Physics 12

June 2002 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.	A	K	2	1	D3, 5	16.	C	U	2	4	J2
2.	A	U	2	1	C4, 3	17.	C	U	2	4	I4; J2
3.	A	U	2	1	C8, 7	18.	C	H	2	4	J6, 7; E7
4.	C	U	2	1	D6; C4	19.	B	K	2	5	L1
5.	D	U	2	1	C4, 8	20.	B	U	2	5	K8; C4
6.	B	U	2	2	E10	21.	B	H	2	5	K8; D3, 5; C7
7.	A	K	2	2	F6	22.	D	K	2	6	M9
8.	D	U	2	2	F4; A10	23.	B	U	2	6	M7, 11, 6
9.	A	U	2	2	G3	24.	D	H	2	6	M5, 6, 11; N2
10.	A	K	2	3	H8, 11	25.	A	K	2	7	O3, 8
11.	B	U	2	3	H3, 2	26.	C	U	2	7	O5, 4
12.	A	U	2	3	H5	27.	A	U	2	7	O6
13.	C	K	2	4	I1, 3	28.	B	U	2	7	P5, 3
14.	D	K	2	4	J3	29.	D	U	2	7	P8, 9, 10
15.	C	U	2	4	J1, 2	30.	D	U	2	7	P4, 8, 11

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	7	1	B8, 7
2.	2	U	7	2	E7
3.	3	U	7	3	H11, 5
4.	4	H	9	4	I4
5.	5	U/A	7	5	L2, 8
6.	6	U	7	6	M11; N2
7.	7	U	7	7	P3, 5
8	8	H	5	1	A10; F4
9.	9	U	4	7	O4; P6

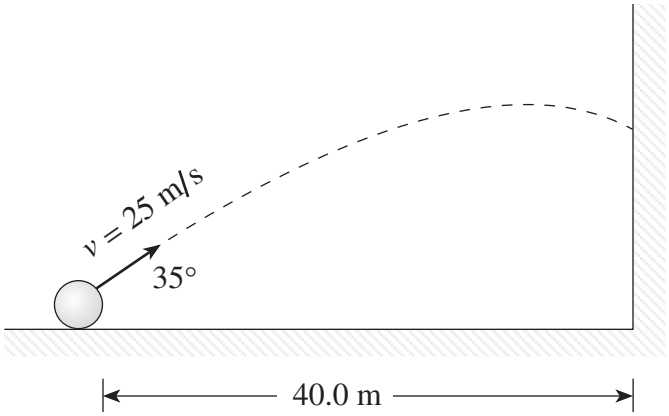
Written Response = 60 marks

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 projectile is launched towards a wall as shown in the diagram below.



With what velocity (magnitude and direction) does the projectile hit the wall? **(7 marks)**

$d_x = v_x \cdot t$

$v_x = v \cdot \cos 35$

$= 25 \cdot \cos 35$ ← **1 mark**

$= 20.5$ m/s

$\therefore t = \dfrac{d_x}{v_x}$

$= \dfrac{40.0}{25 \cdot \cos 35}$

$= 1.95$ s ← **1 mark**

$v_{y_f} = v_{y_i} + at$

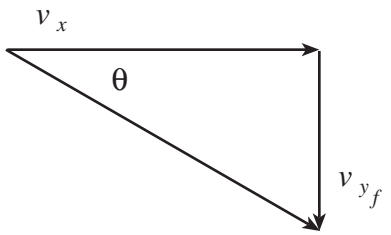
$= 25 \cdot \sin 35 + (-9.8 \cdot 1.95)$ ← **1 mark**

$= -4.77$ m/s ← **1 mark**

$\therefore v^2 = v_x^{\,2} + v_{y_f}^{\,2}$

$= (20.5)^2 + (-4.77)^2$

$\therefore v = 21$ m/s ← **1 mark**



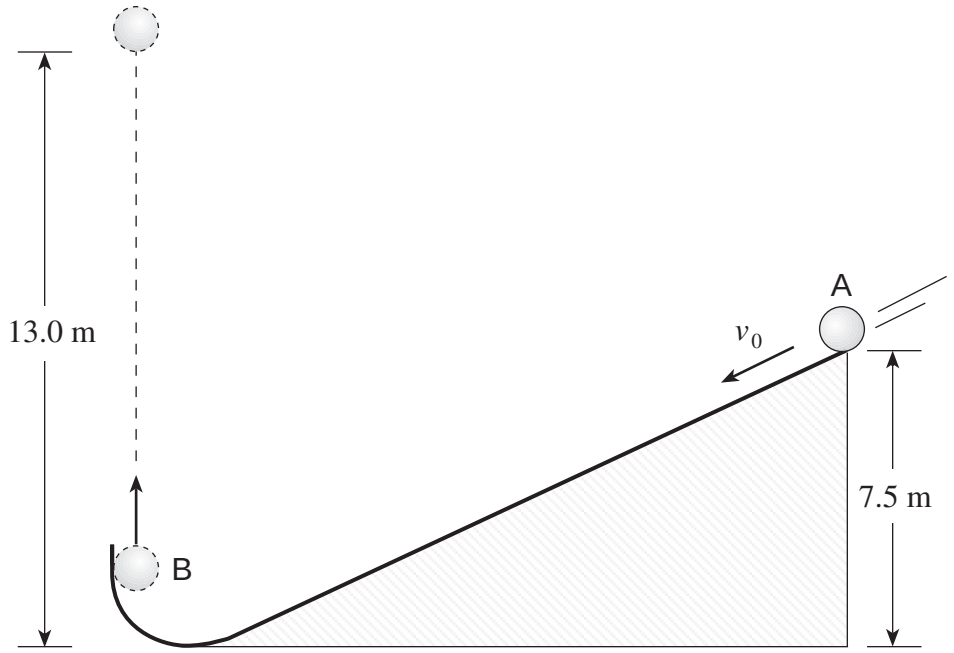
$\theta = \tan^{-1}\left(\dfrac{v_{y_f}}{v_x}\right)$

$= \tan^{-1}\left(\dfrac{4.77}{20.5}\right)$

$= 13°$ ← **2 marks**

2. A 0.50 kg ball starting from position A which is 7.5 m above the ground, is projected down an incline as shown. Friction produces 10.7 J of heat energy.

The ball leaves the incline at position B travelling straight upward and reaches a height of 13.0 m above the floor before falling back down.



What was the initial speed, v_0, at position A? Ignore air resistance. **(7 marks)**

$$E_{TA} = E_{Total} \qquad \leftarrow \textbf{2 marks}$$

$$E_{K_A} + E_{P_A} = E_{P_{top}} + E_h$$

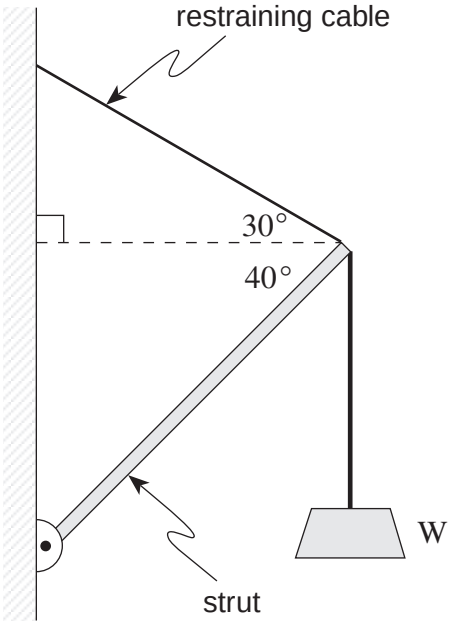
$$\frac{1}{2}mv^2 + mgh_A = mgh + E_h \qquad \leftarrow \textbf{2 marks}$$

$$\frac{1}{2} \times 0.50\left(v^2\right) + 0.50 \times 9.8 \times 7.5 = 0.50 \times 9.8 \times 13 \times +10.7 \qquad \leftarrow \textbf{1 mark}$$

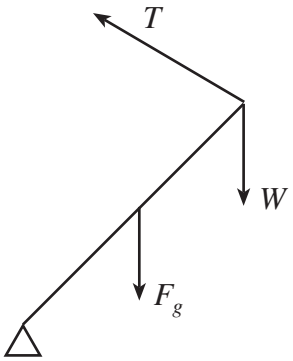
$$v^2 = \frac{74.4 - 36.75}{0.25} \qquad \leftarrow \textbf{1 mark}$$

$$v = 12 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

3. The crane assembly shown in the diagram below consists of a uniform 4.0 m long 65 kg strut and a restraining cable.



What is the maximum weight W that can be supported by this crane if the maximum tension that the restraining cable can withstand is 2400 N? The vertical rope is strong enough to support any required load. **(7 marks)**



$$\Sigma\tau_{pivot} = 0$$

or $\Sigma\tau_{cw} = \Sigma\tau_{ccw}$ } **$\frac{1}{2}$ mark**

$$W \sin 50 \cdot \cancel{l} + F_g \cdot \sin 50 \cdot \frac{\cancel{l}}{2} = T \sin 70 \cdot \cancel{l}$$ ← **4 $\frac{1}{2}$ marks**

$$\therefore W = \frac{T \sin 70 - \frac{F_g \sin 50}{2}}{\sin 50}$$

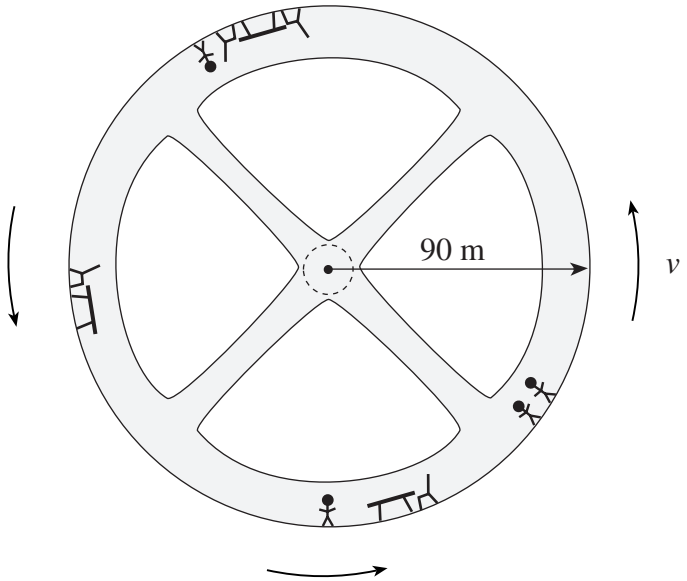
$$= \frac{2\,400 \sin 70 - \frac{65 \cdot 9.8 \cdot \sin 50}{2}}{\sin 50}$$ ← **1 mark**

$$= \frac{2\,255 - 244}{\sin 50}$$

$$= 2\,626 \text{ N}$$

$$= 2.6 \times 10^3 \text{ N}$$ ← **1 mark**

4. A space station of radius 90 m is rotating to simulate a gravitational field.



a) What is the period of the space station's rotation so that a 70 kg astronaut will experience a normal force by the outer wall equal to 60% of his weight on the surface of the earth? **(5 marks)**

$F_{net} = ma_c$ ← **1 mark**

$0.60\,mg = m\dfrac{4\pi^2}{T^2}R$

$T^2 = \dfrac{4\pi^2(90)}{0.60(9.8)}$

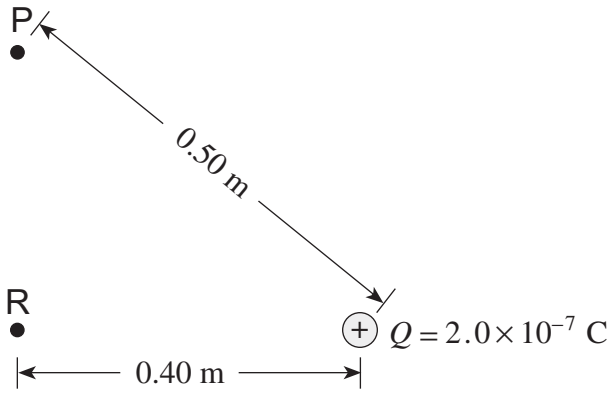
← **3 marks**

$T = 25$ s ← **1 mark**

b) What would be the effect experienced by the astronaut if the space station rotated faster so that the period of rotation was decreased? Explain your predicted effect. **(4 marks)**

The period is decreased and therefore the centripetal force increases ($F_c \propto \dfrac{1}{T^2}$). Since the centripetal force is only provided by the normal force, the normal force on the astronaut increases (F_N is perceived as weight.)

5. What is the electric potential difference between points P and R due to the fixed point charge Q? **(7 marks)**



$$V_p = \frac{kQ}{R_1}$$
$$= \left(\frac{9.00 \times 10^9 \cdot 2.0 \times 10^{-7}}{0.50} \right)$$
$$= 3\,600 \text{ V}$$

← **2 marks**

$$V_R = \frac{kQ}{R_2}$$
$$= \left(\frac{9.00 \times 10^9 \cdot 2.0 \times 10^{-7}}{0.40} \right)$$
$$= 4\,500 \text{ V}$$

← **2 marks**

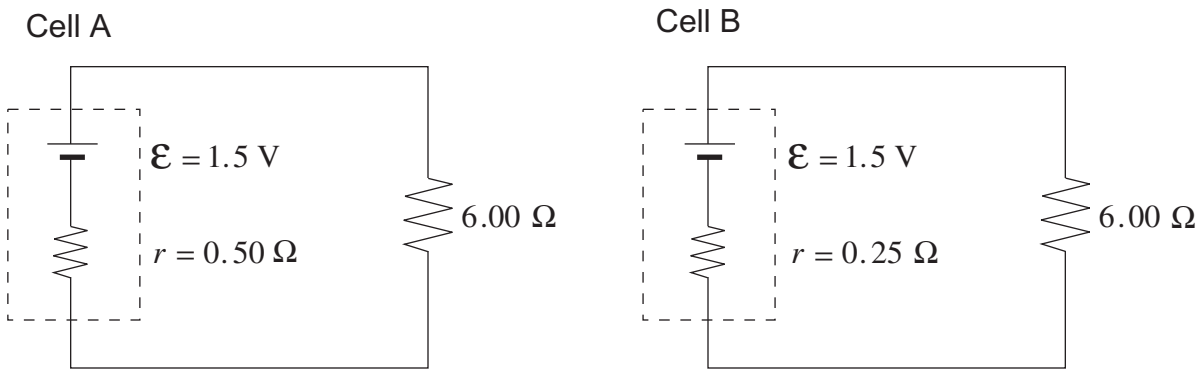
$$\therefore \Delta V_{pR} = V_p - V_R = 4\,500 - 3\,600$$

← **2 marks**

$$= \pm 900 \text{ V}$$

← **1 mark**

6. Each of the two cells shown is connected to an external $6.00\ \Omega$ resistor.



With supporting calculations, state which cell delivers the greater power to the $6.00\ \Omega$ resistor.

(7 marks)

Cell A:

$I = \dfrac{\mathcal{E}}{6.00 + r}$ ← **1 mark**

$I = \dfrac{1.5}{6.50}$

$= 0.23$ ← **1 mark**

$P_L = I^2 R$

$= 0.23^2 \times 6.00$

$= 0.32$ W ← **1 mark**

Cell B:

$I = \dfrac{\mathcal{E}}{6.00 + r}$ ← **1 mark**

$I = \dfrac{1.5}{6.25}$

$= 0.24$ ← **1 mark**

$P_L = I^2 R$

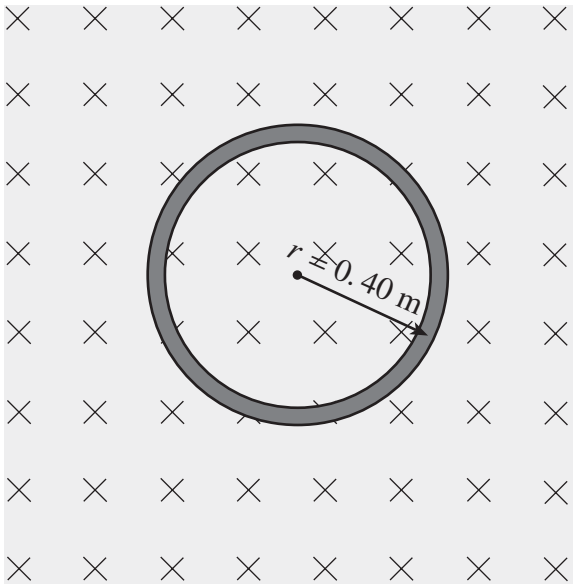
$= 0.24^2 \times 6.00$

$= 0.35$ W ← **1 mark**

Therefore, cell B delivers more power. ← 1 mark

Note: Sig figs were ignored, since answer is not numerical. Also, units were ignored for the same reason.

7. A coil of wire containing 50 loops is lying on a flat surface in a 0.60 T magnetic field pointing directly into the surface.



The magnetic field then changes to a value of 0.10 T in the opposite direction in 2.10 s. What is the average emf induced in the coil during the time that the magnetic field was changing? **(7 marks)**

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

$$= -50 \cdot \frac{\pi(0.40)^2\left(0.10-(-0.60)\right)}{2.10} \qquad \leftarrow \textbf{5 marks}$$

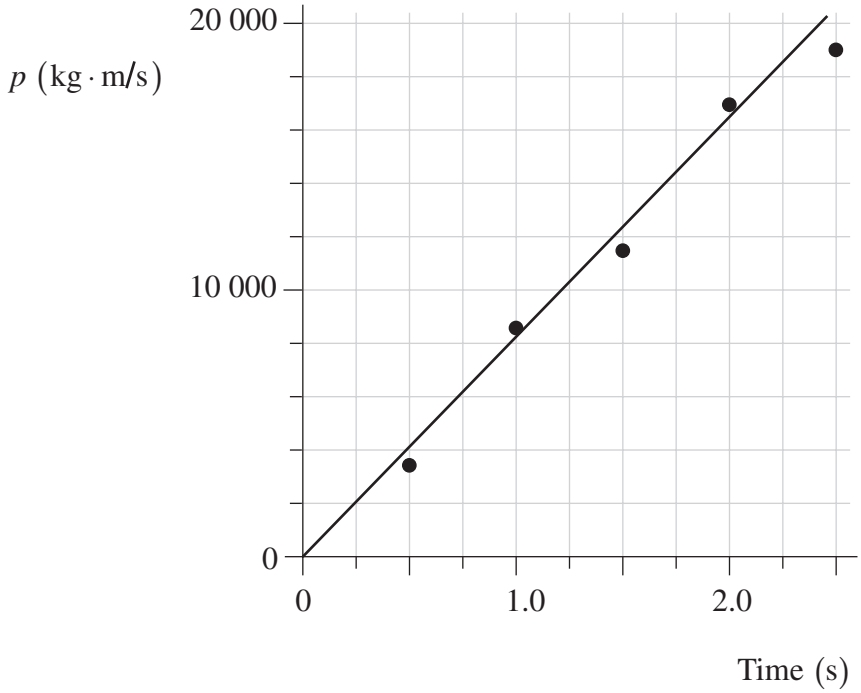
$$= -50 \cdot \frac{0.352}{2.10}$$

$$= 8.4 \text{ V} \qquad \leftarrow \textbf{1 mark}$$

8. As a formula one race car accelerates uniformly from rest, its momentum is recorded at regular time intervals. This data is shown below.

Time (s)	$p(\text{kg} \cdot \text{m/s})$
0.50	3 800
1.0	8 300
1.5	11 500
2.0	16 800
2.5	19 000

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



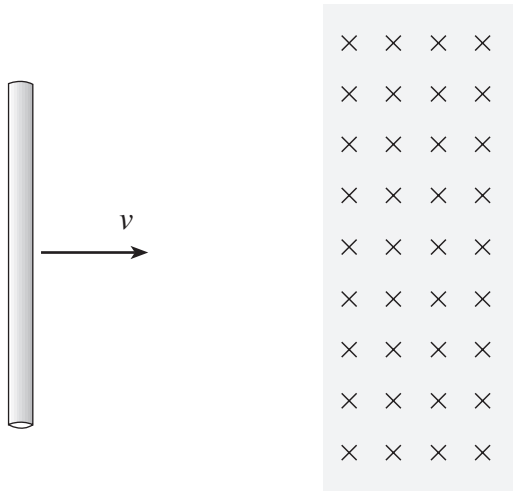
b) Determine the slope of the line (include units). **(1 mark)**

$slope \approx 8\ 000\ \text{kg} \cdot \text{m/s}^2$ or $8\ 000\ \text{N}$

c) What does the slope of this line represent? **(2 marks)**

the net force on the car

9. A steel rod passes through a region where a magnetic field exists.



The rod slows as it passes through the magnetic field. Using principles of physics, explain why this happens. **(4 marks)**

As the rod passes through the magnetic field the free charges within it experience a magnetic force. ← 1 mark This force moves the charges along the rod . ← 1 mark As the charges begin to move along the rod they experience another magnetic force. ← 1 mark This second force is directed against the motion of the rod . ← 1 mark

END OF KEY