Physics 12

June 1999 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.	C	K	1	C6	16.	A	H	4	I4, A10
2.	A	U	1	C7, 8, D5	17.	D	K	4	J10
3.	B	U	1	C4, 7, D3	18.	C	U	4	J8, I4
4.	C	U	1	C3, 7, D1, 5	19.	D	K	5	L7
5.	B	U	1	C4, 8, D3, 6	20.	C	U	5	L6
6.	B	U	2	E1	21.	B	H	5	K2, I4
7.	A	K	2	F2	22.	C	K	6	M9
8.	D	U	2	E7, F7	23.	D	U	6	N2
9.	C	U	2	G3	24.	C	H	6	M7, 5, N2
10.	C	K	3	H9	25.	A	K	7	O3
11.	B	U	3	H2, 3	26.	C	U	7	O6
12.	D	U	3	H11	27.	A	U	7	O8, P1
13.	B	K	4	I3	28.	D	U	7	P4
14.	C	U	4	I4	29.	C	U	7	P9
15.	C	U	4	I4, J2	30.	D	U	7	P11

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	7	1	B8
2.	2	U	7	2	E8
3.	3	H	9	3	H11
4.	4	U	7	4	J9, 8, E7
5.	5	U	7	5	K8, L7, M8
6.	6	U	7	6	M11, M6, 7
7.	7	U	7	7	P5
8	8	H	5	1	A10, E3
9.	9	H	4	7	O6

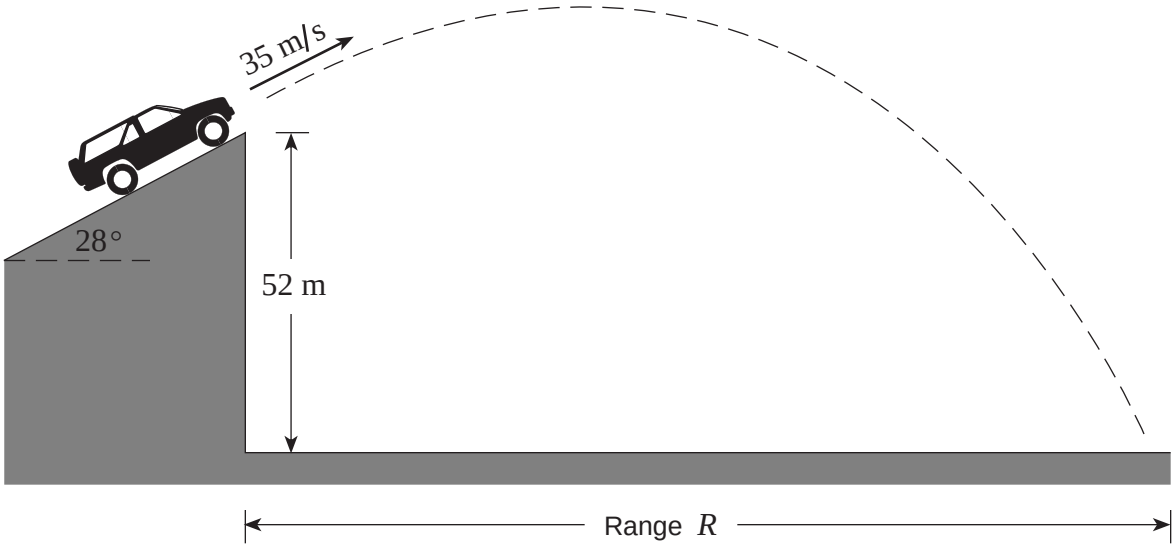
Written Response = 60 marks

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

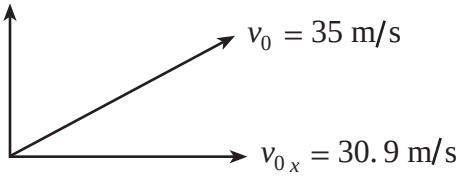
1. A stunt vehicle leaves an incline with a speed of 35 m/s at a height of 52 m above level ground. Air resistance is negligible.



a) What are the vehicle's vertical and horizontal velocity components as it leaves the incline?

(1 mark)

Components: $v_{0y} = 16.4 \text{ m/s}$



b) What is the vehicle's time of flight? **(4 marks)**

$$d = v_0 t + \frac{1}{2} a t^2$$

$$-52 = 16.4t + \frac{1}{2}(-9.8)t^2$$

$t = 5.3 \text{ s}$ ← **4 marks**

c) What is the vehicle's range, R ? **(2 marks)**

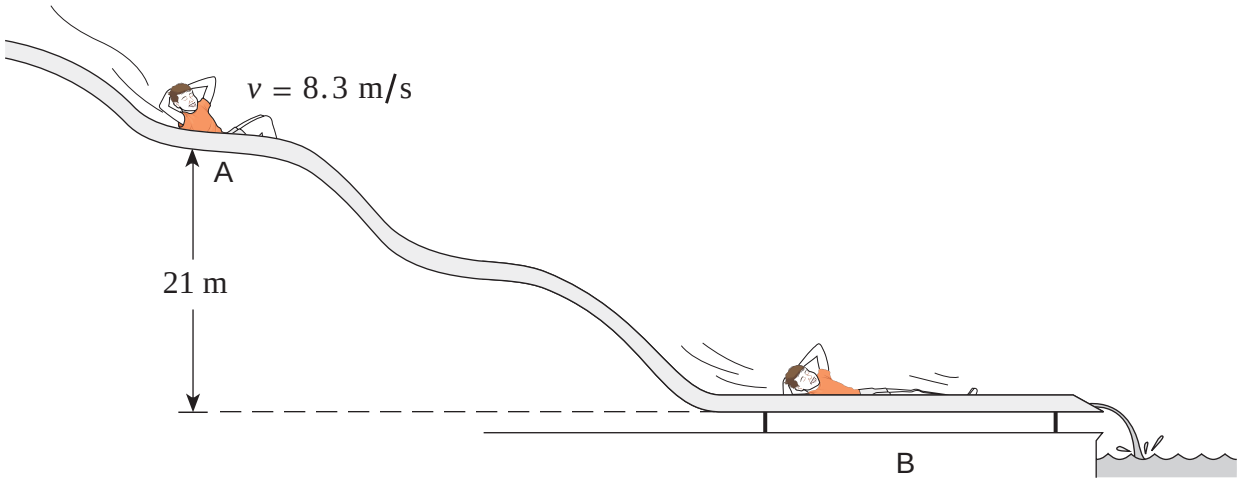
$R = v_x t$

$R = 30.9(5.3)$

$R = 165 \text{ m}$

$R = 1.6 \times 10^2 \text{ m}$ ← **2 marks**

2. A 45 kg child on a water slide passes point A at 8.3 m/s.



As the child descends from A to B, 3 600 J of heat energy is created because of friction. What is his speed at B? **(7 marks)**

$$E = E' \qquad \leftarrow \textbf{1 mark}$$

$$E_k + E_p + E_H = E_k' + E_p' + E_H' \qquad \leftarrow \textbf{2 marks}$$

$$\tfrac{1}{2}mv^2 + mgh = \tfrac{1}{2}m(v')^2 + E_H' \qquad \leftarrow \textbf{1 mark}$$

$$\tfrac{1}{2}(45)(8.3)^2 + 45(9.8)(21) = \tfrac{1}{2}(45)(v')^2 + 3\,600 \qquad \leftarrow \textbf{1 mark}$$

$$1\,550 + 9\,260 = 22.5(v')^2 + 3\,600 \qquad \leftarrow \textbf{1 mark}$$

$$v' = 18 \text{ m/s} \qquad \leftarrow \textbf{1 mark}$$

OR

$E = E'$

$E_k + E_p + E_H = E_k' + E_p' + E_H'$ $\leftarrow$ **2 marks**

$E_k = \tfrac{1}{2}mv^2 = 1\,550$ J $\leftarrow$ **1 mark**

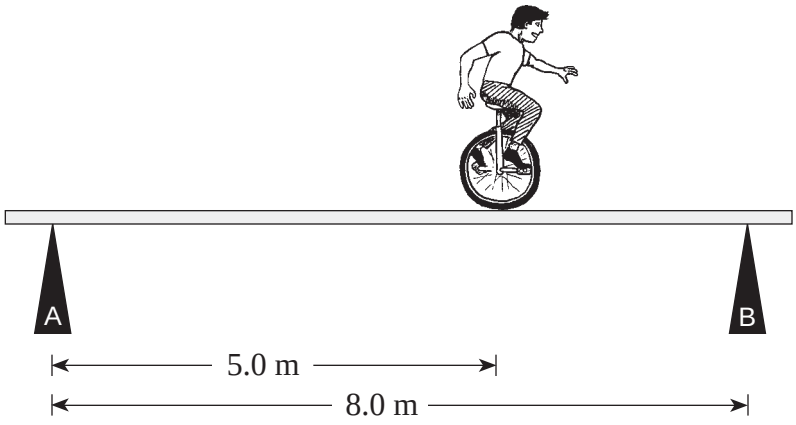
$E_p = mgh = 9\,260$ J $\leftarrow$ **1 mark**

$E_k' = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(45)(v')^2$ $\leftarrow$ **1 mark**

$E_H' = 3\,600$ J $\leftarrow$ **1 mark**

$v' = 18$ m/s $\leftarrow$ **1 mark**

3. A circus performer on a unicycle of total mass 55 kg rides across a uniform 30 kg beam. The supports are placed equal distances from the ends of the beam.



a) When he is at the position shown, determine the forces exerted by the supports on the beam. **(5 marks)**

$\Sigma\tau = 0$

$0 = -30(9.8)(4) + (-55)(9.8)(5) + F_B(8)$ } ← **3 marks**

$F_B = 480$ N

$\Sigma F = 0$

$0 = F_A + 480 - 30(9.8) - 55(9.8)$ } ← **2 marks**

$F_A = 350$ N

b) As the performer moves toward the right the force exerted by support B will

- ☐ remain the same.
- ☑ increase.
- ☐ decrease.

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

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

As the cyclist moves toward B the lever arm increases and thus there is a larger clockwise torque. In order to remain in static equilibrium, the counter-clockwise torque must increase. Since the distance is fixed, the force must increase.

4. A 1 500 kg satellite travels in a stable circular orbit around the earth. The orbital radius is 4.2×10^{7} m. What is the satellite's kinetic energy? **(7 marks)**

$$F_{net} = ma_c$$

$$\frac{Gm_E m_s}{r^2} = \frac{m_s \cdot v^2}{r} \qquad \leftarrow \textbf{2 marks}$$

$$\therefore v = \left(\frac{Gm_E}{r}\right)^{\frac{1}{2}} \qquad \leftarrow \textbf{1 mark}$$

$$= \left(\frac{6.67\times10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2 \cdot 5.98\times10^{24}\ \text{kg}}{4.2\times10^{7}\ \text{m}}\right)^{\frac{1}{2}} \qquad \leftarrow \textbf{1 mark}$$

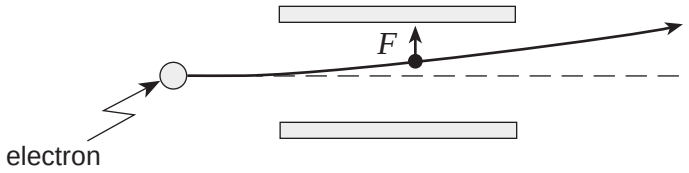
$$= 3.1\times10^{3}\ \text{m/s} \qquad \leftarrow \textbf{1 mark}$$

$$E_k = \tfrac{1}{2}mv^2$$

$$= \tfrac{1}{2}\cdot 1\,500\ \text{kg}\left(3.1\times10^{3}\ \text{m/s}^2\right)^2$$

$$= 7.1\times10^{9}\ \text{J} \qquad \leftarrow \textbf{2 marks}$$

5. An electron passing between parallel plates 0.025 m apart experiences an upward electrostatic force of 5.1×10^{-16} N.



a) What is the magnitude of the electric field between the plates? **(3 marks)**

$$E = \frac{F}{q} \qquad \leftarrow \textbf{1 mark}$$

$$= \frac{5.1\times10^{-16}\ \text{N}}{1.6\times10^{-19}\ \text{C}} \qquad \leftarrow \textbf{1}\tfrac{\textbf{1}}{\textbf{2}}\ \textbf{marks}$$

$$= 3.2\times10^{3}\ \text{N/C} \qquad \leftarrow \tfrac{\textbf{1}}{\textbf{2}}\ \textbf{mark}$$

b) What is the potential difference between the plates? **(2 marks)**

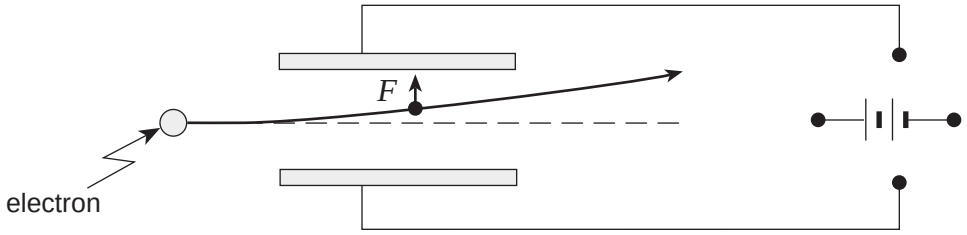
$$E = \frac{V}{d} \qquad \leftarrow \textbf{1 mark}$$

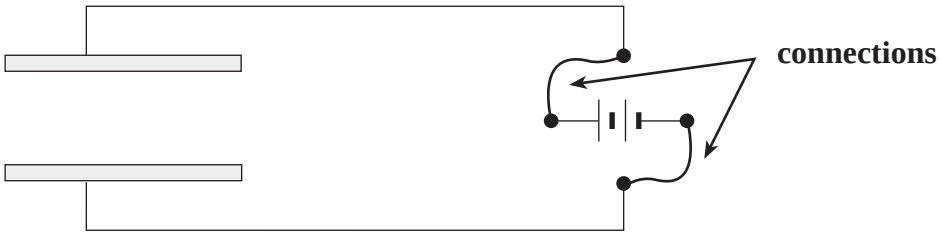
$$V = Ed$$

$$= 3.2\times10^{3}\times0.025$$

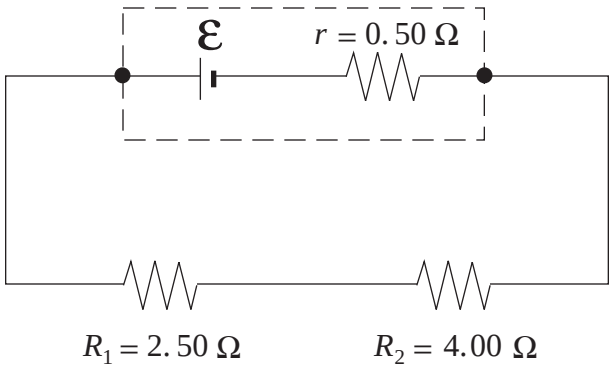
$$= 80\ \text{V} \qquad \leftarrow \textbf{1 mark}$$

c) On the diagram below draw in the connections to the power supply necessary for the electron to experience this upward force. **(2 marks)**





6. The cell shown in the diagram supplies a 1.80 A current to the resistors R_1 and R_2.



a) What is the terminal voltage of the cell? **(3 marks)**

$V_T = IR$ ← **½ mark**

$= 1.80(2.50 + 4.00)$ ← **2 marks**

$= 11.7$ V ← **½ mark**

b) What is the emf of the cell? **(4 marks)**

$V_T = \mathcal{E} - Ir$ ← **1 mark**

$11.7 = \mathcal{E} - 1.80(0.50)$ ← **2 marks**

$\mathcal{E} = 12.6$ V ← **1 mark**

7. A rectangular coil of wire containing 250 loops is placed in a magnetic field. Each loop measures 0.075 m by 0.28 m. The magnetic field changes over a time interval of 0.36 s producing an average emf of 1.3 V. What is the change in the magnetic field strength?

(7 marks)

$$\mathcal{E} = \frac{-N\Delta\Phi}{t} \qquad \Delta\Phi = \Delta BA$$

$$\Delta B = \frac{\mathcal{E} \cdot t}{N \cdot A} \qquad \leftarrow \textbf{3 marks}$$

$$= \frac{1.3 \text{ V} \times 0.36}{250(0.075 \times 0.28)} \qquad \leftarrow \textbf{3 marks}$$

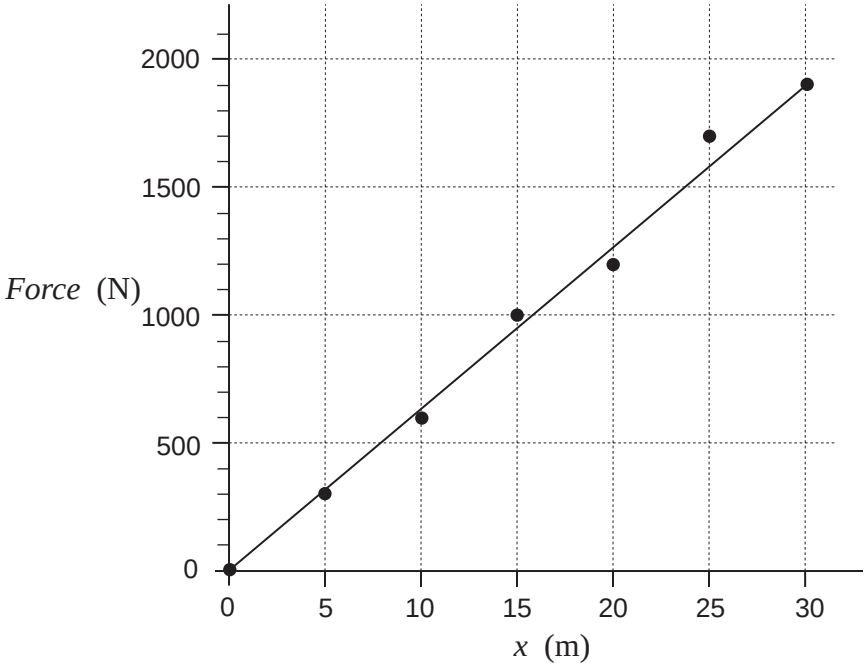
$$\Delta B = 0.089 \text{ T} \qquad \leftarrow \textbf{1 mark}$$

(Accept + or − answers)

8. A daredevil is attached by his ankles to a bungee cord and drops from the top of a bridge. The force exerted on the daredevil by the bungee cord is measured against the change in length, x, of the cord as the cord is stretched, slowing the daredevil's fall.

Force (N)	0	300	600	1 000	1 200	1 700	1 900
x (m)	0	5	10	15	20	25	30

a) Plot a graph of force vs. change in length on the graph below. **(2 marks)**

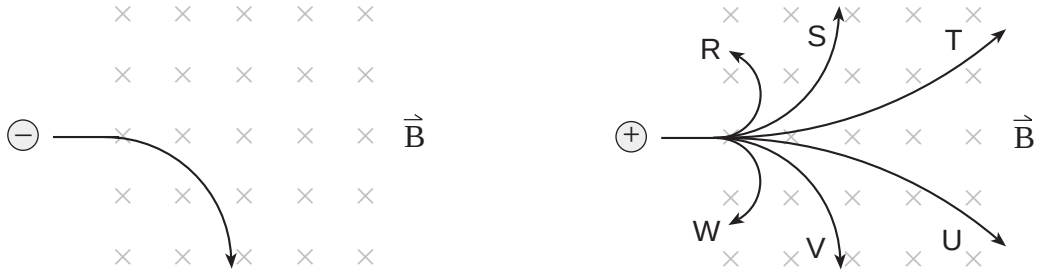


b) Use the graph to determine the work done by the bungee cord during its stretch. **(3 marks)**

$$Area = \frac{1\,900 \cdot 30}{2} = 28\,500 \text{ J}$$

$$= 2.9 \times 10^4 \text{ J} \qquad \leftarrow \textbf{3 marks}$$

9. An electron travelling at a high speed enters a magnetic field as shown. A proton travelling at the same speed then enters the magnetic field.



a) Which of the six possible paths shown does the proton follow? **(1 mark)**

Path T

b) Using principles of physics, explain why the proton takes the path selected in a). **(3 marks)**

Since a proton has a positive charge it will travel in the opposite direction as the electron. The proton is also more massive than the electron, therefore the F_B will cause a smaller a_C and hence a larger radius for its path.

END OF KEY