Physics 12

August 1998 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.	B	K	1	D4	16.	C	H	4	C8, I4
2.	C	U	1	A10	17.	D	K	4	J1, 3
3.	A	U	1	C7	18.	B	U	4	J6
4.	B	U	1	D3, 5, C4	19.	A	U	5	K6
5.	B	U	1	D6, C8, C4	20.	B	U	5	K3
6.	C	U	2	E10	21.	C	H	5	L7
7.	A	K	2	F1	22.	C	K	6	M3
8.	C	U	2	F4	23.	D	U	6	N3
9.	B	U	2	F4, E7	24.	C	H	6	M5, 6
10.	B	U	2	G1, 3	25.	B	K	7	P12
11.	A	K	3	H4	26.	D	U	7	O4, 6
12.	C	U	3	H11	27.	C	U	7	O5
13.	B	K	4	I3	28.	C	U	7	P3, 5
14.	B	U	4	D4, I5	29.	D	U	7	P4
15.	A	U	4	I4, 5	30.	C	U	7	P10

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	CO	S	CGR
1.	1	U	1	7	B8, 7
2.	2	U	2	7	E3, 10
3.	3	U	3	9	H3
4.	4	U	4	7	J6, 9
5.	5	U	5	7	L6
6.	6	U	6	7	M5, 6, N2
7.	7	U	7	7	P9
8.	8	H	1	5	A10
9.	9	H	7	4	O7

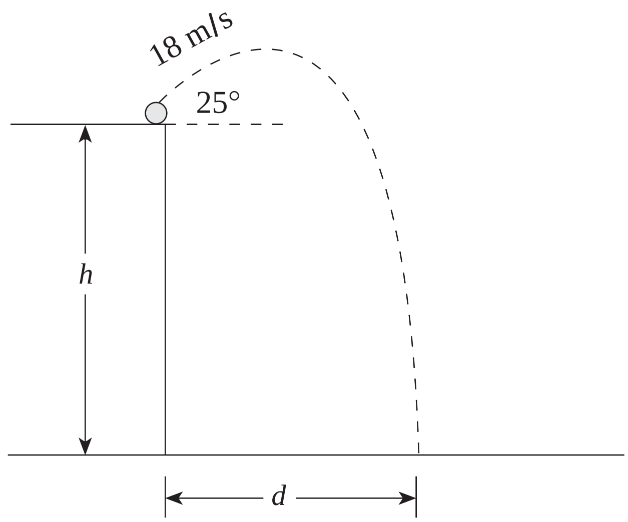
Written Response = 60 marks

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 rock is thrown from a clifftop at $18\ \text{m/s}$, $25°$ above the horizontal. It lands on the beach $4.2\ \text{s}$ later.



a) What is the height h of the cliff? **(4 marks)**

$$d = v_0 t + \frac{1}{2}at^2 \qquad \leftarrow \textbf{1 mark}$$

$$= (18\sin 25°)(4.2) + \frac{1}{2}(-9.8)(4.2)^2 \qquad \leftarrow \textbf{2 marks}$$

$$= -54\ \text{m} \quad (h = 54\ \text{m}) \qquad \leftarrow \textbf{1 mark}$$

b) How far from the base of the cliff d did the rock land? **(3 marks)**

$$d = vt \qquad \leftarrow \textbf{1 mark}$$

$$= (18\cos 25°)(4.2) \qquad \leftarrow \textbf{1 mark}$$

$$= 69\ \text{m} \qquad \leftarrow \textbf{1 mark}$$

2. A $0.030\ \text{kg}$ toy car is pushed back against a spring-based launcher as shown in Diagram 1.

Diagram 1

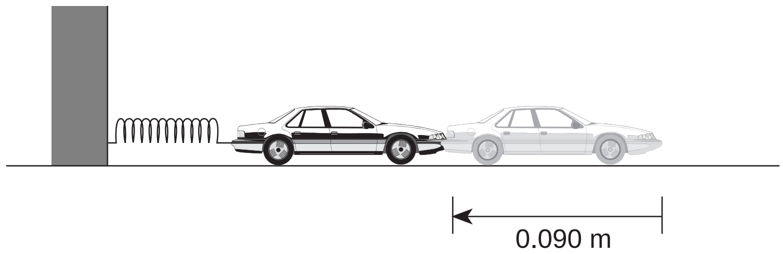
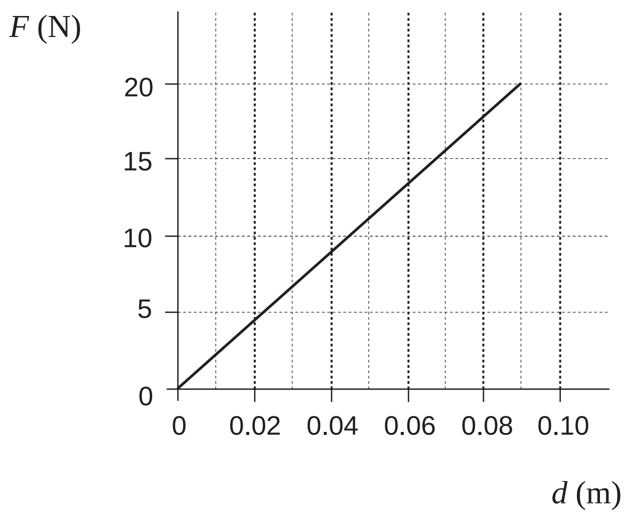


Diagram 2 shows a graph of the force required to compress the spring $0.090\ \text{m}$.

Diagram 2



a) What is the work done in compressing the spring? **(3 marks)**

Suggestion: Allow 1 to 3 sig figs for all parts of question 2.

$$W = Area\ under\ graph$$

$$= \frac{1}{2}(0.09\ \text{m})(20\ \text{N})$$

$$= 0.90\ \text{N}\cdot\text{m} \quad (0.90\ \text{J}) \qquad \leftarrow \textbf{3 marks}$$

$(\text{Will accept } 0.9\ \text{J})$

b) Assuming no losses due to heat, what maximum speed is reached by the toy car when it is released? **(3 marks)**

$$W = \Delta E_k$$

$$\therefore \Delta E_k = 0.90\ \text{J}$$

$$\therefore \frac{1}{2} m v_{\max}{}^2 = 0.90\ \text{J}$$

$$\therefore v_{\max} = \left(\frac{2 \cdot 0.90\ \text{J}}{0.030\ \text{kg}}\right)^{\frac{1}{2}}$$

$$= 7.7\ \text{m/s} \quad \leftarrow \textbf{3 marks}$$

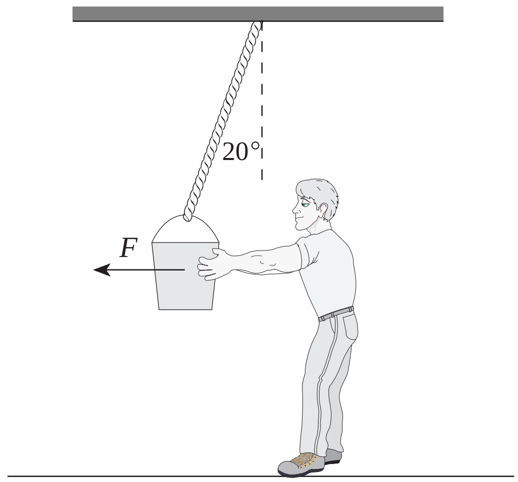
c) If in fact the maximum kinetic energy of the car is $0.18\ \text{J}$, what is the efficiency of the spring-based launcher? **(1 mark)**

$$Efficiency = \frac{Energy\ out}{Energy\ in} \times 100$$

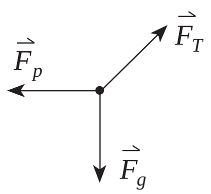
$$\therefore Efficiency = \frac{0.18\ \text{J}}{0.90\ \text{J}} \times 100 = 20\% \quad \leftarrow \textbf{1 mark}$$

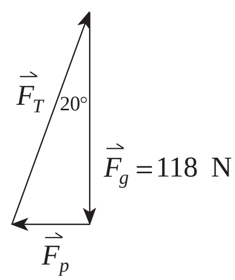
(Accept 0.2)

3. Peter exerts a horizontal force F on a $12\ \text{kg}$ bucket of concrete so that the supporting rope makes an angle of $20°$ with the vertical.



a) Find the tension force in the supporting rope. **(5 marks)**





$\leftarrow$ **2 marks**

$$F_T = \frac{118}{\cos 20°}$$ $\leftarrow$ **2 marks**

$$= 125\ \text{N}$$ $\leftarrow$ **1 mark**

$$F_T = 1.3 \times 10^2\ \text{N}$$

b) Peter now exerts a new force which causes the rope to make a greater angle with the vertical. How will the tension force in the supporting rope change?

- [x] The tension force will increase.
- [ ] The tension force will decrease.
- [ ] The tension force will remain the same.

(Check one response.) **(1 mark)**

c) Using principles of physics, explain your answer to b). **(3 marks)**

The vertical component of the tension is equal to the weight and is unchanged. Peter's horizontal force increases with a larger angle. The horizontal component of the tension is equal to Peter's and therefore is also increased. Thus, the resultant tension is increased.

4. A 650 kg satellite in circular orbit around Earth has an orbital period of $1.5 \times 10^4\text{ s}$.

a) What is the satellite's orbital radius? **(5 marks)**

$$F_G = F_C \qquad \leftarrow \textbf{1 mark}$$

$$\frac{G\cancel{m}M}{\cancel{R}^2} = \cancel{m}\frac{4\pi^2}{T^2}R \qquad \leftarrow \textbf{2 marks}$$

$$R^3 = \frac{GMT^2}{4\pi^2} = \frac{6.67\times10^{-11}\left(5.98\times10^{24}\right)\left(1.5\times10^4\right)^2}{4\pi^2}$$

$$R = 1.3\times10^7\text{ m} \qquad \leftarrow \textbf{2 marks}$$

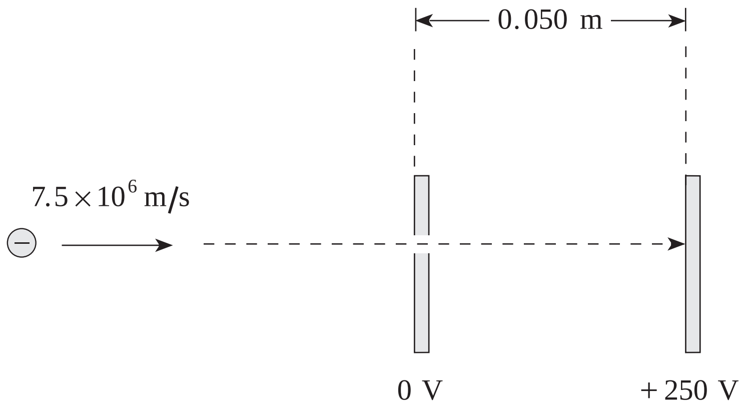
b) What is the gravitational potential energy of this satellite? **(2 marks)**

$$E_p = -\frac{GmM}{R} \qquad \leftarrow \textbf{1 mark}$$

$$= \frac{-\left(6.67\times10^{-11}\right)(650)\left(5.98\times10^{24}\right)}{\left(1.3\times10^7\right)}$$

$$E_p = -2.0\times10^{10}\text{ J} \qquad \leftarrow \textbf{1 mark}$$

5. An electron moving at 7.5×10^6 m/s enters a region of electric field between parallel plates by passing through a small hole in one of the plates.



What is the impact speed of the electron on the second plate? **(7 marks)**

$$E_k = E_{k_i} + \Delta E_p$$

$$E_{k_i} = \frac{1}{2} m v_i^2$$

$$= \frac{1}{2} \cdot 9.11 \times 10^{-31} \text{ kg} \cdot \left(7.5 \times 10^6 \text{ m/s}\right)^2$$

$$= 2.56 \times 10^{-17} \text{ J}$$ ← **1 mark**

$$\Delta E_p = QV$$

$$= 1.6 \times 10^{-19} \text{ C} \cdot 250 \text{ V}$$

$$= 4.0 \times 10^{-11} \text{ J}$$ ← **2 marks**

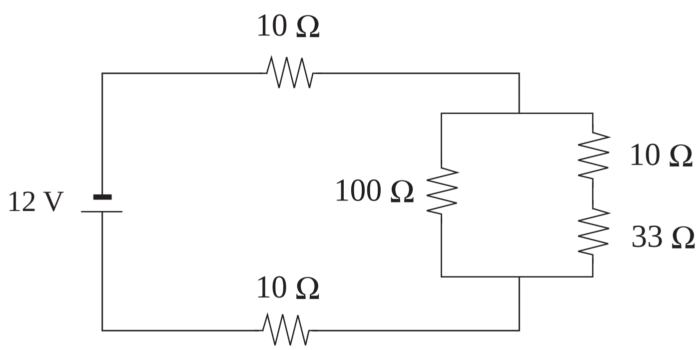
$$\therefore E_k = 2.56 \times 10^{-17} \text{ J} + 4.0 \times 10^{-17} \text{ J}$$ ← **2 marks**

$$= 6.56 \times 10^{-17} \text{ J}$$

$$\therefore v_f = \left(\frac{2 \cdot 6.56 \times 10^{-17} \text{ J}}{9.11 \times 10^{-31} \text{ kg}} \right)^{\frac{1}{2}}$$

$$= 1.2 \times 10^7 \text{ m/s}$$ ← **2 marks**

6. What is the power dissipated in the $33\ \Omega$ resistor in the circuit shown below? **(7 marks)**



$$\frac{1}{R_{||}} = \frac{1}{100} + \frac{1}{(10+33)}$$

$$\therefore R_{||} = 30.1\ \Omega$$

$$R_T = 10\ \Omega + 30.1\ \Omega + 10\ \Omega$$

$$= 50.1\ \Omega$$ ← **2 marks**

$$I_T = \frac{V}{R_T}$$

$$= \frac{12\ \text{V}}{50.1\ \Omega}$$

$$= 0.24\ \text{A}$$ ← **1 mark**

$$V_{||} = I_T \cdot R_{||}$$

$$= 0.24\ \text{A} \cdot 30.1\ \Omega$$

$$= 7.22\ \text{V}$$ ← **2 marks**

$$\therefore I_{33} = \frac{V_{||}}{(33+10)\Omega}$$

$$= 0.17\ \text{A}$$ ← **1 mark**

$$\therefore P_{33} = I^2 R$$

$$= (0.17)^2 \cdot 33\ \Omega$$

$$= 0.95\ \text{W}$$ ← **1 mark**

7. A motor is connected to a constant 120 V source and draws a current of 38.0 A when it first starts up. At its normal operating speed, the motor draws a current of 2.50 A.

a) What is the resistance of the armature coil? **(3 marks)**

$$V = IR$$

$$120 = (38.0)R$$

$$R = 3.16\ \Omega \qquad \leftarrow \textbf{3 marks}$$

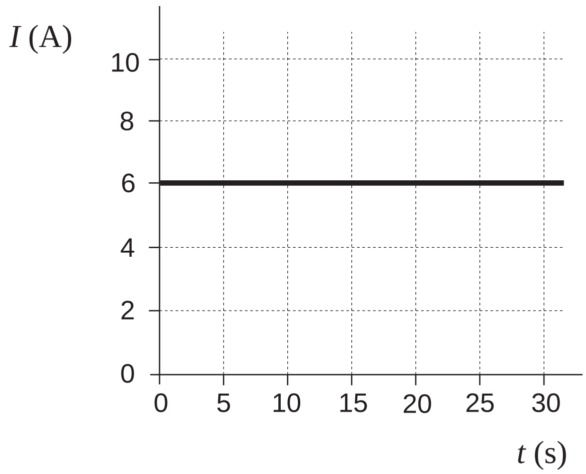
b) What is the back emf at normal speed? **(4 marks)**

$$\varepsilon_{back} = V_{applied} - IR \qquad \leftarrow \textbf{2 marks}$$

$$= 120 - (2.50)(3.16)$$

$$= 112\text{ V} \qquad \leftarrow \textbf{2 marks}$$

8. A power supply was connected to a resistor and a student plotted the graph of current, I, flowing through the resistor versus time, t, as shown below.



a) Calculate the area under the graph between $t = 0$ s and $t = 30$ s. **(2 marks)**

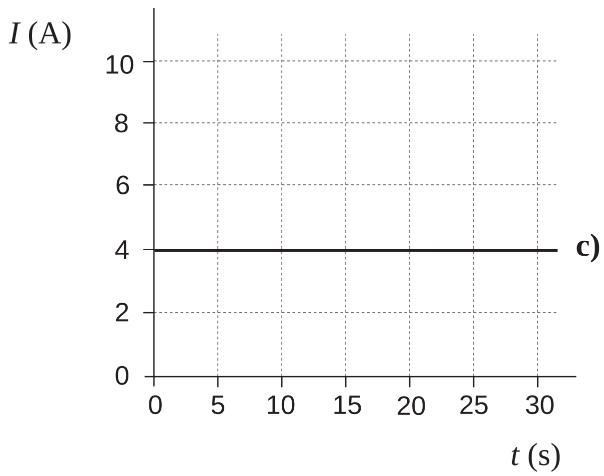
$Area = (6\ \text{A})(30\ \text{s})$

$180\ \text{A} \cdot \text{s} = 180\ \text{C}$

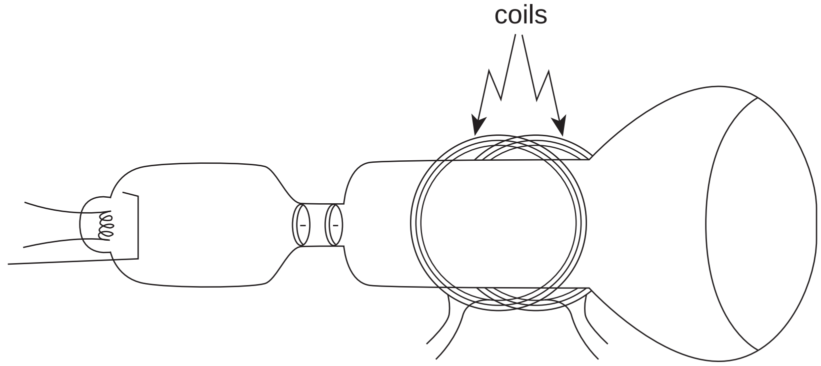
b) What does this area represent? **(1 mark)**

This area represents the charge delivered.

c) The same power supply is connected to a resistor of greater resistance. For this new set-up, sketch a possible graph on the axes below and label it c). **(2 marks)**



9. In a cathode ray tube, the purpose of the coils is to



- ☐ focus the beam of electrons.
- ☑ deflect the beam of electrons.
- ☐ decrease the speed of the electrons.

(Check one response.) **(1 mark)**

b) Using the principles of electromagnetism, explain how this effect on the electrons is achieved by the coils. **(3 marks)**

The electrons are already moving by the time they reach the area between the coils. By allowing current to travel through the coils, a magnetic field is produced. This magnetic field applies a force on the moving electron. $(F = qvB)$

By changing the magnitude and direction of the current through the coils, the magnitude and direction of the electron deflection can be controlled.

END OF KEY