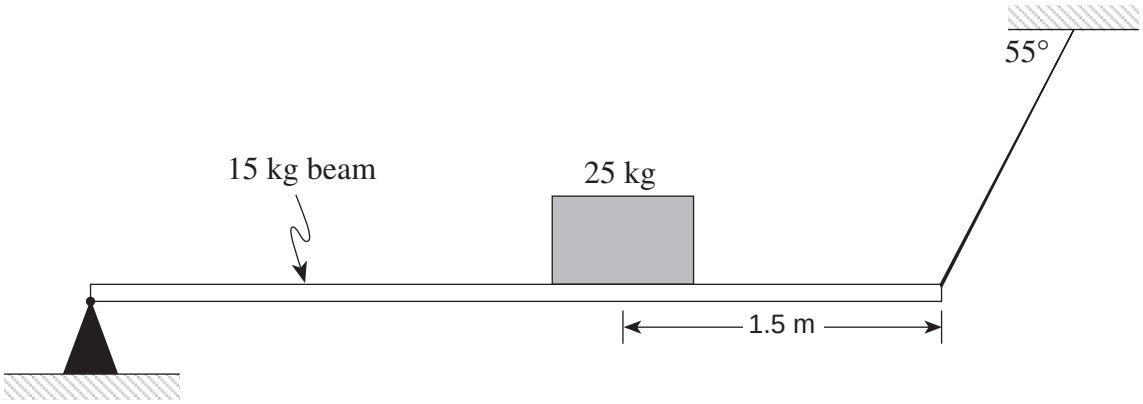
b) 150 J of heat energy is produced through friction during the 10 m pull. What is the final speed of the crate at $d = 10$ m?
(4 marks)

$W = \Delta E_p + \Delta E_k + \Delta E_H$ ← **1 mark**

$575 = 10(9.8)4.0 + \frac{1}{2}10v_f^2 + 150$ ← **2 marks**

$v_f = 2.6$ m/s ← **1 mark**

3. A uniform 4.0 m long beam with a mass of 15 kg rests on a pivot at one end and is kept horizontal by a cable at the other end. The beam is supporting a 25 kg mass as shown. What is the tension in the cable? **(7 marks)**



$$\Sigma\tau_{cw} = \Sigma\tau_{ccw} \quad \leftarrow \textbf{1 mark}$$

1 mark **1 mark** **1 mark**

$$F_b \cdot d_b + F_m \cdot d_m = F_c \cdot d_c \cdot \sin\theta_c$$

$$F_c = \frac{F_b d_b + F_m d_m}{d_c \cdot \sin\theta_c}$$

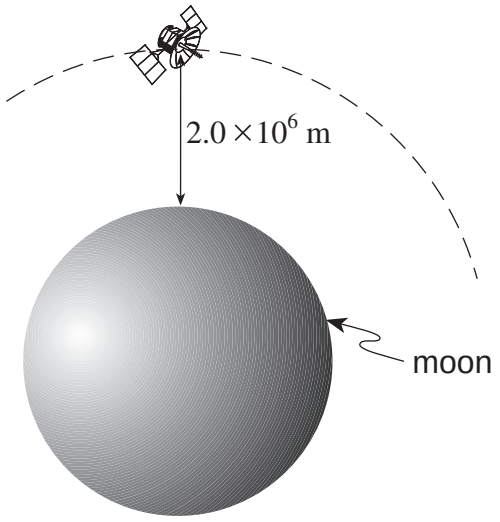
$$= \frac{15 \cdot 9.8 \cdot 2.0 + 25 \cdot 9.8 \cdot 2.5}{4.0 \cdot \sin 55} \quad \leftarrow \textbf{2 marks}$$

$$= \frac{294 + 612.5}{3.28}$$

$$= 277 \text{ N}$$

$$= 2.8 \times 10^2 \text{ N} \quad \leftarrow \textbf{1 mark}$$

4. A stationary 1.60×10^{3} kg vehicle is taken from the surface of the moon and placed into a circular orbit at a height of 2.0×10^{6} m above the surface of the moon. Its speed in this orbit is 1.15×10^{3} m/s. How much work is required for this process? **(7 marks)**



$$E_{p\ surface} + W = E_{p\ altitude} + E_{k\ orbital} \qquad \leftarrow \textbf{1 mark}$$

$$-\frac{GmM}{R_1} + W = -\frac{GmM}{R_2} + \frac{1}{2}mv^2 \qquad \leftarrow \textbf{2 marks}$$

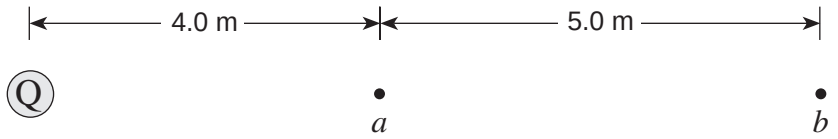
$$\left[\frac{-6.67\times10^{-11}\left(1.60\times10^{3}\right)\left(7.35\times10^{22}\right)}{1.74\times10^{6}}\right] + W = \left[\frac{-6.67\times10^{-11}\left(1.60\times10^{3}\right)\left(7.35\times10^{22}\right)}{3.74\times10^{6}} + \frac{1}{2}\left(1.60\times10^{3}\right)\left(1.15\times10^{3}\right)^{2}\right]$$

$$\left[-4.51\times10^{9}\right] + W = \left[-2.10\times10^{9}\right] + \left[1.06\times10^{9}\right] \qquad \leftarrow \textbf{3 marks}$$

$$-4.51\times10^{9} + W = \left[-1.04\times10^{9}\right]$$

$$W = 3.5\times10^{9}\ \text{J} \qquad \leftarrow \textbf{1 mark}$$

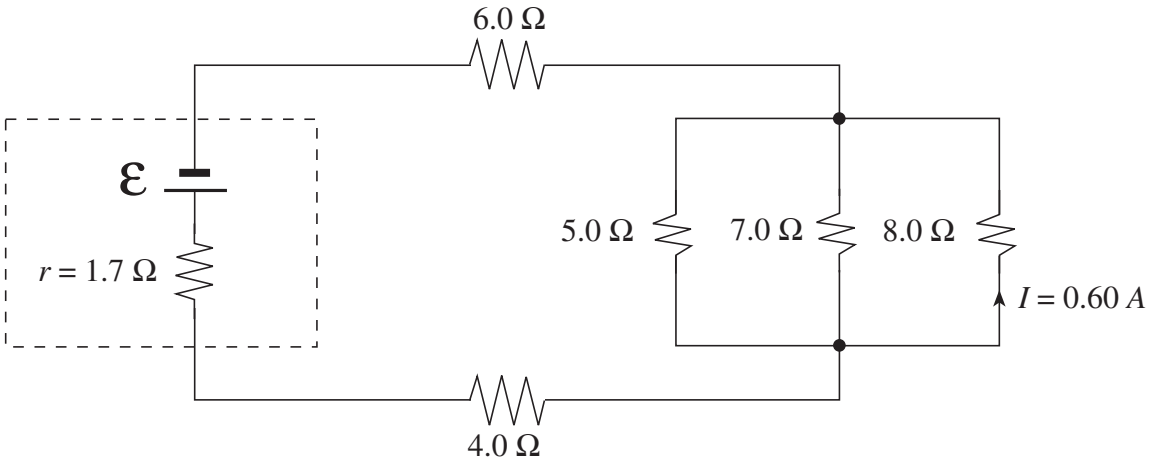
5. The potential difference in moving from position *a* to position *b* $\left(\Delta V_{a->b}\right)$ in the diagram below is equal to $+400$ V. Determine the size and polarity of the charge Q. **(7 marks)**



$$\left.\begin{aligned} \Delta V_{a\to b} &= \frac{kQ}{r_b} - \frac{kQ}{r_a} \\ 400 &= \frac{9.0\times10^9 Q}{9} - \frac{9.0\times10^9 Q}{4} \end{aligned}\right\} \leftarrow \textbf{5 marks}$$

$$Q = -3.2\times10^{-7} C \qquad \leftarrow \textbf{2 marks}$$

6. The current through the $8.0\ \Omega$ resistor shown below is $0.60\ A$. Determine the terminal voltage of the battery. **(7 marks)**



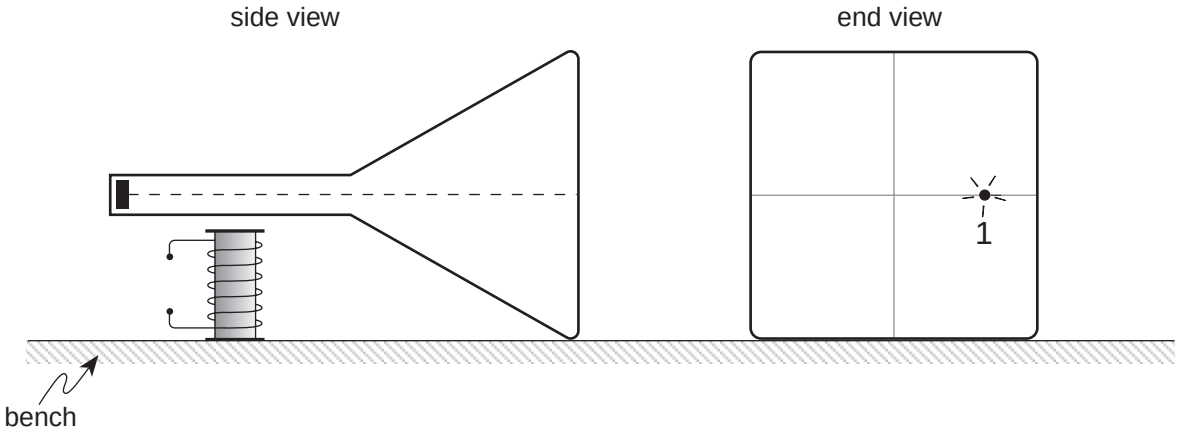
$$V_{8.0\Omega} = 0.60 \cdot 8.0 = 4.8 \text{ V} \quad \leftarrow \textbf{1 mark}$$

$$I_{circuit} = 4.8 \Big/ \left[1 \Big/ \left(8.0^{-1} + 7.0^{-1} + 5.0^{-1}\right)\right] = 2.245\ A \quad \leftarrow \textbf{3 marks}$$

$$Terminal\ voltage = 2.245\left[6.0 + 4.0 + 1 \Big/ \left(8.0^{-1} + 7.0^{-1} + 5.0^{-1}\right)\right] \quad \leftarrow \textbf{2 marks}$$

$$Terminal\ voltage = 27 \text{ V} \quad \leftarrow \textbf{1 mark}$$

7. A solenoid placed beneath a cathode ray tube as shown below produces a magnetic field of 0.011 *T* on the electron beam causing it to hit the screen at position 1.



a) The electrons that make up the beam travel at 4.7×10^{7} m/s. What is the acceleration of the electrons in this field? **(5 marks)**

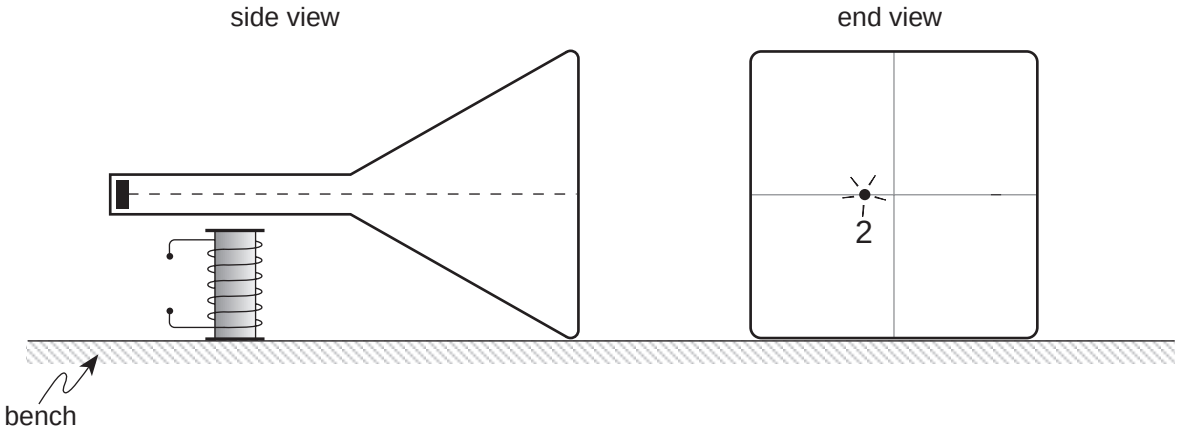
$$a = \frac{F}{m} \qquad \leftarrow \textbf{1 mark}$$

$$= \frac{qvB}{m} \qquad \leftarrow \textbf{2 marks}$$

$$= \frac{1.6\times10^{-19}\times4.7\times10^{7}\times0.011}{9.11\times10^{-31}} \qquad \leftarrow \textbf{1 mark}$$

$$= 9.1\times10^{16}\ \text{m/s}^2 \qquad \leftarrow \textbf{1 mark}$$

b) The electron beam is then made to strike the screen at position 2. What two changes were made to the current in the solenoid? State the effect on the electron beam produced by each change. **(4 marks)**

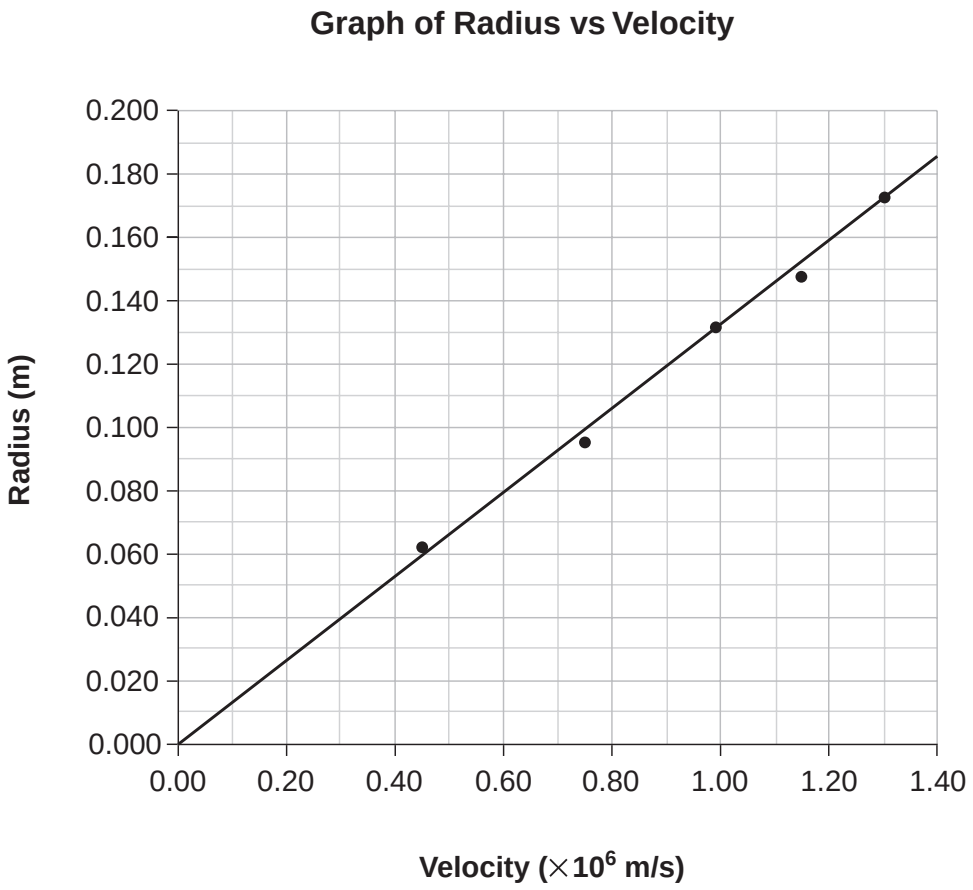


Change in Current	Effect
i) Reduce current	**Smaller deflection**
ii) Change direction of current	**Change direction of deflection**

8. In an experiment, protons are accelerated to different velocities and then subjected to a constant perpendicular magnetic field. The radii of the paths of the protons are measured against their velocities. The data is shown below.

RADIUS (m)	0.061	0.095	0.132	0.149	0.174
VELOCITY $\left(\times 10^6 \text{ m/s}\right)$	0.44	0.76	0.98	1.16	1.31

a) Plot the data on the graph below and draw the best fit straight line. **(2 marks)**



← **2 marks** for graph

b) Determine the slope of the line. (Include units.) **(2 marks)**

$$\text{slope} = m = \frac{\Delta R}{\Delta V} = \frac{0.187}{1.40 \times 10^{6}}$$

$m = 1.33 \times 10^{-7}\,\text{s}$ ← **2 marks**

c) Electrons replace the protons in the above experiment. The slope of the line will now be: **(1 mark)**

- ☐ larger than before
- ☐ same as before
- ☑ smaller than before

9. An object is dropped from a significant height above the surface of the Moon. It is observed to fall with increasing acceleration. Using principles of physics, give an explanation for this observation. **(4 marks)**

As the height decreases the force increases (3 marks).
As the force increases the acceleration increases (1 mark).

END OF KEY