Physics 12

August 2000 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**	**CO**	**PLO**	**Q**	**K**	**C**	**CO**	**PLO**
1.	D	K	1	C2, 3	16.	D	U	4	J2
2.	B	U	1	C4, 3	17.	A	U	4	J6
3.	C	U	1	C4	18.	D	K	4	K7
4.	A	U	1	C8, D5	19.	B	U	5	K5
5.	A	U	1	D6	20.	B	H	5	L6
6.	A	K	2	E8	21.	A	K	5	M4, A10
7.	B	U	2	E10	22.	B	U	6	M11, 6
8.	C	U	2	E7	23.	C	H	6	M6, 7
9.	B	H	2	E7, B8	24.	C	K	6	O2
10.	D	K	3	H4	25.	B	U	7	O4
11.	B	U	3	H3	26.	A	U	7	O6
12.	A	K	3	I1, 2	27.	B	U	7	O7
13.	C	U	4	I4	28.	B	U	7	P5, 3
14.	D	U	4	I4	29.	B	U	7	P8, 9
15.	D	K	4	J4	30.	A	U	7	P11

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	7	1	A9
2.	2	U	9	2	F4, 7
3.	3	U	7	3	H11
4.	4	U	7	4	J7
5.	5	U	7	5	L6
6.	6	U	7	6	M5, 6, 7, N2
7.	7	U	7	7	O8, P3
8	8	H	5	1, 2	A10, E10
9.	9	H	4	3	H2, H3

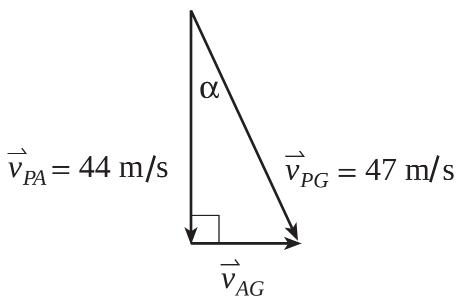
Written Response = 60 marks

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. An aircraft heads due south with a speed relative to the air of 44 m/s. Its resultant speed over the ground is 47 m/s. The wind blows from the west.

   a) What is the speed of the wind? **(4 marks)**



← **2 marks for diagram**

$$\left.\begin{aligned} v_{PA}^2 + v_{AG}^2 &= v_{PG}^2 \\ 44^2 + v_{AG}^2 &= 47^2 \end{aligned}\right\} \leftarrow \textbf{1 mark}$$

$$v_{AG} = 16.5 \text{ m/s}$$

$$v_{AG} = 17 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

b) What is the direction of the aircraft's path over the ground? **(3 marks)**

$$\cos\alpha = \frac{44}{47} \qquad \leftarrow \mathbf{1\frac{1}{2}\ marks}$$

$$\alpha = 20.6°$$

$$= \underbrace{21°}_{\textbf{1 mark}} \ \underbrace{\text{east of south}}_{\mathbf{\frac{1}{2}}\textbf{ mark}}$$

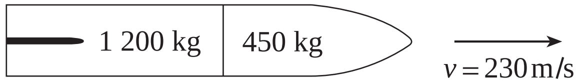
or

69° south of east

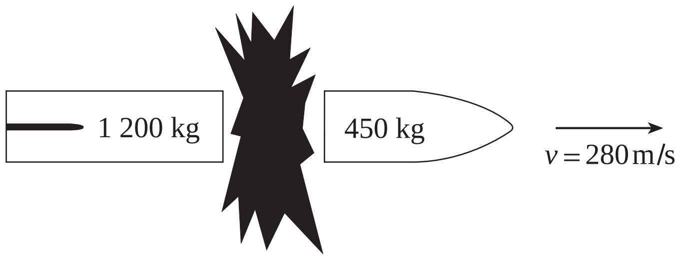
or

south 21° east

2. A space vehicle made up of two parts is travelling at 230 m/s as shown.



An explosion causes the 450 kg part to separate and travel with a final velocity of 280 m/s as shown.



a) What was the momentum of the space vehicle before the explosion? **(2 marks)**

$\rho = mv$

$= (1\,200 + 450)230$

$= 3.8 \times 10^5 \text{ kg m/s}$ $\leftarrow$ **2 marks**

b) What was the magnitude of the impulse on the 1 200 kg part during the separation? **(3 marks)**

$Impulse = \Delta p$

$= P_b - P_a$ $\leftarrow$ **1 mark**

$= (450 \times 280) - (450 \times 230)$ $\leftarrow$ **1 mark**

$= 2.3 \times 10^4 \text{ N} \cdot \text{s}$ $\leftarrow$ **1 mark**

c) Using principles of physics, explain what changes occur, if any, to the

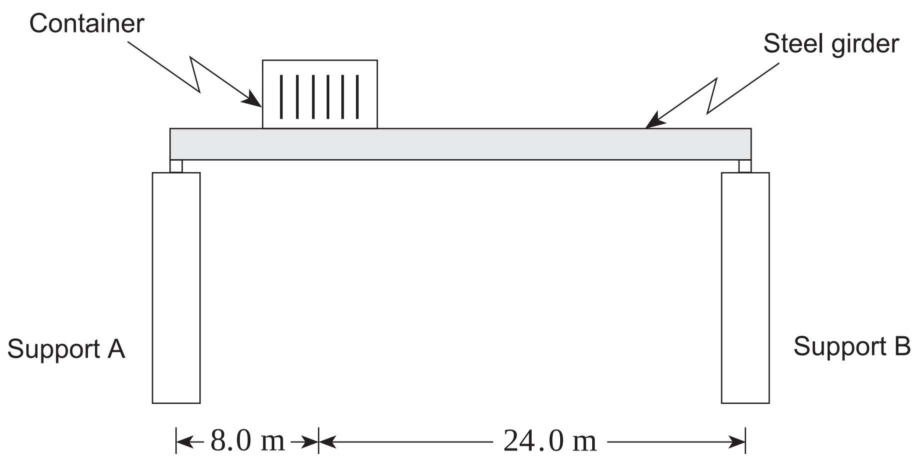
i) momentum of the system as a result of the explosion. **(2 marks)**

In an explosion, momentum must be conserved.

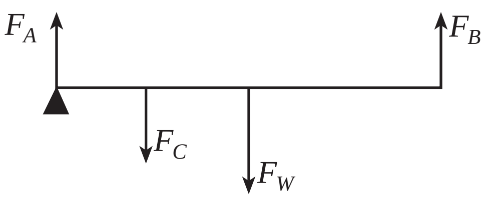
ii) kinetic energy of the system as a result of the explosion. **(2 marks)**

Since the explosion adds energy to the system, the system will gain kinetic energy.

3. A uniform 1 200 kg steel girder is supported horizontally at its endpoints as shown in the diagram.



What are the upward forces at the girder end points when it is bearing a 3 700 kg shipping container 8.0 m from support A? **(7 marks)**



<u>Pivot A</u> (4 marks for first pivot calculation):

$$\Sigma\tau_{cw} = \Sigma\tau_{ccw} \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} F_C L_C + F_W L_W &= F_B L_B \\ 3700(9.8)(8) + 1200(9.8)(16) &= F_B(32) \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

$$2.90\times10^5 + 1.88\times10^5 = F_B(32)$$

$$1.49\times10^4\text{ N} = F_B \qquad \leftarrow \textbf{1 mark}$$

<u>Pivot B</u> (3 marks for second pivot OR sum of forces):

$$\left.\begin{aligned} F_C L_C + F_W L_W &= F_A L_A \\ 3700(9.8)(24) + 1200(9.8)(16) &= F_A(32) \\ \left(8.70\times10^5\right) + \left(1.88\times10^5\right) &= F_A(32) \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

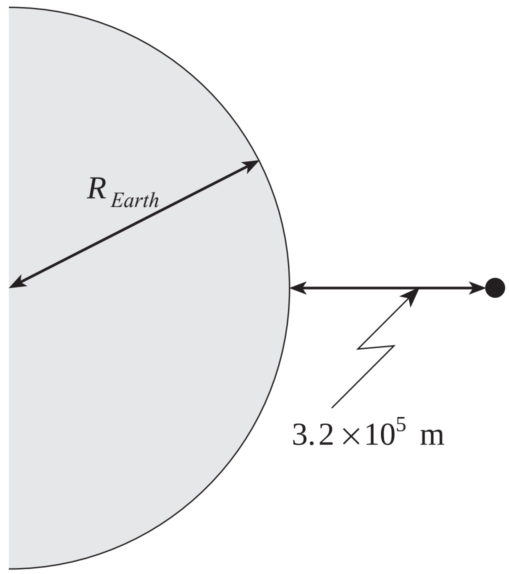
$$3.31\times10^4\text{ N} = F_A \qquad \leftarrow \textbf{1 mark}$$

<u>Forces</u>:

$$\left.\begin{aligned} F_C + F_W &= F_A + F_B \\ 3700(9.8) + 1200(9.8) &= F_A + F_B \\ \left(3.63\times10^4\right) + \left(1.18\times10^4\right) &= F_A + F_B \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

$$F_A \ or\ F_B = \qquad\qquad \leftarrow \textbf{1 mark}$$

4. A 4.00×10^3 kg object is lifted from the earth's surface to an altitude of 3.2×10^5 m. How much work does this require? **(7 marks)**



(Diagram not to scale.)

$R_1 = 6.38 \times 10^6$ m

$R_2 = 6.38 \times 10^6 \text{ m} + 3.2 \times 10^5$ m

$= 6.70 \times 10^6$ m ← **1 mark**

$W = \Delta E$ ← **1 mark**

$$\Delta Ep = Ep_2 - Ep_1$$

$$= \frac{-GMm}{R_2} - \left(-\frac{GMm}{R_1} \right)$$ ← **1 mark**

$$= \frac{-6.67 \times 10^{-11} \cdot 5.98 \times 10^{24} \cdot 4.00 \times 10^3}{6.70 \times 10^6} - \frac{-6.67 \times 10^{-11} \cdot 5.98 \times 10^{24} \cdot 4.00 \times 10^3}{6.38 \times 10^6}$$ ← **2 marks**

$$= -2.38 \times 10^{11} \text{ J} - \left(-2.50 \times 10^{11} \text{ J} \right)$$ ← **1 mark**

$\Delta Ep = 1.2 \times 10^{10}$ J ← **1 mark**

5. A proton, initially at rest at point X, will have what speed at point Y? **(7 marks)**

$$\left.\begin{aligned}\Delta E &= 0\\ \Delta E_k &= -\Delta Ep\end{aligned}\right\} \leftarrow \textbf{1 mark}$$

$$E_{k_2} - E_{k_1} = E_{p_1} - E_{p_2}$$

$$\tfrac{1}{2}mv_2{}^2 - 0 = \frac{kQq}{r_1} - \frac{kQq}{r_2} \qquad \leftarrow \textbf{3 marks}$$

$$= \frac{9.0\times10^9\cdot3.5\times10^{-6}\cdot1.6\times10^{-19}}{1.0} - \frac{9.0\times10^9\cdot3.5\times10^{-6}\cdot1.6\times10^{-19}}{3.0} \qquad \leftarrow \textbf{2 marks}$$

$$= \frac{5.04\times10^{-15}}{1} - \frac{5.04\times10^{-15}}{3}$$

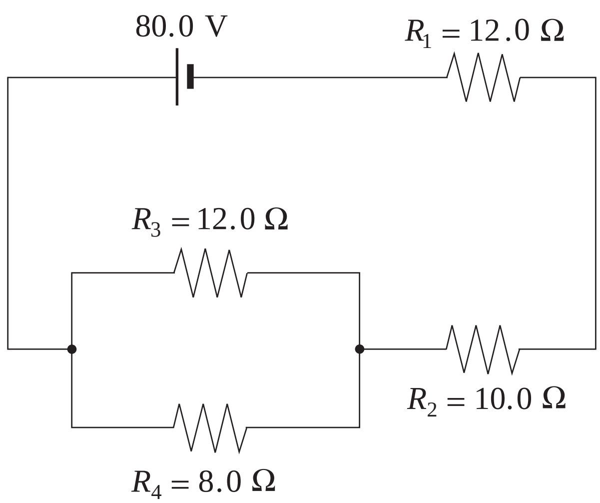
$$= 5.04\times10^{-15} - 1.68\times10^{-15}$$

$$\tfrac{1}{2}mv^2 = 3.36\times10^{-15}$$

$$\tfrac{1}{2}\left(1.67\times10^{-27}\right)v^2 = 3.36\times10^{-15}$$

$$v = 2.0\times10^6 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

6. What is the power dissipated in the $8.0\ \Omega$ resistor in the circuit as shown? **(7 marks)**



$$\frac{1}{R_{||}} = \frac{1}{R_3} + \frac{1}{R_4}$$

$$= \frac{1}{12.0} + \frac{1}{8.0}$$

$R_{||} = 4.8\ \Omega$ ← **1 mark**

$$R_t = R_1 + R_2 + R_{||}$$

$$= (12.0 + 10.0 + 4.8)$$

$R_t = 26.8\ \Omega$ ← **1 mark**

$I_t = \dfrac{V_t}{R_t} = \dfrac{80.0}{26.8} = 2.99\ \text{A}$ ← **2 marks**

$$V_1 = I_t R_1 = 2.99(12) = 35.9\ \text{V}$$

$$V_2 = I \cdot R_2 = 2.99(10) = 29.9\ \text{V}$$

$$V_{||} = 80.0 - (35.9 + 29.9)$$

$= 14.3\ \text{V}$ ← **2 marks**

$P = \dfrac{V^2}{R} = \dfrac{14.3^2}{8.0} = 26\ \text{W}$ ← **1 mark**

7. The magnetic field at the centre of a solenoid of length $0.25\ \text{m}$ is $1.2\times10^{-2}\ \text{T}$. The current in the windings is $7.5\ \text{A}$.

a) How many windings does the solenoid have? **(4 marks)**

$$B=\mu_0\left(\frac{N}{\ell}\right)I \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned}N&=\frac{B\ell}{\mu_0\cdot I}\\&=\frac{\left(1.2\times10^{-2}\right)(0.25)}{\left(4\pi\times10^{-7}\right)(7\cdot5)}\end{aligned}\right\}\leftarrow \textbf{2 marks}$$

$$=318$$

$$=3.2\times10^{2} \qquad \leftarrow \textbf{1 mark}$$

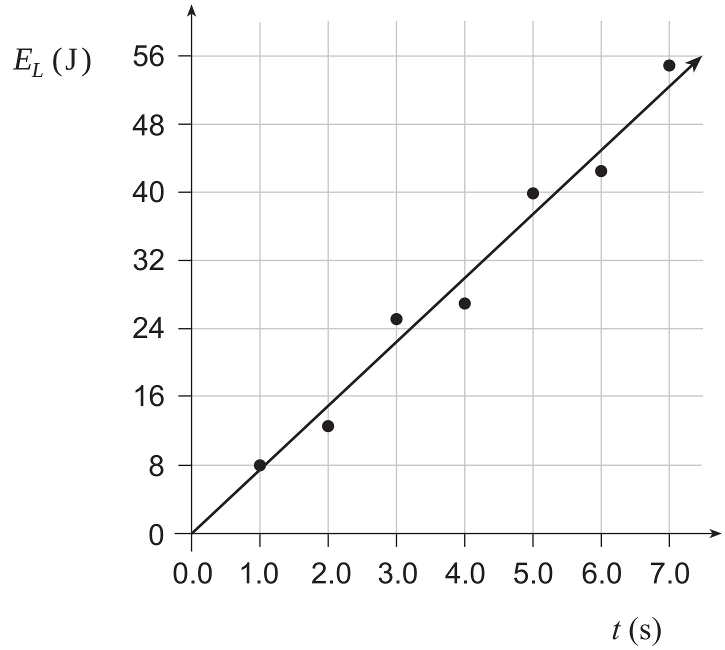
b) If the cross-sectional area of the solenoid is $8.5\times10^{-4}\ \text{m}^2$, what is the flux through it? **(3 marks)**

$$\Phi=BA \qquad \leftarrow \textbf{1 mark}$$

$$=\left(1.2\times10^{-2}\right)\left(8.5\times10^{-4}\right) \qquad \leftarrow \textbf{1 mark}$$

$$=1.0\times10^{-5}\ \text{Wb} \qquad \leftarrow \textbf{1 mark}$$

8. The graph shows the light energy E_L emitted by a bulb versus time t.



a) Find the power output of the bulb. **(2 marks)**

$$P = \frac{\Delta E}{\Delta t}$$ ← **1 mark**

$$\cong 7.6 \text{ W}$$ ← **1 mark**

b) If this bulb is 20% efficient, find the power delivered to the bulb. **(3 marks)**

$$\frac{P_{out}}{P_{in}} = 0.20$$

$$\frac{7.6}{P_{in}} = 0.20$$

$$P_{in} \cong 38 \text{ W}$$ ← **3 marks**

9. In your summer job with the Ministry of Transportation and Highways your supervisor has told you that street signs should no longer be suspended as shown in Diagram A. In order to save money, he would prefer a shorter, perfectly horizontal cable, as shown in Diagram B.

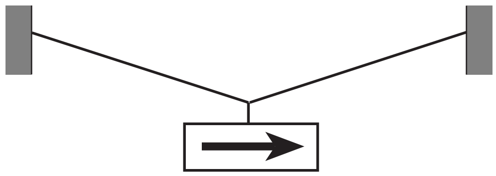


Diagram A

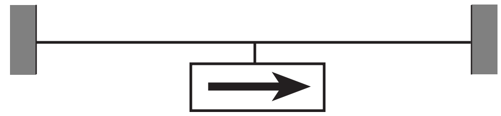


Diagram B

Using principles of physics, argue that the situation in Diagram B is not reasonable. **(4 marks)**

To balance the weight of the sign there must be an upward force. ← 2 marks

In Diagram B there is no vertical component of the cable tension, and hence no upward force to oppose the weight of the sign. ← 2 marks

END OF KEY