Physics 12

August 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**	**Q**	**K**	**C**	**S**	**CO**	**PLO**
1.	A	K	2	1	A8	16.	A	K	2	4	J1; C2
2.	A	U	2	1	A7	17.	B	U	2	4	J2
3.	B	U	2	1	B8	18.	C	H	2	4	J9, 8
4.	D	K	2	1	C8	19.	C	K	2	5	L1; A10
5.	A	U	2	2	E7; C3	20.	C	U	2	5	L6
6.	D	K	2	2	F2	21.	D	U	2	5	L7
7.	B	U	2	2	F4	22.	A	U	2	6	M7; N2
8.	B	U	2	2	F7	23.	D	U	2	6	M11
9.	B	U	2	2	G3	24.	B	K	2	7	O3
10.	B	K	2	3	H1	25.	D	U	2	7	O4
11.	C	U	2	3	H8	26.	B	U	2	7	O6
12.	B	H	2	3	H11	27.	D	U	2	7	P11, 13
13.	D	K	2	4	I1	28.	B	U	2	7	O5
14.	B	U	2	4	I4	29.	C	U	2	7	O3; P6
15.	C	U	2	4	I4	30.	A	H	2	7	O6

Multiple Choice = 60 marks

PART B: Written Response

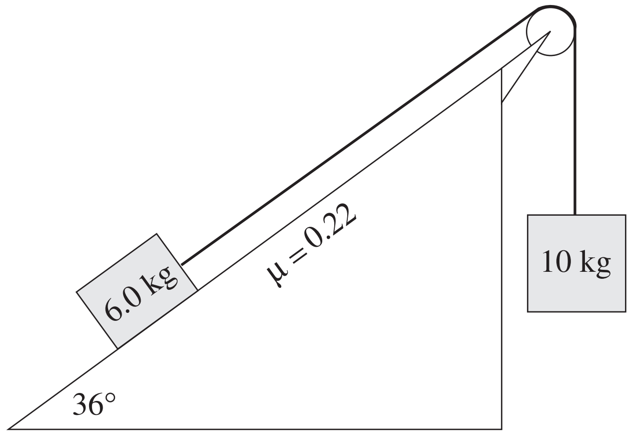
Q	B	C	S	CO	PLO
1.	1	U	7	1	C8; D3, 6
2.	2	U	7	2	E10
3.	3	U	7	3	H3
4.	4	U	7	4, 2	J8; I4
5.	5	U	7	5	L4
6.	6	H	9	6	M11, 7
7.	7	U	7	7, 6	P5; M5
8	8	H	5	1, 7	A10; P1
9.	9	H	4	1	C8; D1

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. Determine the acceleration of the system of masses shown below when it is released. **(7 marks)**



$F_{net} = 10(9.8) - 6.0(9.8)\sin 36° - 0.22(6.0)9.8\cos 36°$ ← **3 marks**

$F_{net} = 53.0\ \text{N}$ ← **1 mark**

$53.0 = (10 + 6.0)a$ ← **2 marks**

$a = 3.3\ \text{m/s}^2$ ← **1 mark**

2. A 3.7×10^3 W motor is 81% efficient. This motor is pulling a 450 kg block along a horizontal surface. If the coefficient of friction is 0.35, what is the speed of the block? **(7 marks)**

$$P = \frac{W}{t} = \frac{F \cdot d}{t}$$

$$P = F \cdot v \qquad \leftarrow \textbf{2 marks}$$

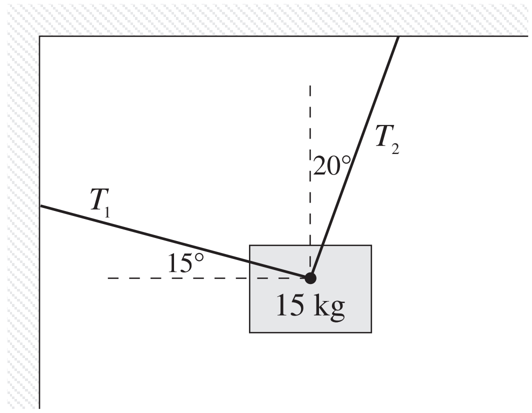
$$0.81P = F_f \cdot v \qquad \leftarrow \textbf{1 mark}$$

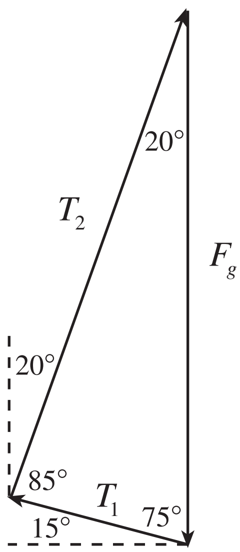
$$0.81\left(3.7\times10^3\right) = \mu F_N v \qquad \leftarrow \textbf{1 mark}$$

$$0.81\left(3.7\times10^3\right) = 0.35(450)9.8 \cdot v \qquad \leftarrow \textbf{2 marks}$$

$$v = 1.9 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

3. A 15 kg store sign is hung using two ropes as shown below. Determine the tension in each rope. **(7 marks)**





← **3 marks for the diagram**

$$\frac{T_1}{\sin 20^\circ} = \frac{147}{\sin 85^\circ} \quad \leftarrow \textbf{1 mark}$$

$$T_1 = 50.5\text{ N}$$

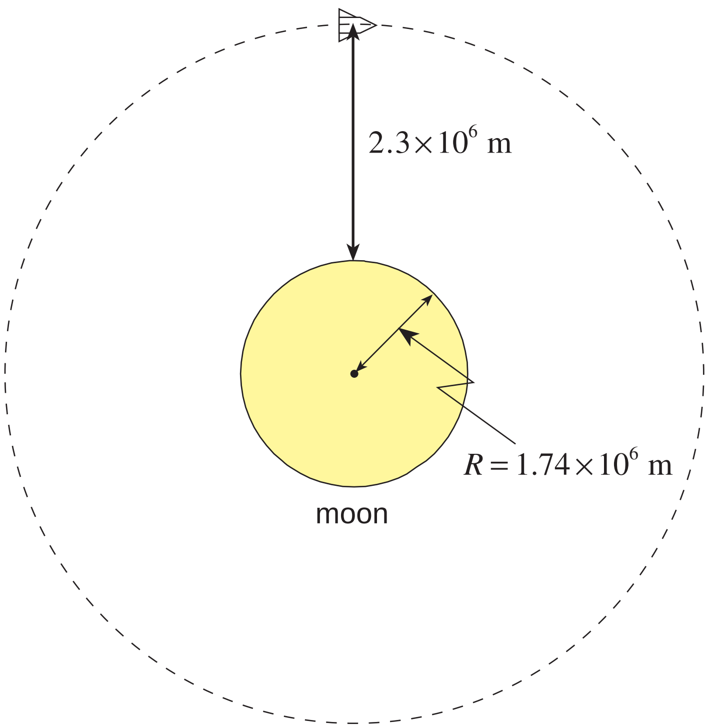
$$= 50\text{N} \quad \leftarrow \textbf{1 mark}$$

$$\frac{T_2}{\sin 75^\circ} = \frac{147}{\sin 85^\circ} \quad \leftarrow \textbf{1 mark}$$

$$T_2 = 143\text{ N}$$

$$= 140\text{N} \quad \leftarrow \textbf{1 mark}$$

4. A 1500 kg satellite orbits the moon at an altitude of 2.3×10^6 m.



What is the period for the satellite? **(7 marks)**

$$F_c = F_g$$ ← **2 marks**

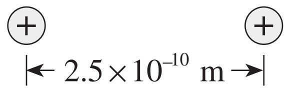
$$\frac{m4\pi^2 r}{T^2} = \frac{Gm_m m}{r^2}$$ ← **1 mark**

$$T = \sqrt{\frac{4\pi^2 r^3}{Gm_m}}$$ ← **1 mark**

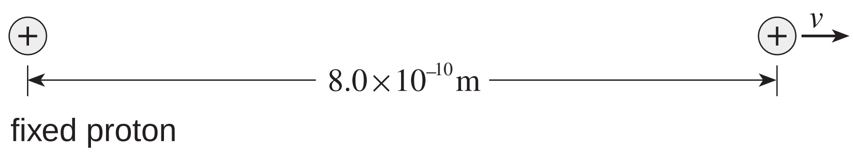
$$= \sqrt{\frac{4\pi^2 \times \left(4.0\times10^6\right)^3}{6.67\times10^{-11}\times7.35\times10^{22}}}$$ ← **2 marks**

$$= 23\,000 \text{ s}$$ ← **1 mark**

5. Two protons are initially held at rest 2.5×10^{-10} m apart.



If one of the protons is released as shown below, what is its speed when it is 8.0×10^{-10} m from the fixed proton? **(7 marks)**



$$E_{p_1} = E_{p_2} + E_k$$

$$E_{p_1} = \frac{kQ_1Q_2}{R_1}$$

$$= \frac{9.0\times10^{9}\left(1.6\times10^{-19}\right)^2}{2.5\times10^{-10}}$$

$$E_{p_1} = 9.2\times10^{-19}\ \text{J} \qquad \leftarrow \textbf{2 marks}$$

$$E_{p_2} = \frac{kQ_1Q_2}{R_2}$$

$$= \frac{9.0\times10^{9}\left(1.6\times10^{-19}\right)^2}{8.0\times10^{-10}}$$

$$E_{p_2} = 2.9\times10^{-19}\ \text{s} \qquad \leftarrow \textbf{2 marks}$$

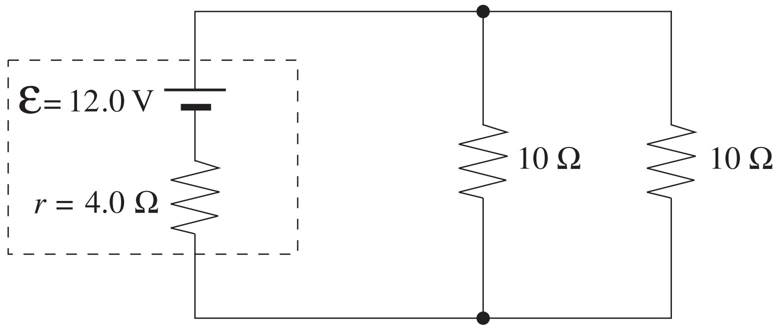
$$E_{p_1} = E_{p_2} + E_k$$

$$9.2\times10^{-19} = 2.9\times10^{-19} + \frac{1}{2}mv^2$$

$$6.3\times10^{-19} = \frac{1}{2}\left(1.67\times10^{-27}\right)v^2 \qquad \leftarrow \textbf{2 marks}$$

$$v = 2.7\times10^{4}\ \text{m/s} \qquad \leftarrow \textbf{1 mark}$$

6. a) For the circuit below, what is the terminal voltage of the battery? **(4 marks)**



$$R_{parallel} = 5.0\ \Omega$$

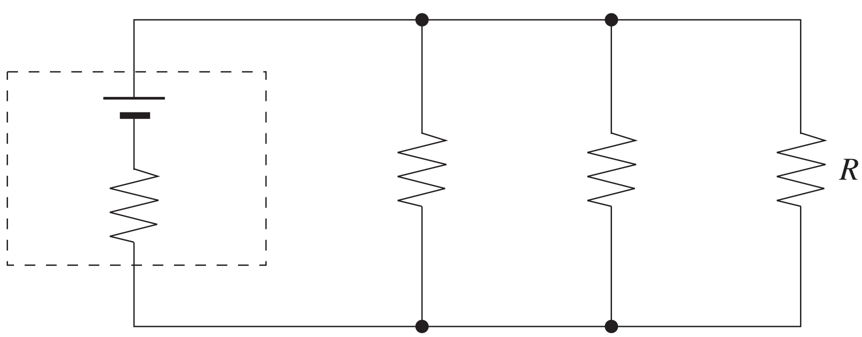
$$R_{total} = 9.0\ \Omega$$

$$I_{total} = \frac{V}{R} = \frac{12.0}{9.0} = 1.33\text{ A}$$

$$Ir\text{ drop} = 1.33(4.0) = 5.3\text{ V}$$

$$V_{terminal} = 12.0 - 5.3 = 6.7\text{ V}$$ ← **4 marks**

b) If resistor R is added in parallel to the circuit as shown, what is the effect on the terminal voltage? **(1 mark)**

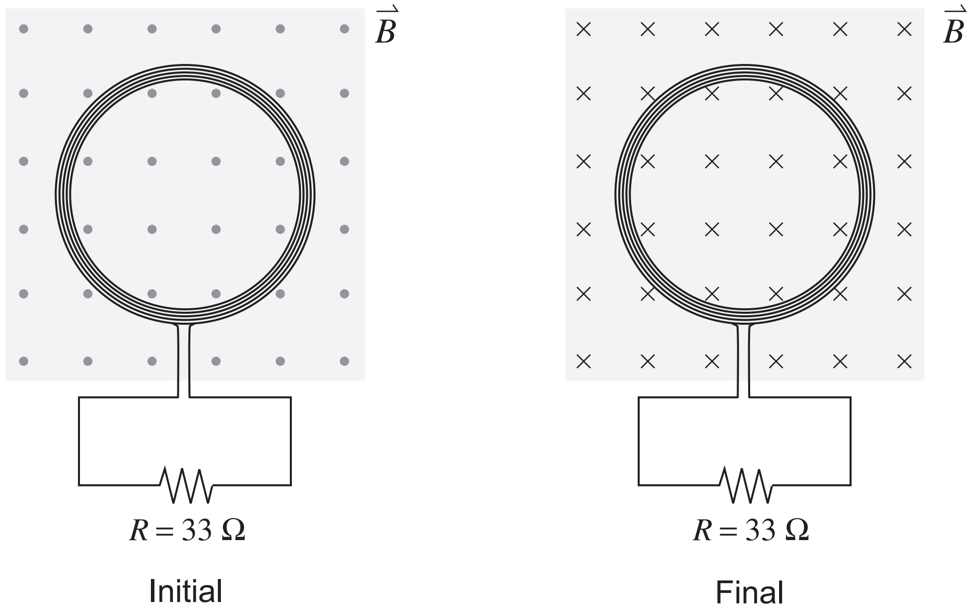


- ☐ increase
- ☐ no change
- ☑ decrease

c) Using principles of physics, explain your choice for b).	**(4 marks)**

Additional *R* in parallel results in an overall lower *R*, thus an increase in current. (2 marks) As a consequence, a greater voltage drop *Ir* occurs across the internal resistance resulting in a smaller terminal voltage. (2 marks)

7. A 0.120 m diameter coil consisting of 200 loops is placed in a 0.35 T magnetic field. The magnetic field is changed to 0.25 T in the opposite direction in 0.80 s.



What is the magnitude of the current through the $33\ \Omega$ resistor connected to the coil? (Ignore the resistance of the coil.) **(7 marks)**

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

$$= \frac{200 \cdot \left(0.25 - (-0.35)\right)\left(\pi \cdot 0.060^2\right)}{0.80} \qquad \leftarrow \textbf{2 marks}$$

$$= \frac{200 \cdot 0.60 \cdot 0.0113}{0.80} \qquad \leftarrow \textbf{1 mark}$$

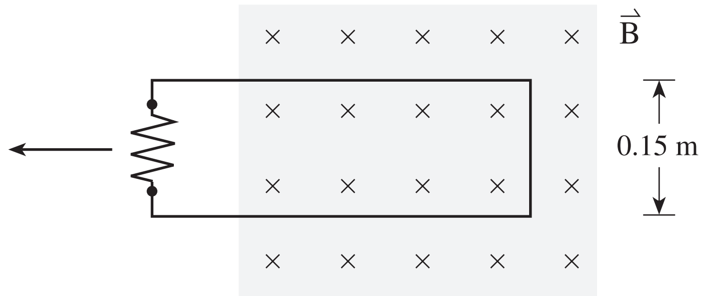
$$= 1.7\ \text{V} \qquad \leftarrow \textbf{1 mark}$$

$$\therefore \text{I} = \frac{\mathcal{E}}{R} \qquad \leftarrow \textbf{1 mark}$$

$$= \frac{1.7}{33}$$

$$= 0.051\ \text{A} \qquad \leftarrow \textbf{1 mark}$$

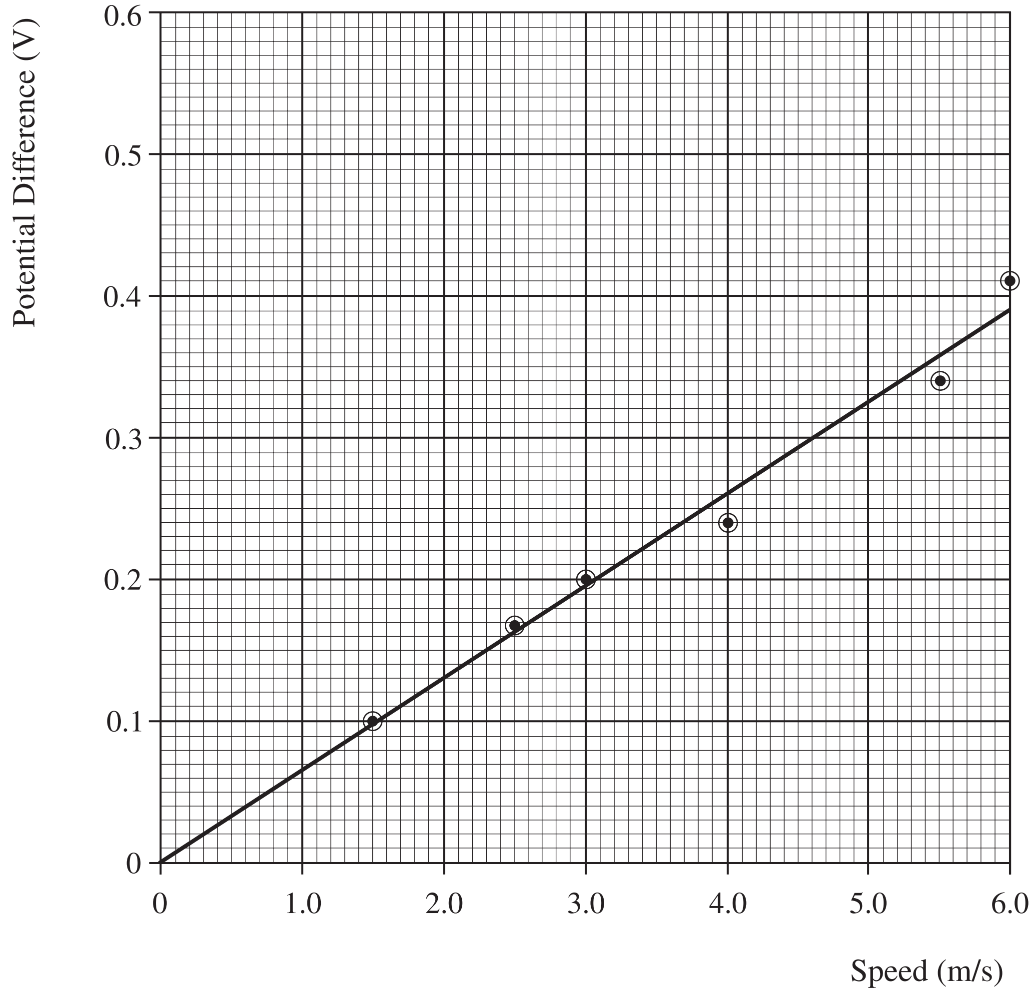
8. A conducting loop is pulled at various speeds through a region of constant magnetic field strength.



A student measures the potential difference across the resistor in the loop for each trial and records the following data.

POTENTIAL DIFFERENCE (V)	SPEED (m/s)
0.10	1.5
0.17	2.5
0.20	3.0
0.24	4.0
0.34	5.5
0.41	6.0

a) Plot a graph of the potential difference vs. speed. **(2 marks)**



b) Calculate the slope of your graph. (Include units.) **(1 mark)**

$$slope \approx 0.065\ \frac{\text{V}}{\text{m/s}} \cong 0.065\ \text{Vs/m}$$

c) What is the strength of the magnetic field?	**(2 marks)**

$$\varepsilon = B\ell v$$

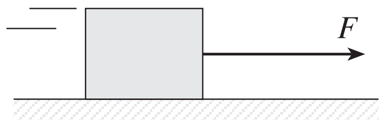
$$\therefore slope = B\ell$$

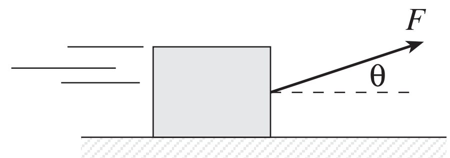
$$\therefore B = \frac{slope}{\ell}$$

$$= \frac{0.065}{0.15}$$

$$\cong 0.43\text{ T}$$

9. A crate is being accelerated across a rough concrete floor by a rope as shown in position 1 below. It is noticed that when the rope is lifted to a small angle θ as shown in position 2 the acceleration of the crate increases (F remains the same).





Using principles of physics, explain why this is the case. **(4 marks)**

The pulling force in position 2 has a vertical component (1 mark) which balances a portion of F_g (1 mark), leaving F_N and therefore F_{fr} reduced (1 mark). The horizontal component of F is changed very little from 1 to 2 (1 mark).

END OF KEY