Physics 12

August 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.	C	K	2	1	C3	16.	C	K	2	4	J3
2.	A	U	2	1	C8; D5	17.	B	U	2	4	J2, 3
3.	C	U	2	1	C4; D5	18.	A	U	2	4	J6, 7
4.	A	U	2	1	C4; B2	19.	D	K	2	5	K4, 8
5.	B	U	2	2	D5, 6; C4	20.	B	U	2	5	K5
6.	C	K	2	2	E6, 8	21.	C	U	2	5	L4
7.	B	U	2	2	E2, 7, 8	22.	B	K	2	6	M10, 11
8.	D	U	2	2	E10; A6	23.	A	U	2	6	M5, 6, 11
9.	A	H	2	2	E3, 8	24.	D	K	2	7	O7; L7
10.	A	K	2	3	H5	25.	D	U	2	7	O3
11.	B	U	2	3	H2, 3	26.	C	U	2	7	O6; I4
12.	A	U	2	3	H11	27.	B	U	2	7	P6
13.	B	K	2	4	I3	28.	C	U	2	7	P9
14.	C	U	2	4	I4; C8	29.	A	U	2	7	P11
15.	B	H	2	4	I4; J2	30.	D	H	2	7	P4, 5

Multiple Choice = 60 marks

PART B: Written Response

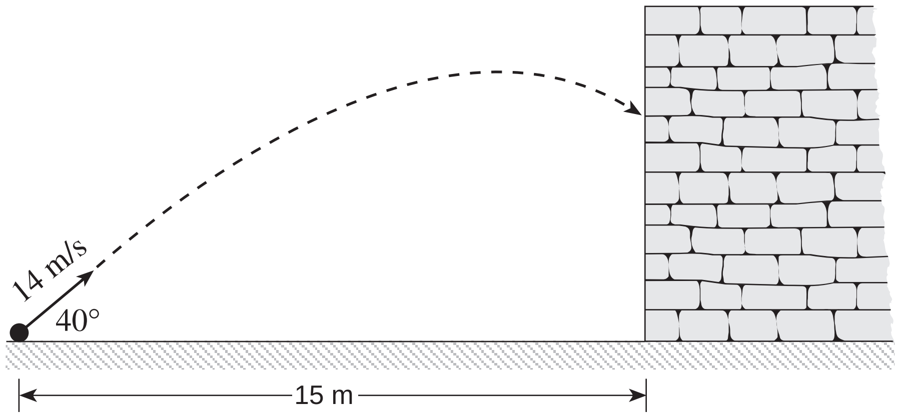
Q	B	C	S	CO	PLO
1.	1	U	7	1	B7, 8
2.	2	U	9	2	F7, 2, 4
3.	3	U	7	3	H11, 5
4.	4	U	7	4	J7; E8
5.	5	U	7	5	L2, 6
6.	6	U	7	6	M5, 6; N2
7.	7	U	7	7	P5; M5
8	8	H	5	1, 4	A10; I4
9.	9	H	4	6	M11; N2

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 2.5 kg projectile is launched towards a brick wall as shown.



a) What are horizontal and vertical components of the launch velocity? **(2 marks)**

$$v_x = v \cdot \cos\theta$$

$$= 14 \cdot \cos 40^\circ$$

$$= 10.7 \text{ m/s} \rightarrow 11 \text{ m/s}$$ $\leftarrow$ **1 mark**

$$v_{y_i} = v \cdot \sin\theta$$

$$= 14 \sin 40^\circ$$

$$= 9.0 \text{ m/s}$$ $\leftarrow$ **1 mark**

b) How much time does it take for the projectile to reach the wall? **(2 marks)**

$$t = \frac{d_x}{v_x}$$ $\leftarrow$ **1 mark**

$$= \frac{15}{10.7}$$

$$= 1.4 \text{ s}$$ $\leftarrow$ **1 mark**

c) What is the projectile's impact speed with the wall? **(3 marks)**

$v_x = 10.7 \text{ m/s}$ $\leftarrow$ **1 mark**

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

$$= 9.0 + (-9.8) \cdot 1.40$$ $\leftarrow$ **1 mark**

$$= -4.72 \text{ m/s}$$

$$v^2 = {v_x}^2 + {v_{y_f}}^2$$

$$= (10.7)^2 + (-4.72)^2$$

$\therefore v = 11.7 \text{ m/s} \rightarrow 12 \text{ m/s}$ $\leftarrow$ **1 mark**

2. A 5.30 kg wagon is moving at 2.00 m/s to the right. A 0.180 kg blob of putty moving at 32.0 m/s also to the right strikes the wagon and sticks to it.

   a) With what speed will the wagon and the putty move after the collision? **(5 marks)**

$$P_{initial} = P_{final} \quad \leftarrow \textbf{1 mark}$$

$$P_{putty} + P_{wagon} = P_{wagon\,\&\,putty} \quad \leftarrow \textbf{1 mark}$$

$$0.180 \cdot 32.0 + 5.30 \cdot 2.00 = (0.180 + 5.30) \cdot v \quad \leftarrow \textbf{2 marks}$$

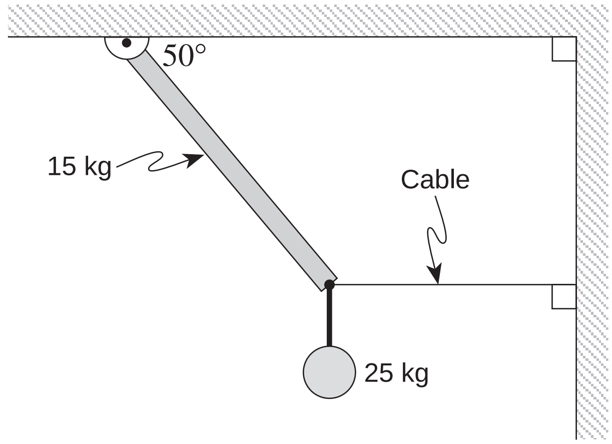
$$5.76 + 10.6 = 5.48\ v$$

$$v = 2.99\ \text{m/s} \quad \leftarrow \textbf{1 mark}$$

b) Suppose the wagon had instead been struck by a ball with the same mass and speed as the putty and the ball rebounded to the left after the collision. How would the speed of the wagon compare with your answer to a)? Using principles of physics, give an explanation for your prediction. **(4 marks)**

The change in momentum of the incident ball is greater than the putty. As momentum is conserved, this means the change in momentum for the wagon must be larger, thus the speed is greater. (4 marks)

3. A 4.0 m long uniform pole with a mass of 15 kg is pivoted at one end and held in position by a horizontal cable at the other end. If a 25 kg mass is suspended from the end of the pole, what is the tension in the horizontal cable? **(7 marks)**



$$\Sigma \tau_{cw} = \Sigma \tau_{ccw}$$ **← 1 mark**

$$F_p d_p \sin\theta_p + F_m d_m \sin\theta_m = F_c d_c \sin\theta_c$$

$$15 \cdot 9.8 \cdot 2.0 \cdot \sin 40 + 25 \cdot 9.8 \cdot 4.0 \cdot \sin 40 = F_c \cdot 4.0 \cdot \sin 50$$

$$\therefore F_c = \frac{15 \cdot 9.8 \cdot 2.0 \cdot \sin 40 + 25 \cdot 9.8 \cdot 4.0 \cdot \sin 40}{4.0 \cdot \sin 50}$$

$$= \frac{189.0 + 629.9}{3.06}$$

← 5 marks

$$= 2.7 \times 10^2 \text{ N}$$ **← 1 mark**

4. A 7.5×10^4 kg space vehicle leaves the surface of the earth with a speed of 1.3×10^4 m/s. What will its speed be when it is infinitely far from the earth? **(7 marks)**

$$E_i = E_f \qquad \leftarrow \textbf{1 mark}$$

$$E_{p_i} + E_{k_i} = E_{p_f} + E_{k_f} \qquad \leftarrow \textbf{1 mark}$$

$$-\frac{GmM}{R_E} + \frac{1}{2}mv_i^2 = 0 + \frac{1}{2}mv_f^2 \qquad \leftarrow \textbf{1 mark}$$

$$\left[\frac{-6.67\times10^{-11}\left(5.98\times10^{24}\right)}{6.38\times10^6}\right] + \left[\frac{1}{2}\left(1.3\times10^4\right)^2\right] = \frac{1}{2}v_f^2 \qquad \leftarrow \textbf{2 marks}$$

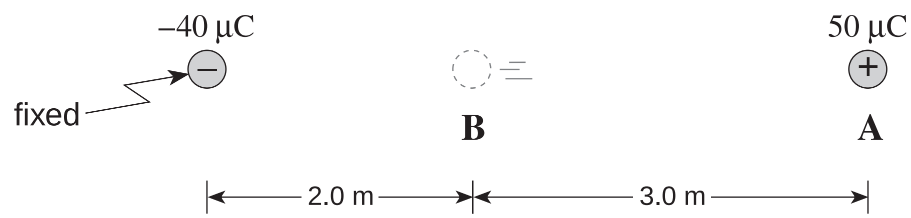
$$-6.25\times10^7 + 8.45\times10^7 = \frac{1}{2}v_f^2 \qquad \leftarrow \textbf{1 mark}$$

$$\frac{1}{2}v_f^2 = 2.2\times10^7$$

$$v_f^2 = 4.4\times10^7$$

$$v_f = 6.6\times10^3 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

5. A 1.0×10^{-3} kg styrofoam ball carrying $50\ \mu C$ of charge is released from rest from position **A** as shown in the diagram below. ($1\ \mu C = 1\times10^{-6}$ C)



a) Determine the change in electric potential energy, ΔE_p, of the ball as it moves from position **A** to position **B**. **(5 marks)**

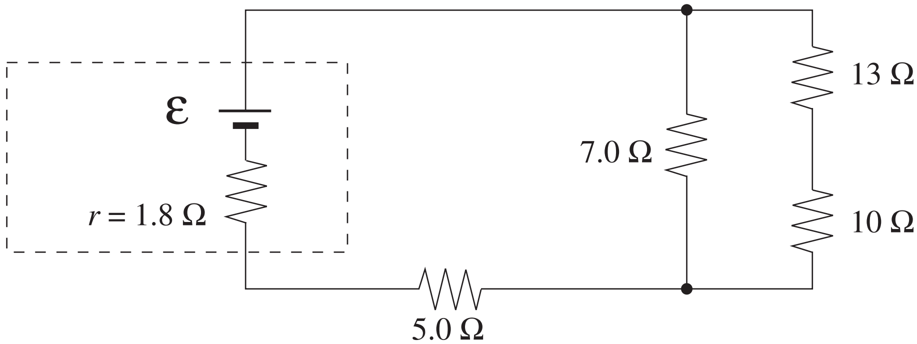
$$\Delta E_p = k\frac{Q_1Q_2}{r} - k\frac{Q_1Q_2}{r_0} \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned}
\Delta E_p &= 9\times10^9\,\frac{\left(50\times10^{-6}\right)\left(-40\times10^{-6}\right)}{2} - 9\times10^9\,\frac{\left(50\times10^{-6}\right)\left(-40\times10^{-6}\right)}{5}\\
\Delta E_p &= -9-(-3.6)\\
\Delta E_p &= -5.4\ \text{J}
\end{aligned}\right\} \leftarrow \textbf{4 marks}$$

b) What is the speed of the ball as it reaches position **B**? $\left(v_i = 0 \text{ at } \mathbf{A}\right)$ **(2 marks)**

$$\left.\begin{aligned}
-\Delta E_p &= \Delta E_k\\
-(-5.4) &= \frac{1}{2}(0.0010)v^2 - 0\\
v &= 1.0\times10^2\ \text{m/s}
\end{aligned}\right\} \leftarrow \textbf{2 marks}$$

6. The internal resistance of the battery shown in the circuit below dissipates 10 W of power. Determine the current through the $13\ \Omega$ resistor. **(7 marks)**



$$10 = I^2_{circuit} \cdot 1.8 \qquad \leftarrow \textbf{2 marks}$$

$$I_{circuit} = 2.357\ \text{A} \qquad \leftarrow \textbf{1 mark}$$

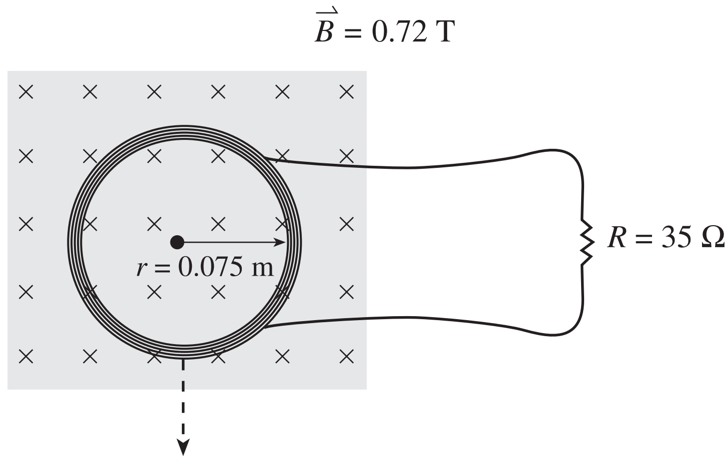
$$R_T = \left[\frac{1}{7} + \frac{1}{23}\right]^{-1} + 5 + 1.8 = 12.12\ \Omega \qquad \leftarrow \textbf{1 mark}$$

$$\varepsilon = IR = (2.357)(12.17) = 26.68\ \text{V} \qquad \leftarrow \textbf{1 mark}$$

$$\text{V}_{\parallel} = 28.68 - (6.8 \times 2.357) = 12.65\ \text{V} \qquad \leftarrow \textbf{1 mark}$$

$$I_{13} = \frac{V_{\parallel}}{R_{13,10}} = \frac{12.65}{23} = 0.55\ \text{A} \qquad \leftarrow \textbf{1 mark}$$

7. A 480-turn circular coil of radius 0.075 m is placed in a perpendicular magnetic field of 0.72 T. The coil is connected to a resistor of $35\ \Omega$ as shown.



a) Calculate the average current through the resistor as the coil is removed from the magnetic field in a time of 0.22 s. **(6 marks)**

$\varepsilon = \dfrac{N\Delta BA}{t}$ ← **1 mark**

$A = \pi(0.075)^2 = 0.0177$ ← **1 mark**

$= \dfrac{480 \times 0.72 \times \pi \times 0.075^2}{0.22}$ ← **2 marks**

$= 27.8$ V ← **1 mark**

$I = \dfrac{V}{R} = \dfrac{27.8}{35}$ ← **1 mark**

$I = 0.79$ A ← **1 mark**

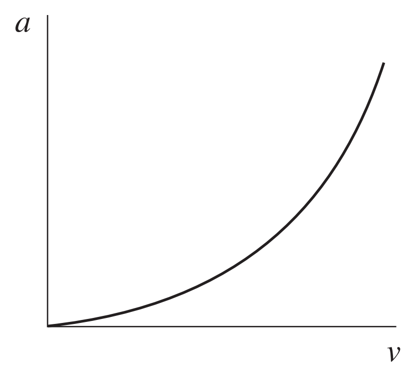
b) In which direction will the current flow in the coil? **(1 mark)**

☑ clockwise
❑ counterclockwise

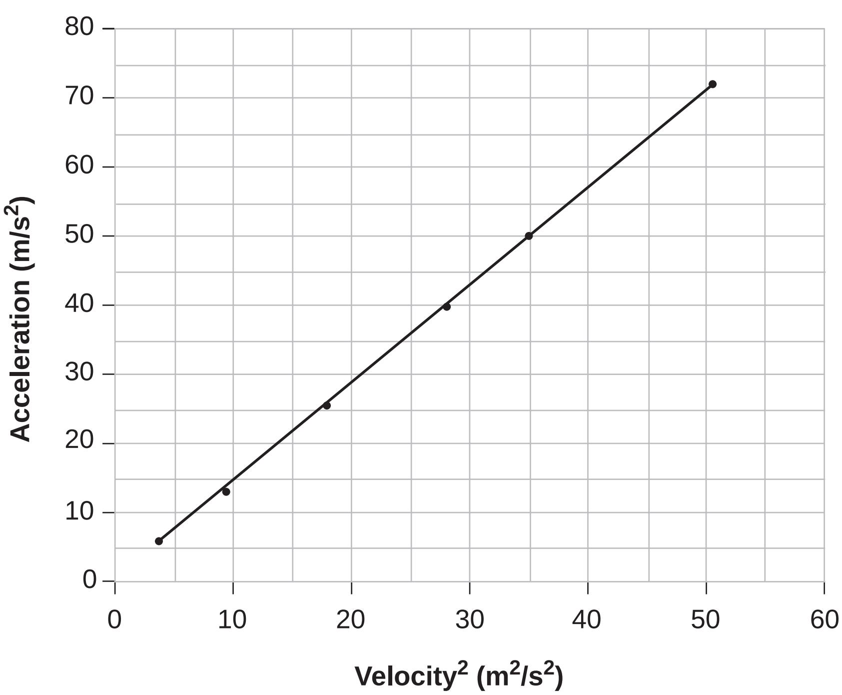
8. A student measures the acceleration of a lab cart as it moves at different speeds around a circular horizontal path. The data collected by the student is shown below:

ACCELERATION (m/s^2)	5.7	12.9	25.2	40	49.7	72
VELOCITY (m/s)	2.0	3.0	4.2	5.3	5.9	7.1
VELOCITY^2 (m^2/s^2)	4.0	9.0	17.6	28.1	34.8	50.4

When a graph of acceleration versus velocity is plotted a curve results as shown.



a) Manipulate the **velocity data** and use it to plot a straight line on the graph below. **(3 marks)**

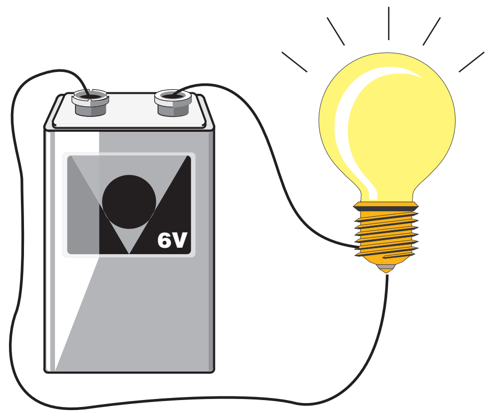


b) Calculate the slope of this graph including units. **(2 marks)**

$$\text{slope} = \frac{\Delta a}{\Delta v^2} = \frac{72 - 5.7}{50.4 - 4} = 1.43\ \frac{\text{m}/\text{s}^2}{\text{m}^2/\text{s}^2} \quad \leftarrow \textbf{2 marks}$$

$$= 1.4\ \text{m}^{-1}$$

9. Explain why a 6.0 V battery feels warm to the touch when it is being used to run a low resistance light bulb. **(4 marks)**



Low resistance light bulb will result in a high current through the battery (1 mark). This high current is passing through the battery's internal resistance (1 mark), resulting in the dissipation of an appreciable amount of heat (2 marks).

END OF KEY