Physics 12

January 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	C1	16.	D	U	2	4	J9
2.	B	U	2	1	C4, 7	17.	A	U	2	4	J7
3.	D	U	2	1	D1, 3	18.	D	K	2	5	K6
4.	A	U	2	1	C8, C4	19.	A	U	2	5	K5
5.	C	U	2	1	D6; B2	20.	C	H	2	5	L6
6.	C	K	2	2	E1	21.	A	K	2	6	M4, 7
7.	B	U	2	2	E7; A10	22.	B	U	2	6	N2; M7
8.	B	U	2	2	E2, 7	23.	B	H	2	6	M5
9.	A	H	2	2	E7, 8, 2	24.	C	K	2	7	P2
10.	D	K	2	3	H4	25.	A	U	2	7	O4, 5
11.	B	U	2	3	H1	26.	C	U	2	7	O8
12.	D	K	2	4	I5, 1; B3	27.	D	U	2	7	O6
13.	D	U	2	4	I4	28.	C	U	2	7	P5
14.	C	U	2	4	I4	29.	B	U	2	7	P9
15.	A	K	2	4	J8	30.	A	U	2	7	P11

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	7	1	B2, 8
2.	2	H	9	2	F4, 7, 5
3.	3	U	7	3	H8, 10, 11
4.	4	U	7	4	J3, 7
5.	5	U	7	5	L4
6.	6	U	7	6	M11, 10
7.	7	U	7	7	O5; P1
8	8	H	5	1	A10; B2
9.	9	H	4	3	H2, 3

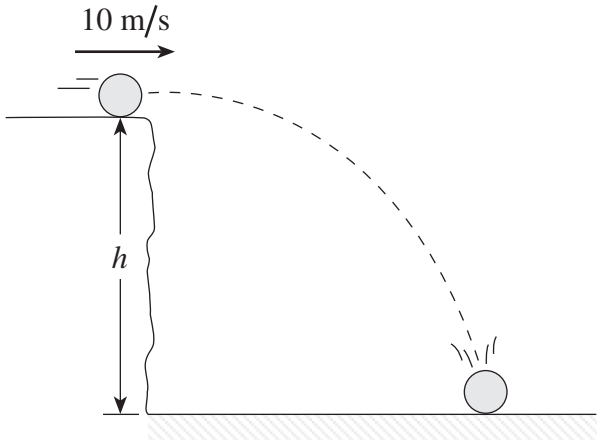
Written Response = 60 marks

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

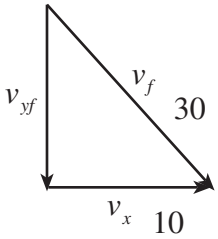
LEGEND:

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

1. A blue ball rolls off the cliff shown below at 10 m/s and hits the ground with a speed of 30 m/s.



a) What is the vertical component of the ball's impact velocity? **(4 marks)**



← **1 mark**

$v_{yf}^{\,2} = v_f^{\,2} - v_x^{\,2}$ ← **2 marks**

$v_{yf}^{\,2} = 30^2 - 10^2$

$v_{yf} = -28.3 \text{ m/s}$ ← **$\frac{1}{2}$ mark for magnitude, $\frac{1}{2}$ mark for direction**

b) How high (h) is the cliff? **(3 marks)**

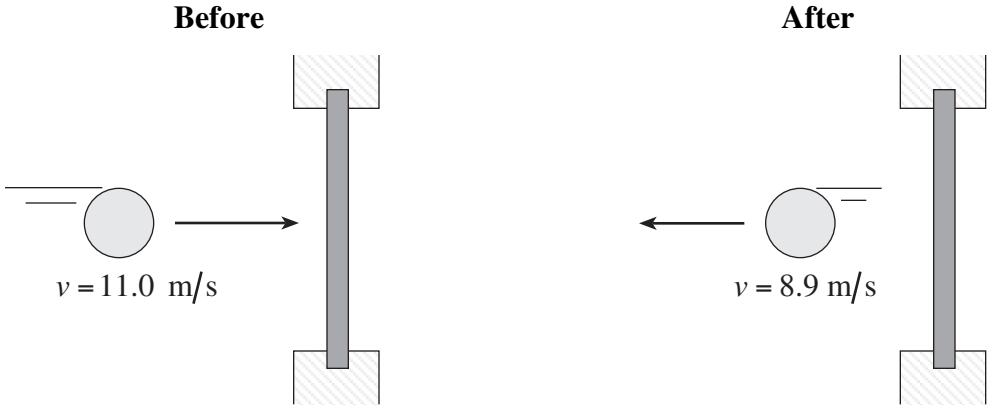
$v_{yf}^{\,2} = v_{yi}^{\,2} + 2(a_g)d_y$ ← **2 marks**

$-28.3^2 = 0^2 + 2(-9.8)d_y$

$d_y = -40.9 \text{ m}$ ← **1 mark**

$\therefore h = 41 \text{ m}$

2. a) A 0.120 kg ball travelling at 11.0 m/s impacts a solid massive steel wall. The ball bounces straight back at 8.9 m/s.



If the ball was in contact with the steel wall for 0.17 s, what is the magnitude of the force that the steel wall imparted on the ball? **(5 marks)**

Impulse = change in momentum ← **1 mark**

$F \times t = m_2 v_2 - m_1 v_1$ ← **2 marks**

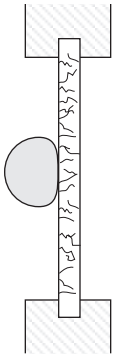
$$F = \frac{m_2 v_2 - m_1 v_1}{t}$$

$$F = \frac{0.120 \times (-8.9) - 0.120 \times (11.0)}{0.17}$$ ← **1 mark**

$$F = \frac{-2.388}{0.17}$$

$F = 14\ \text{N}$ ← **1 mark**

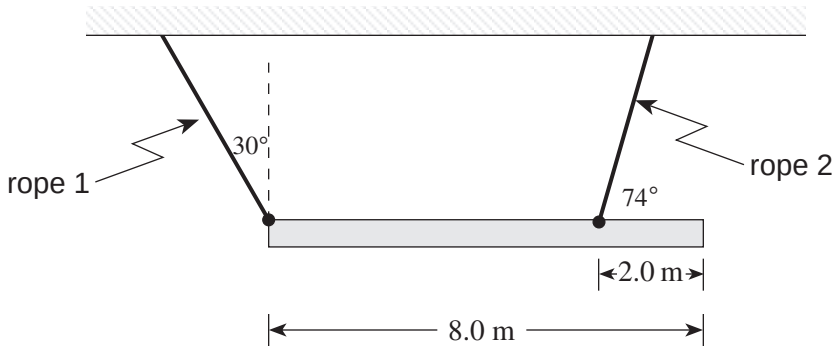
b) An identical ball with the same initial speed as in part a) is then thrown towards a glass window. The glass window cracks and the ball stops in 0.17 s.



Using principles of physics, explain which ball, from part a) or part b), experiences the greater force. **(4 marks)**

The force experienced is equal to the rate of change in momentum. $(\Delta p/\Delta t)$ **(1 mark)**
Since both collisions occur in the same time the greater force is experienced by the ball experiencing the greater change in momentum. (2 marks)
The ball in part a) experienced a larger change in momentum as it changed direction. (1 mark)

3. The 8.0 m uniform beam shown below, suspended horizontally by two ropes, has a mass of 75 kg.



Determine the tension in rope 1 and the tension in rope 2. **(7 marks)**

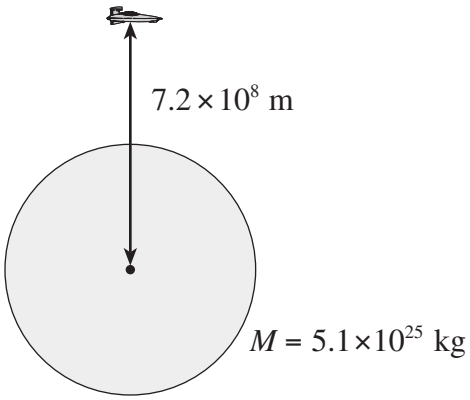
$$\Sigma\tau = 0 = -F_{T1}\cos 30°(6.0) + 75(9.8)(2.0)$$

$F_{T1} = 2.8 \times 10^2$ N ← **4 marks**

$$\Sigma F_y = 0 = -75(9.8) + 283\cos 30° + F_{T2}\sin 74°$$

$F_{T2} = 5.1 \times 10^2$ N ← **3 marks**

4. A 12 000 kg spaceship is 7.2×10^8 m from the centre of a planet that has a mass of 5.1×10^{25} kg.



The spaceship gains 9.0×10^{11} J of kinetic energy as it falls to the planet's surface. What is the radius of this planet? **(7 marks)**

$$E_{p_1} = E_{p_2} + E_k \qquad \leftarrow \textbf{1 mark}$$

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

$$-\frac{GMm}{R_2} = -\frac{GMm}{R_1} - E_k \qquad \leftarrow \textbf{1 mark}$$

$$\frac{-6.67 \times 10^{-11} \times 5.1 \times 10^{25} \times 12\,000}{R_2} = \frac{-6.67 \times 10^{-11} \times 5.1 \times 10^{25} \times 12\,000}{7.2 \times 10^8} - 9.0 \times 10^{11} \qquad \leftarrow \textbf{3 marks}$$

$$\frac{-4.082 \times 10^{19}}{R_2} = -5.6695 \times 10^{10} - 9.0 \times 10^{11}$$

$$\frac{-4.082 \times 10^{19}}{R_2} = -9.567 \times 10^{11} \qquad \leftarrow \textbf{1 mark}$$

$$\frac{-4.082 \times 10^{19}}{-9.567 \times 10^{11}} = R_2$$

$$4.3 \times 10^7 \text{ m} = R_2 \qquad \leftarrow \textbf{1 mark}$$

5. A proton, accelerated from rest through a potential difference of 1.2×10^4 V, is directed at a fixed 5.0×10^{-6} C charge.

(Diagram not to scale.)

a) What is the speed of the proton as it leaves the parallel plates? **(4 marks)**

$E_k = \Delta E_p$ ← **1 mark**

$\frac{1}{2}mv^2 = q\Delta V$ ← **1 mark**

$v^2 = \frac{2q\Delta V}{m}$

$v^2 = \frac{2\left(1.6 \times 10^{-19}\right)\left(12\,000\right)}{1.67 \times 10^{-27}}$ ← **1 mark**

$v = 1.5 \times 10^6$ m/s ← **1 mark**

b) What is the distance d from the fixed charge when the proton is stopped? **(3 marks)**

$\Delta E_p = \Delta E_p$ ← **1 mark**

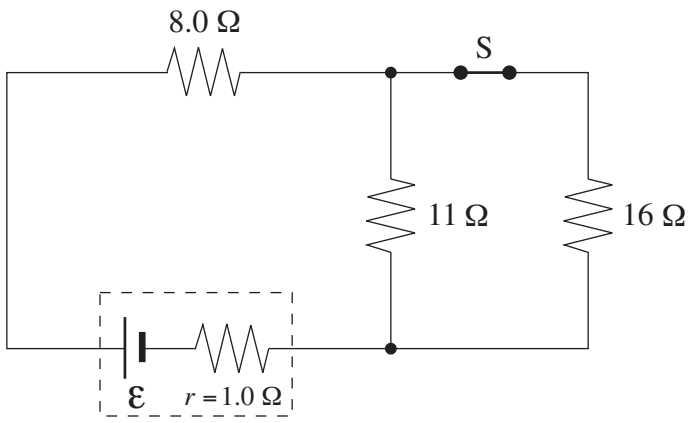
$q\Delta V = \frac{kqQ}{R}$ ← **1 mark**

$R = \frac{kQ}{\Delta V}$

$= \frac{\left(9.0 \times 10^9\right)\left(5.0 \times 10^{-6}\right)}{12\,000}$ ← **½ mark**

$R = 3.8$ m ← **½ mark**

6. The terminal voltage of the battery is 5.8 V.



a) What is the emf of this battery? **(6 marks)**

$$\frac{1}{R_{||}} = \frac{1}{11} + \frac{1}{16}$$

$R_{||} = 6.5\ \Omega$ ← **1 mark**

external $R_T = 6.5\ \Omega + 8.0\ \Omega$

external $R_T = 14.5\ \Omega$ ← **1 mark**

$$I_t = \frac{V_t}{R_t} \quad \text{← 1 mark}$$

$$= \frac{5.8}{14.5}$$

$I_t = 0.40$ A ← **1 mark**

$V = \mathcal{E} - Ir$ ← **1 mark**

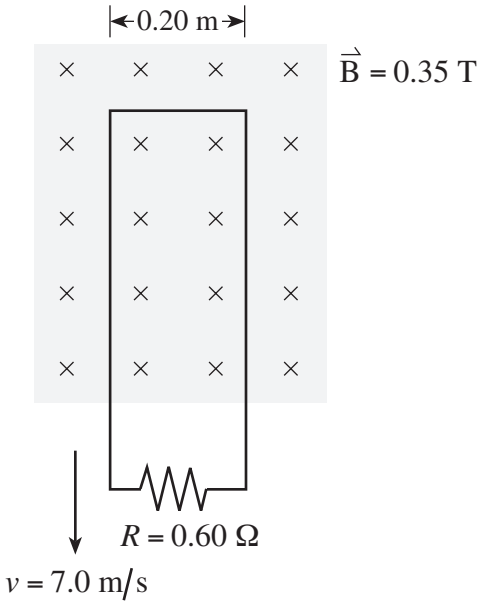
$5.8 = \mathcal{E} - 0.40(1.0)$ ← **½ mark**

$\mathcal{E} = 6.2$ V ← **½ mark**

b) What is the effect on the emf of the battery when switch S is opened? **(1 mark)**

no effect

7. A rectangular wire loop with a resistance of $0.60\ \Omega$ is pulled out of a magnetic field at $7.0\ \text{m/s}$ as shown in the diagram.



a) What is the current in the loop? **(5 marks)**

$\mathcal{E} = B\ell v$

$\mathcal{E} = 0.35 \times 0.20 \times 7$

$\mathcal{E} = 0.49\ \text{V}$

← **2 1/2 marks**

$I = \dfrac{\mathcal{E}}{R}$

$= \dfrac{0.49}{0.60} = 0.82\ \text{A}$ **(1 mark)**

← **2 1/2 marks**

b) What is the direction of the current in the loop? **(2 marks)**

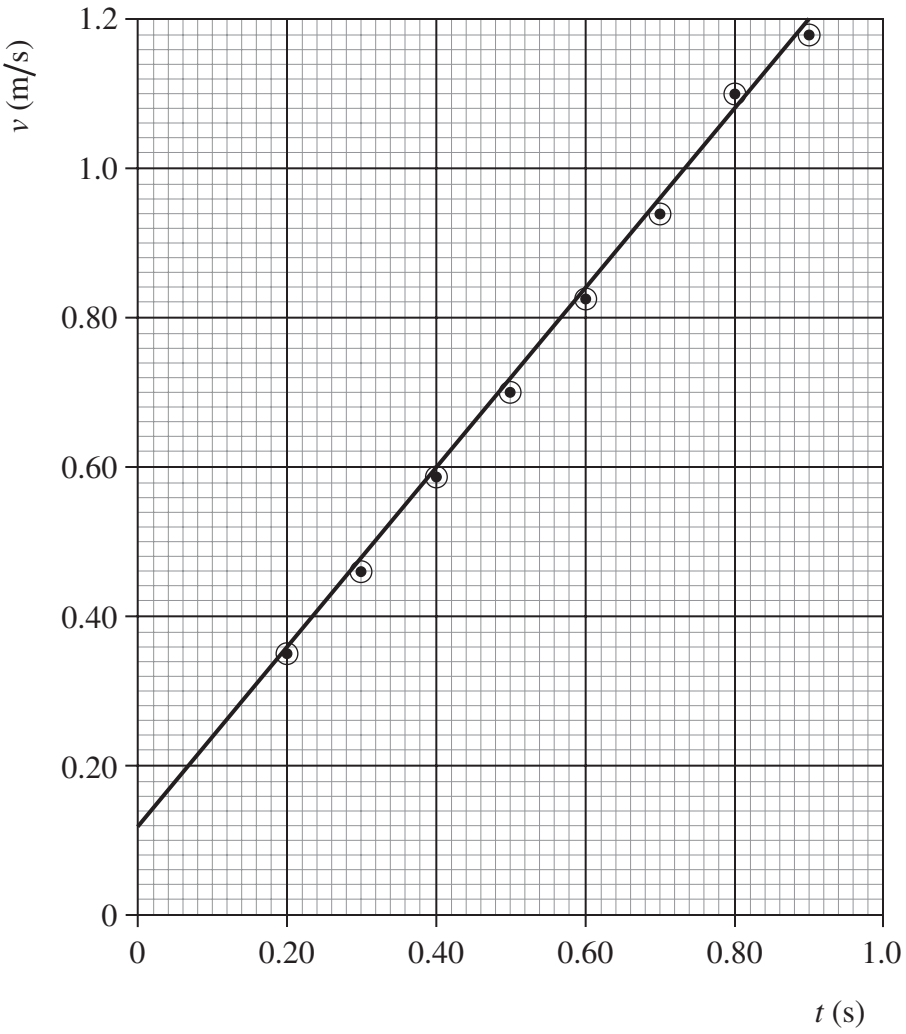
☑ clockwise

☐ counter-clockwise

8. The following data is collected in a kinematics experiment using a toy car.

t (s)	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
$v\left(\text{m/s}\right)$	0.35	0.46	0.59	0.70	0.83	0.94	1.10	1.18

a) Plot the data on a v vs. t graph and extrapolate your line back to $t = 0$. **(2 marks)**



b) What is the displacement of the toy car from $t = 0$ to $t = 0.90\ \text{s}$? **(2 marks)**

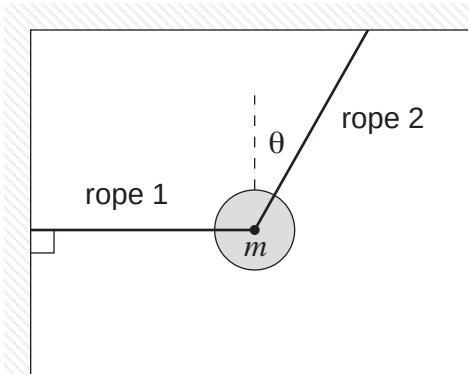
$$\Delta x \doteq \frac{1}{2}(0.12 + 1.20)(0.90\ \text{s})$$

$$\doteq 0.59\ \text{m}$$

c) What does the *y*-intercept of the graph represent? **(1 mark)**

initial speed of the car

9. A mass suspended by two ropes is shown below. It is noticed that for any angle θ used for rope 2, the tension in rope 2 is always greater than the tension in rope 1.



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

Rope 1 always has a tension equal to only the horizontal component of rope 2, whereas rope 2 (1 mark) also has a vertical component equal to the weight of the mass. (1 mark) These 2 conditions require the T_2 to be larger than T_1. (2 marks)

END OF KEY