Physics 12

2009/10 Released Exam

January 2010 — Form A

Provincial Examination — Answer Key

Cognitive Processes	Weightings	Question Types
K = Knowledge	10%	**35** = Multiple Choice (MC)
U = Understanding	80%	**6** = Written Response (WR)
H = Higher Mental Processes	10%	

Topics	Prescribed Learning Outcomes (PLOs)	Weightings
1. Vector Kinematics in Two Dimensions	B, C, D	9%
and Dynamics *and* Vector Dynamics		9%
2. Work, Energy and Power	E	6%
and Momentum	F	6%
3. Equilibrium	G	12%
4. Circular Motion	H	8%
and Gravitation	I	8%
5. Electrostatics	J	12%
6. Electric Circuits	K	12%
7. Electromagnetism	L	18%

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
1.	B	K	2	1	B1	MC	
2.	A	U	2	1	B1	MC	
3.	C	U	2	1	C2	MC	
4.	D	K	2	1	D1	MC	
5.	D	U	2	1	D1	MC	
6.	C	U	2	1	D2	MC	
7.	B	U	2	2	E1	MC	
8.	B	U	2	2	E1	MC	
9.	C	U	2	2	F1	MC	
10.	D	U	2	2	F1	MC	
11.	D	U	2	2	F2	MC	
12.	A	U	2	3	G1	MC	
13.	C	U	2	3	G1	MC	
14.	B	U	2	3	G1	MC	
15.	B	U	2	3	G1	MC	

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
16.	D	U	2	4	H1	MC	
17.	D	K	2	4	H1	MC	
18.	D	U	2	4	H1	MC	
19.	D	U	2	4	I1	MC	
20.	A	H	2	4	I1	MC	
21.	B	K	2	4	I1	MC	
22.	A	U	2	5	J1	MC	
23.	A	U	2	5	J2	MC	
24.	B	U	2	5	J3	MC	
25.	A	U	2	5	J5	MC	
26.	C	U	2	6	K1	MC	
27.	D	U	2	6	K1	MC	
28.	B	U	2	6	K2	MC	
29.	A	U	2	6	K1	MC	
30.	D	K	2	7	L1	MC	
31.	A	U	2	7	L1	MC	
32.	C	U	2	7	L1	MC	
33.	A	U	2	7	L2	MC	
34.	A	U	2	7	L2	MC	
35.	C	U	2	7	L2	MC	

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type	Question Source
1.	–	U	5	2	F2	WR	
2.	–	U	5	3	G1	WR	
3.	–	H	6	6	K1	WR	
4.	–	U	5	7	L2	WR	
5.	–	U/H	5	1	A2	WR	
6.	–	H	4	2	E1	WR	

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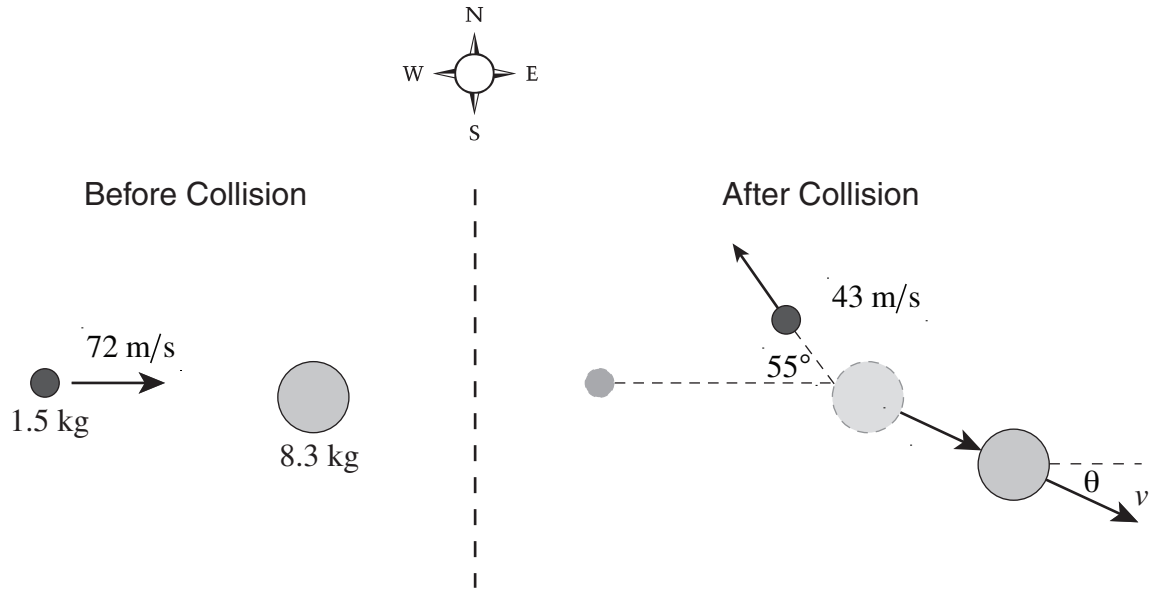
Provincial Examination — Scoring Guide

1. **(5 marks)**

A 1.5 kg ball was moving east at 72 m/s and collided with a stationary 8.3 kg wooden sphere. The ball rebounded at 43 m/s in the direction 55° north of west. What were the speed and direction of the wooden sphere after the collision?



Using the component method,

$p_i = m_1 v_i = 1.5(72) = 108 \text{ kg} \cdot \text{m/s}$

$p_{1f} = m_1 v_{1f} = 1.5(43) = 64.5 \text{ kg} \cdot \text{m/s}$

$p_{1fx} = 64.5\cos 55° = 37.0 \text{ kg} \cdot \text{m/s}$

$p_{1fy} = 64.5\sin 55° = 52.8 \text{ kg} \cdot \text{m/s}$ ← **$\frac{1}{2}$ mark**

	***x*-component**	***y*-component**
p_{1f}	–37.0	+52.8
p_{2f}	+145	–52.8
$p_i = p_f$	108	0

(1 mark)

Therefore the components of the final momentum of the sphere are

$p_{2x} = 145 \text{ kg} \cdot \text{m/s}$

$p_{2y} = -52.8 \text{ kg} \cdot \text{m/s}$ $\leftarrow \mathbf{\frac{1}{2}}$ **mark**

These components give a resultant magnitude of

$p^2 = (145)^2 + (-52.8)^2$

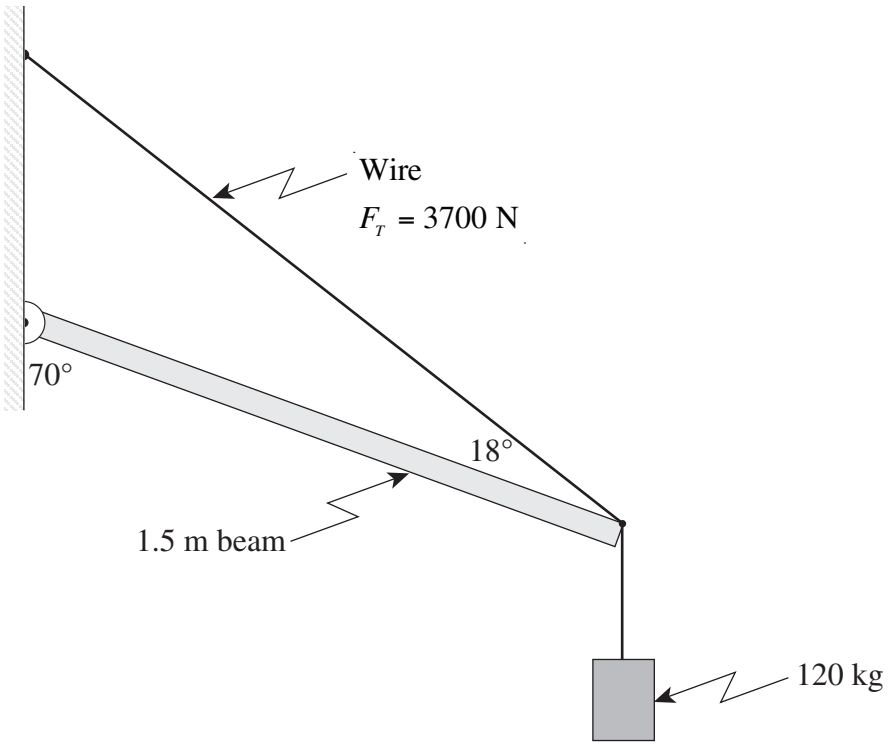
$p = 154 \text{ kg} \cdot \text{m/s}$ $\leftarrow$ **1 mark**

speed $v = p/m = 154/8.3 = 19 \text{ m/s}$ $\leftarrow$ **1 mark**

direction $\tan\theta = 52.8/145, \theta = 20°(\text{S of E})$ $\leftarrow$ **1 mark**

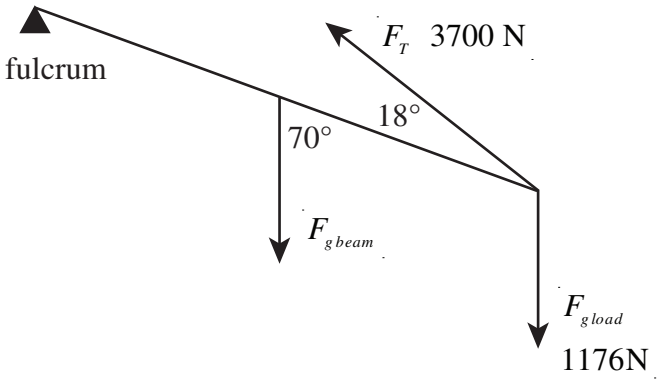
2. **(5 marks)**

A 1.5 m-long uniform beam supports a 120 kg load. The beam is suspended by a wire connected as shown. This wire is under a tension of 3700 N.



What is the mass of the beam?

Working Freebody Diagram



← **1 mark**

Condition II: $\Sigma\tau = 0$ about the chosen fulcrum

$$\tau_{clockwise} = \tau_{counterclockwise}$$

$$\tau_{beam} + \tau_{load} = \tau_{cable} \qquad \leftarrow \textbf{1 mark}$$

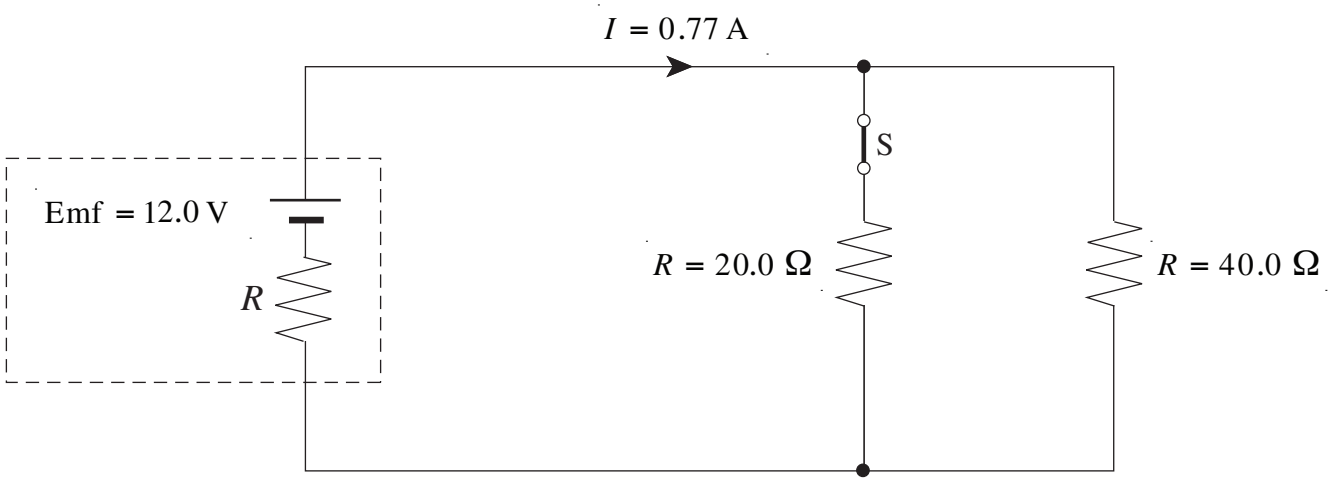
$$l\,F\sin\theta + l\,F\sin\theta = l\,F\sin\theta$$

$$0.75(9.8\text{ m})\sin 70° + 1.5(1176)\sin 70° = 1.5(3700)\sin 18° \qquad \leftarrow \textbf{2 marks}$$

$$m = 8.3\text{ kg} \qquad \leftarrow \textbf{1 mark}$$

3. **(6 marks)**

A battery having an emf of 12.0 V is connected to the circuit as shown.



What is the terminal voltage of the battery?

$$R_p = \frac{1}{\left((1/20.0)+(1/40.0)\right)} = 13.33\ \Omega \quad \leftarrow \textbf{2 marks}$$

$$V_T = I \times R_p = 0.77 \times 13.33$$

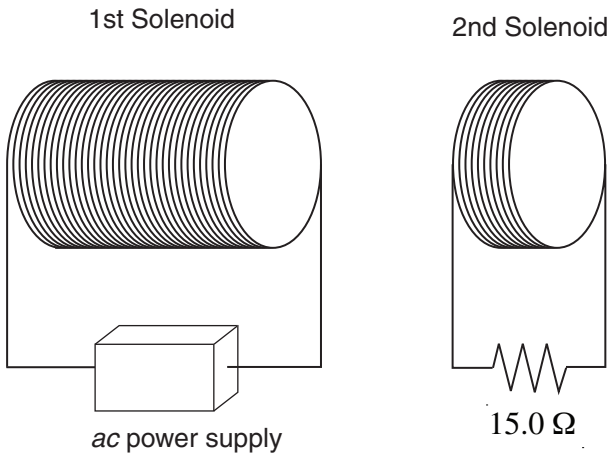
$$V_T = 10.3\ \text{V} \quad \leftarrow \textbf{2 marks}$$

Explain what happens to the terminal voltage of this battery when switch S is opened.

When the switch S is opened, the resistance of the circuit increases and the total current decreases. Less current through the battery decreases the voltage drop across the internal resistance of the battery, thus increasing the terminal voltage. (2 marks)

4. **(5 marks)**

Two solenoids, placed side by side as shown, are functioning together as an ideal transformer. The first solenoid has 230 coils and the second has 46 coils. An *ac* power supply provides the first solenoid with a current of 0.35 A.



What power is dissipated in the 15.0 Ω resistor connected to the second coil?

$$\frac{N_p}{N_s} = \frac{I_s}{I_p} \qquad \leftarrow \textbf{1 mark}$$

$$I_s = \frac{230 \times 0.35}{46} = 1.75 \text{ A} \qquad \leftarrow \textbf{2 marks}$$

$$P = I^2R = 1.75^2 \times 15 = 46 \text{ W} \qquad \leftarrow \textbf{2 marks}$$

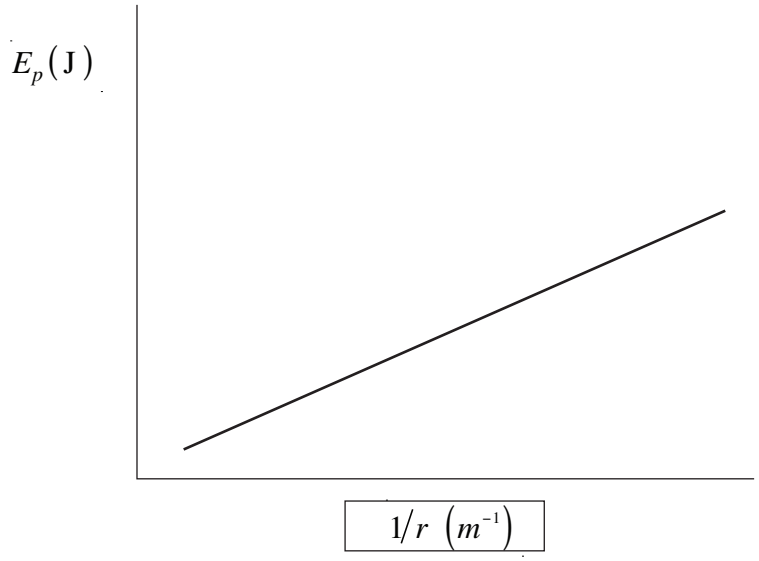
5. **(5 marks)**

During an electrostatics experiment to investigate electric potential energy, a positive point charge, q_1, is moved gradually closer to a $10\ \mu C$ charge that is fixed to a table top. The charges are initially far apart.

The electric potential energy, E_p, of q_1 is determined at several separation distances, r, from the $10\ \mu C$ fixed charge.

It is possible to use such data (E_p and r) to create a linear graph and obtain a slope.

In the box on the graph below write the function (include units) of the separation distance, r, that must be used on the horizontal axis to produce a linear relation from this data.



function of r including units

$E_p = k \cdot q_1 \cdot 10\mu C/r$

E_p varies as the inverse of the separation distance, r.

Therefore $1/r$ **(2 marks)** must be used on the horizontal axis to produce a linear relation from the data.

The units are m^{-1}. **(1 mark)**

Explain how you can use the slope of this graph to determine the unknown charge q_1.

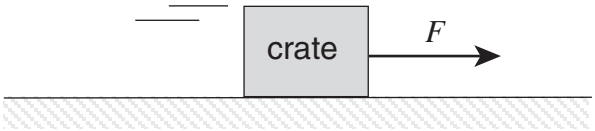
Since $E_p = k \cdot q_1 \cdot 10\mu C/r$ the slope of the graph must be equal to $k \cdot q_1 \cdot 10\mu C$. The charge, q_1, can be determined by equating the slope of the graph with $k \cdot q_1 \cdot 10\mu C$ and solving for q_1, the only unknown.

$slope = k \cdot q_1 \cdot 10 \times 10^{-6}\ \mathrm{C}$

$$q_1 = \frac{slope}{k \cdot 10 \times 10^{-6}\ \mathrm{C}}$$ **(2 marks)**

6. **(4 marks)**

You are pulling a crate across a smooth concrete floor with a constant horizontal force, F. The crate's speed is increasing.



Using principles of physics, explain why your power output is also increasing. **(4 marks)**

As the crate speeds up you must pull it a greater distance each second. (2 marks)
You are therefore exerting the force, F, over a greater distance and doing more work $(W = F \cdot d)$ per second. (2 marks)