Physics 12

June 2003 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

	Organizers	**Sub-Organizers**
1.	Vector Kinematics in Two Dimensions *and* Dynamics *and* Vector Dynamics	A, B / C, D
2.	Work, Energy and Power *and* Momentum	E / F, G
3.	Equilibrium	H
4.	Circular Motion *and* Gravitation	I / 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
1.	B	K	2	1	B5
2.	B	U	2	1	B8
3.	C	U	2	1	A9
4.	C	K	2	1	C1
5.	B	U	2	1	C4; D3
6.	D	K	2	2	E9
7.	D	U	2	2	E10
8.	C	U	2	2	E2; D1
9.	C	U	2	2	E2, 7
10.	C	U	2	2	G1, 3
11.	A	K	2	3	H4
12.	C	U	2	3	H2, 3
13.	A	U	2	3	H11
14.	B	U	2	4	I1, 3; A1
15.	C	U	2	4	I4
16.	D	K	2	4	J3
17.	C	U	2	4	J2
18.	D	K	2	5	K6
19.	A	U	2	5	L8
20.	C	H	2	5	L4, 6
21.	A	K	2	6	M4; A10
22.	D	U	2	6	N2; M7
23.	D	H	2	6	M5, 7
24.	B	K	2	7	O3
25.	B	U	2	7	O2
26.	A	U	2	7	O4
27.	A	U	2	7	O6
28.	C	U	2	7	P1; O4
29.	B	U	2	7	P5
30.	B	H	2	7	P5; M2

Multiple Choice = 60 marks

PART B: Written Response

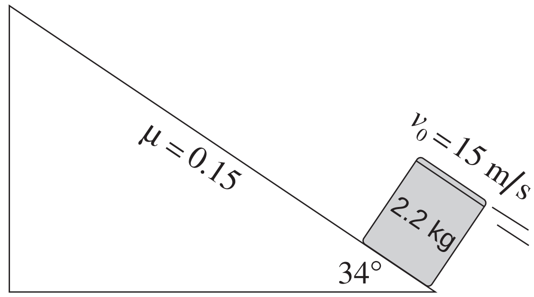
Q	B	C	S	CO	PLO
1.	1	U	7	1	D6
2.	2	U	7	2	G3; E7
3.	3	U	7	3	H3
4.	4	H	9	4	J2, 8
5.	5	U	7	5	K8; L3
6.	6	U	7	6	M11; N2
7.	7	U	7	7	P5
8	8	H	5	1, 2	A10; E3
9.	9	H	4	4	I5

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 2.2 kg can of paint is projected up an inclined plane with an initial velocity of 15 m/s as shown below.



a) Determine the magnitude of the force due to friction which acts on the paint can as it slides up the incline. **(2 marks)**

$F_{fr} = 0.15(2.2) \cdot 9.8 \cdot \cos 34°$ $\leftarrow$ **1 mark**

$F_{fr} = 2.68$ N $\leftarrow$ **1 mark**

$\cong 2.7$ N

b) Determine the magnitude of the net force on the paint can as it slides up the incline. **(3 marks)**

$F_{net} = F_{g_{||}} + F_{fr}$

$F_{net} = 2.2(9.8) \cdot \sin 34° + 2.68$ $\leftarrow$ **2 marks**

$F_{net} = 14.7$ N $\leftarrow$ **1 mark**

$\cong 15$ N

c) Determine how far the paint can slides up the incline before stopping. **(2 marks)**

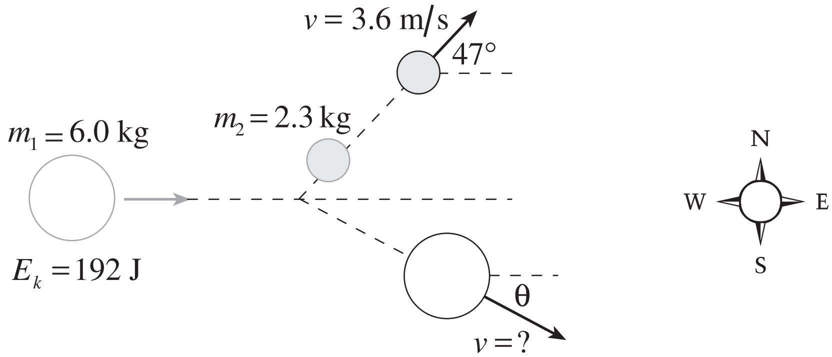
$v^2 = {v_0}^2 + 2ad$

$0^2 = 15^2 + 2\left(\frac{-14.7}{2.2}\right) \cdot d$ $\leftarrow$ **1 mark**

$d = 16.8$ m $\leftarrow$ **1 mark**

$\cong 17$ m

2. A 6.0 kg ball having a kinetic energy of 192 J was travelling due east when it underwent an oblique collision with a stationary 2.3 kg ball. The 2.3 kg ball travelled at 3.6 m/s at an angle of 47° north of east after the collision.



(Diagram not to scale.)

What was the velocity (magnitude and direction) of the 6.0 kg ball after the collision? **(7 marks)**

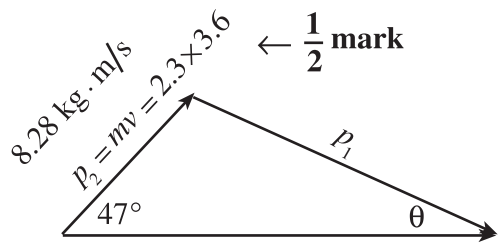
OR

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

$$192\text{ J} = \frac{1}{2}\times 6.0 \times v^2$$

$$\sqrt{\frac{2\times192}{6.0}} = v$$

$$8.0\text{ m s} = v \qquad \leftarrow \textbf{2 marks}$$



$\leftarrow \frac{1}{2}$ **mark**

$$p_b = mv$$
$$= 6.0\times 8.0$$
$$= 48\text{ kg}\cdot\text{m/s} \qquad \leftarrow \tfrac{1}{2}\textbf{ mark}$$

$$p_1^{\,2} = p_b^{\,2} + p_2^{\,2} - 2\times p_b \times p_2 \times \cos\theta$$

$$p_1 = \sqrt{48^2 + 8.28^2 - 2\times 48\times 8.28\times\cos 47^\circ} \qquad \leftarrow \textbf{1 mark}$$

$$p_1 = 42.8\text{ kg}\cdot\text{m/s} \qquad \leftarrow \textbf{1 mark}$$

$$v_1^{\,1} = \frac{p_1}{m}$$
$$= \frac{42.8}{6.0}$$
$$= 7.1\text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

$$\frac{\sin\theta}{8.28} = \frac{\sin 47^\circ}{42.8}$$

$$\theta = 8.1 \qquad \leftarrow \textbf{1 mark}$$

$$\therefore v = 7.1\text{ m/s at } 8.1^\circ\text{ S of E}$$

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

$$192\text{ J} = \frac{1}{2}\times 6.0 \times v^2$$

$$\sqrt{\frac{2\times192}{6.0}} = v$$

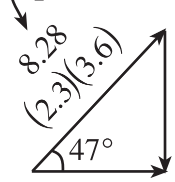
$$8.0\text{ m s} = v \qquad \leftarrow \textbf{2 marks}$$

Momentum is conserved $\leftarrow$ **1 mark**

$$P_x(\text{initial}) = (6)(8) = 48$$

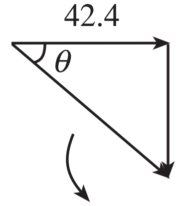
$$P_x(\text{final}) = 48 \qquad \leftarrow \tfrac{1}{2}\textbf{ mark}$$

$\frac{1}{2}$ **mark**



$$8.28\sin 47^\circ = 6.06$$

$$8.28\cos 47^\circ = 5.65$$



$$\sqrt{(42.4)^2 + (6.06)^2} = 42.8 \qquad \leftarrow \textbf{1 mark}$$

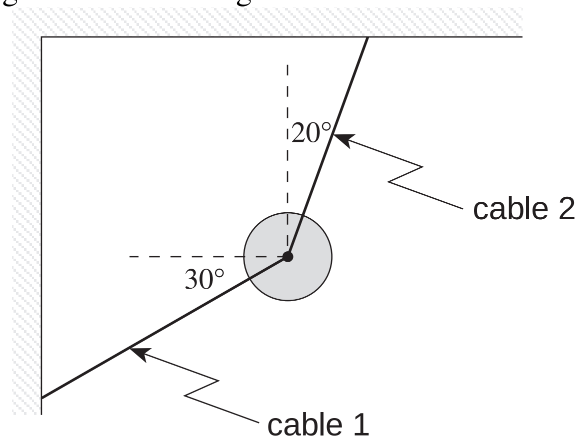
$$42.8 = 6\,v$$

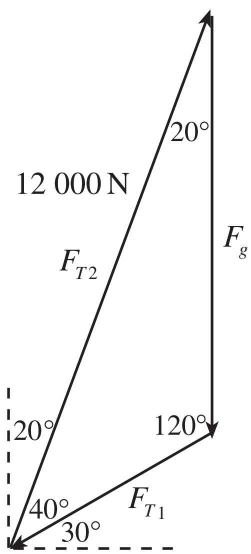
$$v = 7.1\text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

$$\tan\theta = \frac{6.06}{42.4}$$

$$\underbrace{\theta = 8.14^\circ\ \text{ S of E}}_{\uparrow\ \textbf{1 mark}}$$

3. A wrecking ball is suspended by two cables as shown below. If the tension in cable 2 is 12 000 N, what is the weight of the wrecking ball? **(7 marks)**





← **4 marks** for diagram

$$\frac{12\ 000\ \text{N}}{\sin 120°} = \frac{F_g}{\sin 40°}$$ ← **2 marks**

$$F_g = 8\ 900\ \text{N}$$ ← **1 mark**

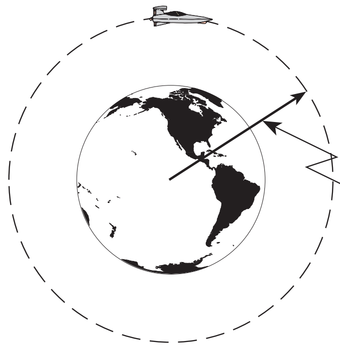
OR

$$\left.\begin{aligned} \varepsilon F_x &= 0 \\ T_{2x} &= 12\ 000 \sin 20° \\ T_{2x} &= 4\ 100 \\ T_{1x} &= T_{2x} = 4\ 100 \\ T_{1y} &= 4\ 100 \tan 30° \\ T_{1y} &= 2\ 370 \end{aligned}\right\}$$ ← **3 ½ marks**

$$\varepsilon F_y = 0$$

$$\left.\begin{aligned} T_{2y} &= 12\ 000 \cos 20° \\ T_{2y} &= 11\ 300 \\ T_{1y} + F_g &= T_{2y} \\ F_g &= 11\ 300 - 2\ 370 \\ F_g &= 8\ 900\ \text{N} \end{aligned}\right\}$$ ← **3 ½ marks**

4. A 3.2×10^4 kg spacecraft is in a circular orbit of radius 6.68×10^6 m around the earth.



a) Calculate the period of this spacecraft. **(5 marks)**

$$F_c = F_g \qquad \leftarrow \textbf{1 mark}$$

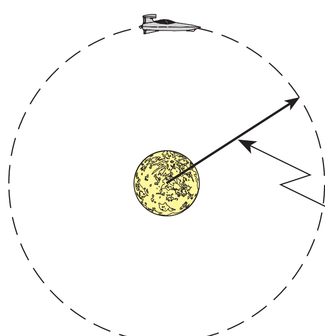
$$\frac{m4\pi^2R}{T^2} = \frac{GMm}{R^2} \qquad \leftarrow \textbf{2 marks}$$

$$T = \sqrt{\frac{4\pi^2R^3}{GM}}$$

$$= \sqrt{\frac{4\times\pi^2\times\left(6.68\times10^6\right)^3}{6.67\times10^{-11}\times5.98\times10^{24}}} \qquad \leftarrow \textbf{1 mark}$$

$$T = 5430\text{ s} \quad \cong 5400\text{ s} \qquad \leftarrow \textbf{1 mark}$$

b) If this spacecraft is then placed into an orbit of the same radius around the moon,

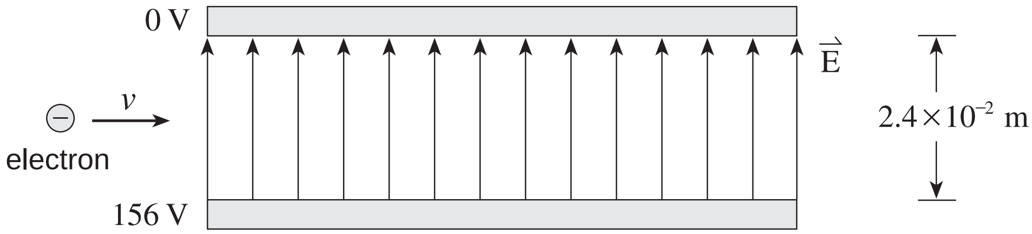


explain how and why the period of this spacecraft would be different than when it was orbiting the earth. **(4 marks)**

The moon has a smaller mass than that of the earth. This will produce longer periods around the moon when a satellite is placed at an equal orbital radius. $\left(T \propto \frac{1}{\sqrt{M}}\right)$ **(4 marks)**

OR The gravitational field strength is smaller which means that the centripetal acceleration is smaller. Therefore the spacecraft has to travel slower and therefore has a longer period. (4 marks)

5. Electrons with a speed of 3.3×10^{7} m/s are directed between charged parallel plates as shown.



a) What are the magnitude and direction of the electrostatic force on the electron while it is between the plates? **(5 marks)**

$F = qE$ ← **1 mark**

$= q\left(\frac{V}{d}\right)$ ← **1 mark**

$= \left(1.6\times10^{-19}\ \text{C}\right)\left(\frac{156\ \text{V}}{2.4\times10^{-2}\ \text{m}}\right)$ ← **1 mark**

$F = 1.04\times10^{-15}$ N ← **1 mark**

downward ← **1 mark**

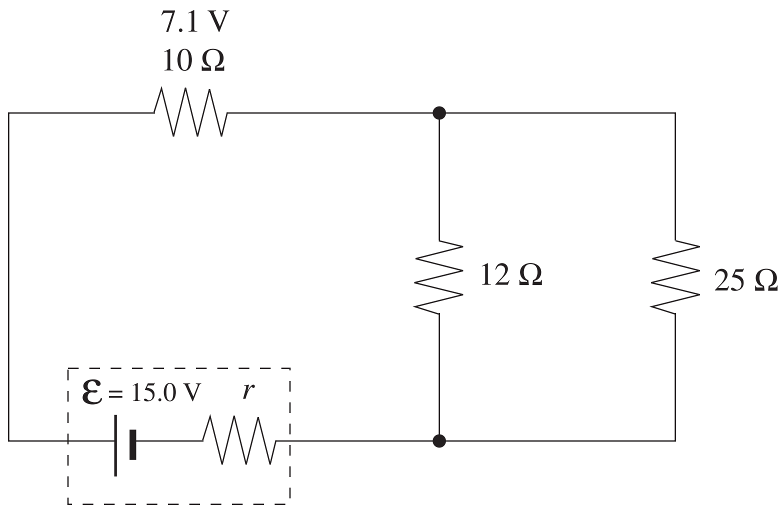
b) What is the magnitude of the acceleration of the electron while it is between the plates? **(2 marks)**

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

$$= \frac{1.04\times10^{-15}\ \text{N}}{9.11\times10^{-31}\ \text{kg}}$$

$a = 1.1\times10^{15}$ m/s^2 ← **2 marks**

6. The potential difference across the $10\,\Omega$ resistor is 7.1 V.



a) What is the power dissipated by the $25\,\Omega$ resistor? **(4 marks)**

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

$$= \frac{7.1}{10}$$

$$I = 0.71 \text{ A} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$\frac{1}{R_{||}} = \frac{1}{12} + \frac{1}{25}$$

$$R_{||} = 8.1\,\Omega \qquad \leftarrow \textbf{1 mark}$$

$$V_{||} = IR_{||}$$

$$= 0.71(8.1)$$

$$V_{||} = 5.76 \text{ V} \qquad \leftarrow \textbf{1 mark}$$

$$P_{25} = \frac{V^2}{R} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

$$= \frac{5.76^2}{25}$$

$$P_{25} = 1.3 \text{ W} \qquad \leftarrow \textbf{1 mark}$$

b) What is the internal resistance of the battery? **(3 marks)**

$$V_t = IR_{external}$$

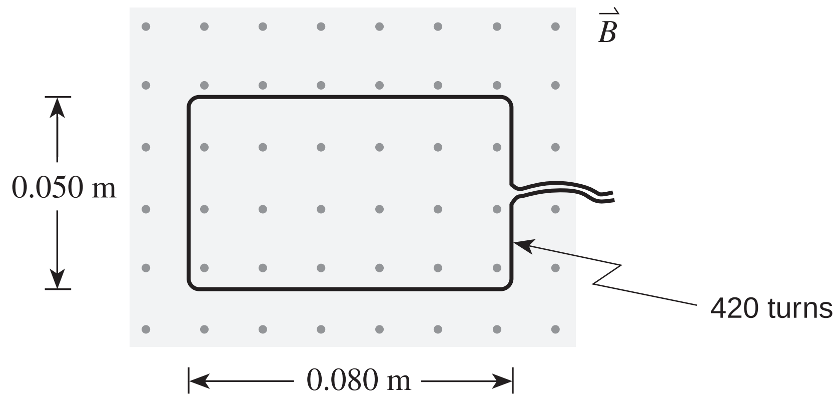
$$= 0.71(18.1) = 12.9 \text{ V} \quad \leftarrow \textbf{1 mark}$$

$$\text{V} = \mathcal{E} - I(r) \quad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$12.9 = 15.0 - 0.71r \quad \leftarrow \tfrac{1}{2} \textbf{ mark}$$

$$r = 3.0\ \Omega \quad \leftarrow \textbf{1 mark}$$

7. A 420-turn rectangular coil is positioned as shown in a 0.14 T magnetic field.



The magnetic field strength is increased over a 0.20 s interval, inducing an average emf of 1.8 V in the coil. What is the final magnetic field strength? **(7 marks)**

$$\mathcal{E} = \frac{-N\Delta\Phi}{\Delta t} \qquad \leftarrow \textbf{1 mark}$$

$$\Delta\Phi = \frac{\mathcal{E}\cdot\Delta t}{N}$$

$$\Delta B\cdot A = \frac{\mathcal{E}\cdot\Delta t}{N} \qquad \leftarrow \textbf{1 mark}$$

$$\Delta B = \frac{\mathcal{E}\cdot\Delta t}{N\cdot A} \qquad \leftarrow \textbf{1 mark}$$

$$= \frac{(1.8\cdot 0.20)}{420\cdot(0.050\cdot 0.080)} \qquad \leftarrow \textbf{2 marks}$$

$$= 0.21\ \text{T}$$

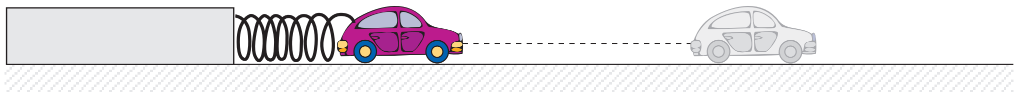
$$\therefore B_f - B_i = 0.21$$

$$\therefore B_f = 0.21 + B_i$$

$$= 0.21 + 0.14$$

$$= 0.35\ \text{T} \qquad \leftarrow \textbf{2 marks}$$

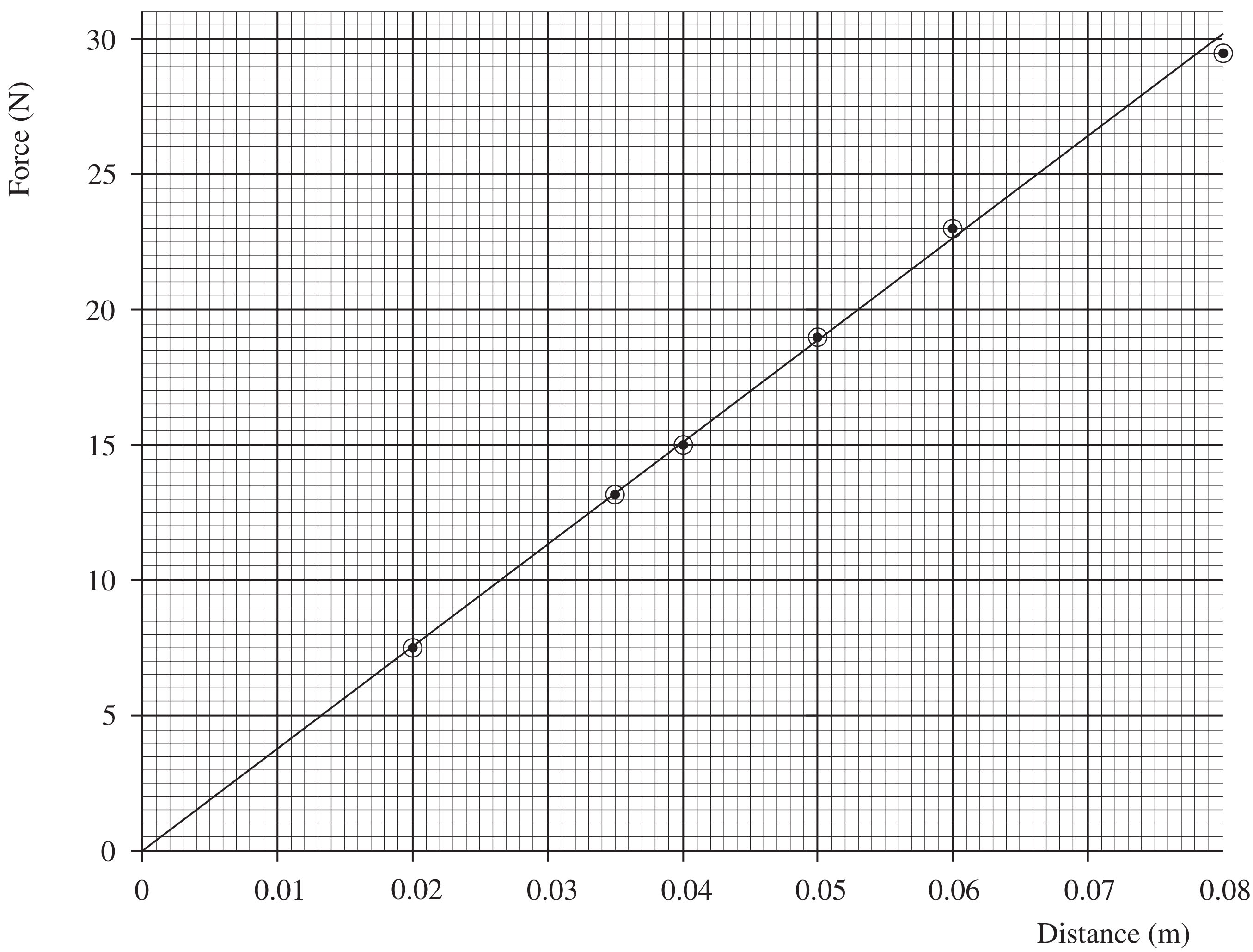
8. A small toy car is placed in a spring-loaded launcher.



The force needed to compress the spring is recorded as a function of distance.

a) Plot a graph of force vs. distance using the data table shown. **(2 marks)**

Force (N)	Distance (m)
7.5	0.020
13.2	0.035
14.8	0.040
19.1	0.050
23.0	0.060
29.5	0.080



b) Calculate the area under this graph from distance $= 0.0$ m to distance $= 0.080$ m. **(2 marks)**

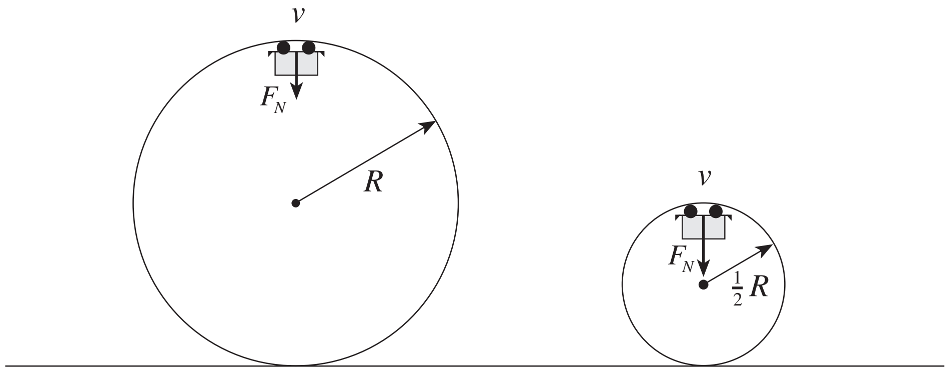
$$Area \approx \frac{1}{2} \cdot 0.080 \cdot 30.0$$

≈ 1.2 J $\leftarrow$ **2 marks**

c) What does this area represent? **(1 mark)**

Work done on the spring, energy stored in spring $\leftarrow$ 1 mark

9. During a roller coaster ride, the riders move through two loops, the second being one-half the radius of the first. The riders, however, travel at the same speed at the top of each of these two loops.



Using principles of physics, explain why the riders would experience a greater normal force at the top of the second smaller loop than at the top of the first larger loop. **(4 marks)**

The centripetal force is the sum of the normal force and the force of gravity on the riders (1 mark). Since the radius decreases while the velocity does not change in the smaller loop the centripetal force must increase $\left(F_c \propto \frac{1}{R}\right)$ **(2 marks). The normal force must increase to provide a greater centripetal force as force of gravity remains constant (1 mark).**

END OF KEY