Applications of Physics 12

June 2000 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

	Organizers	Sub-Organizers
1.	Transformers	A, B, C
2.	Momentum	D, E
3.	Energy Conversion	F
4.	Transducers	G, H
5.	Waves and Vibrations	I, J
6.	Electricity and Magnetism	K, L, M

PART A: Multiple Choice

Q	K	C	CO	PLO	Q	K	C	CO	PLO
1.	D	U	1	A4	19.	B	U	4	G10, 1
2.	B	K	1	B2	20.	D	U	4	H5
3.	C	U	1	B2	21.	C	K	5	I3
4.	B	U	1	B1, 3	22.	D	U	5	I3, 5
5.	A	K	1	D1	23.	D	U	5	I4
6.	A	U	1	D7	24.	A	U	5	I5
7.	B	K	1	E6	25.	D	H	5	I6, 9
8.	A	U	2	E2	26.	B	U	5	J2
9.	D	U	2	E2	27.	D	U	5	J10
10.	C	U	2	E2	28.	B	K	6	K5
11.	C	U	2	E4	29.	C	U	6	K11, 12
12.	D	H	2	E4	30.	B	U	6	K6
13.	C	K	3	F3	31.	A	U	6	K4
14.	C	U	3	F5	32.	B	H	6	K8
15.	C	U	3	F5	33.	B	U	6	L2
16.	C	K	4	G3, 8	34.	C	K	6	M4
17.	A	H	4	G5, 11	35.	D	U	6	M8
18.	D	U	4	G8	36.	C	H	6	M5

Multiple Choice = 36 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	H	4	1	A4
2.	2	U	4	1	C5, 6
3.	3	U	4	2	D3, 7
4.	4	U	3	4	G7
5.	5	H	4	4	H8
6.	6	U	5	5	I10, 11
7.	7	U	3	5	J9
8.	8	U	5	6	K5, 8
9.	9	U	4	6	L4

Written Response = 36 marks

Multiple Choice = 36 (36 questions)
Written Response = 36 (9 questions)
EXAMINATION TOTAL = 72 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 cyclist rides up a 4.4 km long trail to climb a 1 200 m high mountain. Due to friction, the efficiency of the trail, as a simple machine, is 40% in getting the cyclist up the mountain. The mass of the cyclist and the bike is 75 kg. What is the average force of friction (from all sources) on the cyclist? **(4 marks)**

$$\begin{aligned} efficiency &= \frac{E_{out}}{E_{in}} = \frac{mgh}{E_{in}} \\ 0.40 &= \frac{75(9.8)(1\,200)}{E_{in}} \\ E_{in} &= 2\,205\,000 \\ F \cdot d &= 2\,205\,000 \\ F &= \frac{2\,205\,000}{4\,400} \\ &= 501.2 \text{ N} \end{aligned}$$

← **2 marks**

if $efficiency = 100\%$, then

$$\begin{aligned} E_{in} &= E_{out} = mgh = 882\,000 \\ F \cdot d &= 882\,000 \\ F &= \frac{882\,000}{4\,400} \\ &= 200.5 \text{ N} \\ \therefore F_{fr} &= 501.2 - 200.5 \\ &= 300.7 \\ &= 301 \text{ N} \end{aligned}$$

← **2 marks**

2. An electric power generating plant produces electrical energy at a rate of 50 MW and at a voltage of 15 000 V. The power is to be transmitted at 500 000 V.

a) What is the turns ratio of the transformer? (The transformers needed may be assumed to be 100% efficient.) **(2 marks)**

$$\frac{V_{out}}{V_{in}} = \frac{N_{out}}{N_{in}} \qquad \leftarrow \textbf{1 mark}$$

$$500\ 000\ \text{V} = \frac{N_{out}}{N_{in}}(15\ 000\ \text{V}) = \frac{N_{out}}{N_{in}} = 33.3 \qquad \leftarrow \textbf{1 mark}$$

or

$$= 0.030$$

b) At 500 000 V, what is the transmission current? **(2 marks)**

$$P_{input} = P_{output}$$

$$500\ \text{MW} = (500\ 000\ \text{V})(I) \qquad \leftarrow \textbf{1 mark}$$

$$I = 100\ \text{A} \qquad \leftarrow \textbf{1 mark}$$

3. A 250 g ball moving directly toward a brick wall at 22 m/s rebounds at 18 m/s.

a) What is the impulse exerted on the ball? **(2 marks)**

$\Delta p = 0.25\big(22-(-18)\big) = 10\ \text{N}\cdot\text{s}$ or $-10\ \text{N}\cdot\text{s}$ ← **2 marks**

b) What is the change in the kinetic energy of the ball? **(2 marks)**

$\Delta KE = \frac{1}{2}(0.25\ \text{kg})\left[(18\ \text{m/s})^2 - (22\ \text{m/s})^2\right] = -20\ \text{J}$ or $+20\ \text{J}$ ← **2 marks**

4. a) Name a type of fluid transducer. **(1 mark)**

For example:

An anemometer.

b) Describe how it operates in a practical application. **(2 marks)**

For example:

When placed in the wind, the wind causes the cup system to rotate. The rate of rotation is proportional to the wind speed and allows for a determination of the wind speed.

5. a) Explain how a thermocouple is used to determine temperature. **(2 marks)**

A thermocouple converts temperature differences into electric voltages. The voltage between the two junctions of a thermocouple is proportional to the temperature difference between the junctions. Therefore, a voltage measurement will allow for a temperature determination.

b) State **two** significant advantages of using thermocouples and thermistors to determine temperature as opposed to using either liquid-in-glass thermometers or bimetallic strips. **(2 marks)**

Some advantages of thermistors and thermocouples are:

- **They are small and can be placed in regions not easily accessible to larger devices.**
- **They come to equilibrium quickly and can follow rapid temperature changes.**
- **Output is electrical and can be easily monitored or used to control devices.**

6. In a pipe closed at one end, resonance occurs at the following wavelengths.

$L = \frac{\lambda}{4}$ $L = \frac{3\lambda}{4}$ $L = \frac{5\lambda}{4}$ where L = length of pipe

a) Determine the lowest resonant frequency for a pipe of length 80 cm. The speed of sound is 340 m/s at room temperature. **(2 marks)**

$$L = \frac{\lambda}{4}$$

$$0.8 \text{ m} = \frac{\lambda}{4}$$

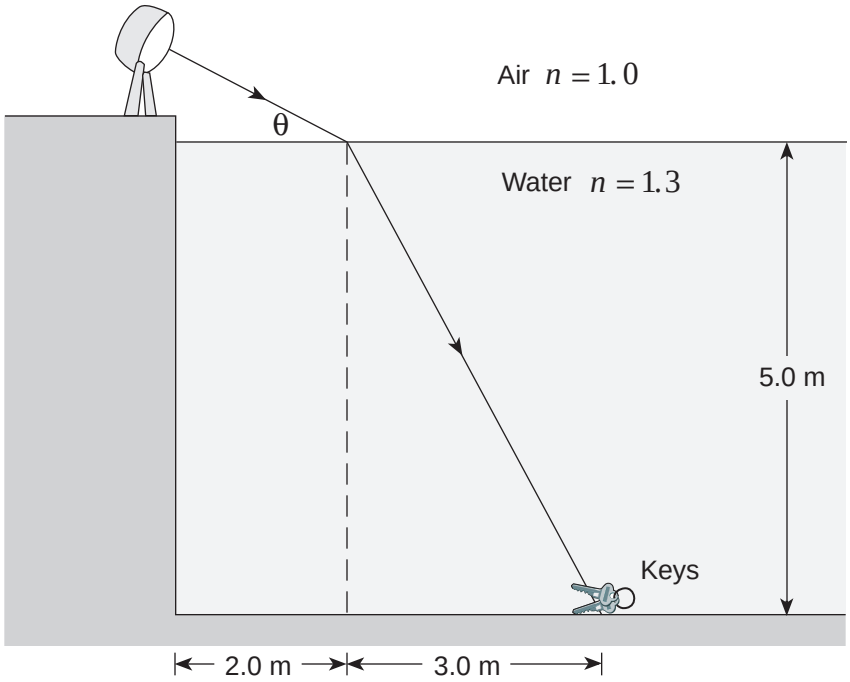
$$\lambda = 3.2 \text{ m}$$

$$f = \frac{v}{\lambda} = \frac{340 \text{ m/s}}{3.2 \text{ m}} = 106 \text{ Hz}$$

b) Explain why resonance occurs at specific frequencies in a pipe. You may use a diagram to aid in your explanation. **(3 marks)**

The reflected sound wave interferes with the incoming wave. This creates a standing wave. Resonance will only occur when the pipe length matches specific fractions of the wavelength.

7. A searchlight is being used at the edge of a swimming pool to locate some keys at the bottom of the pool. The pool is 5.0 m deep and the keys are 5.0 m from the edge of the pool.



(Diagram not drawn to scale.)

At what angle, θ, should the searchlight be pointed if the light enters the water 2.0 m from the edge? **(3 marks)**

$$\tan(\theta_r) = \frac{3}{5}$$

$$\theta_r = 31^\circ \qquad \leftarrow \textbf{1 mark}$$

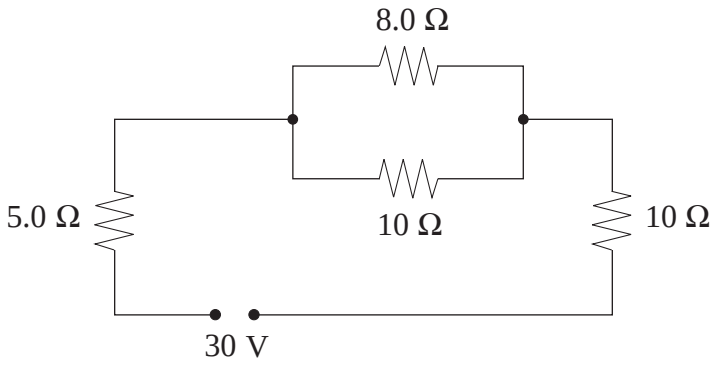
$$\sin(\theta_i) = 1.3\sin(31^\circ)$$

$$\theta_i = 42^\circ \qquad \leftarrow \textbf{1 mark}$$

$$\therefore \theta = 90 - 43$$

$$= 48^\circ \qquad \leftarrow \textbf{1 mark}$$

8. Consider the following diagram.



Determine the power consumed by the $8.0\ \Omega$ load. **(5 marks)**

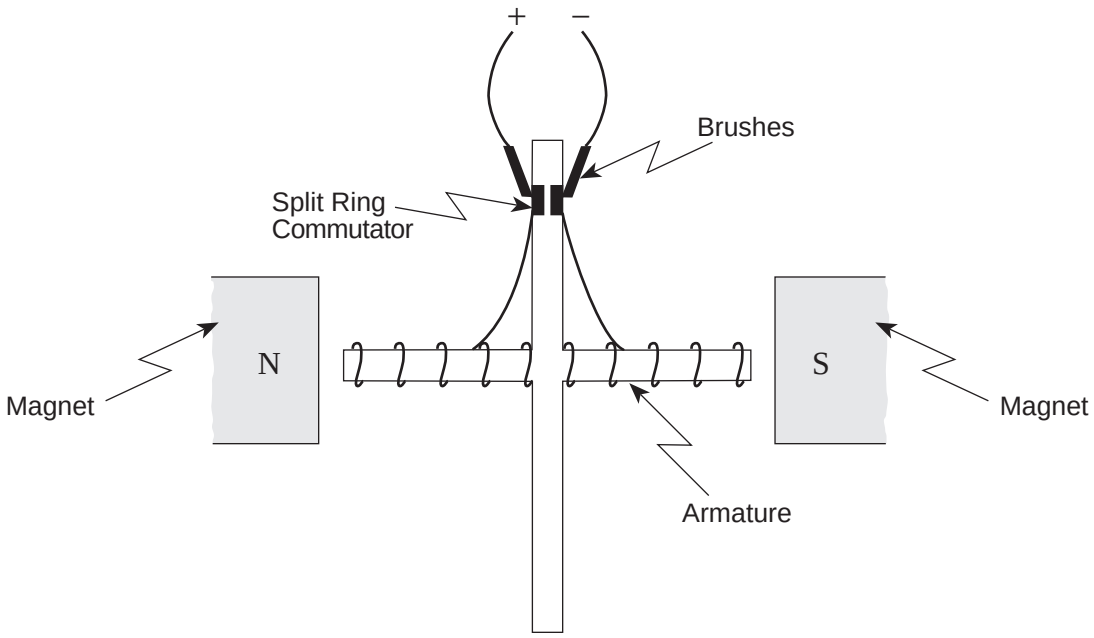
$R_{eq} = 19.44\ \Omega$ ← **2 marks**

$I_{tot} = 1.54\ \text{A}$ ← **1 mark**

$V_{8\Omega} = 6.9\ \text{V}$ ← **1 mark**

$P = \frac{V^2}{R} = 5.9\,\text{W}$ ← **1 mark**

9. Draw a sketch of a model dc motor. Include and label all important features. **(4 marks)**



1 mark—magnet
1 mark—split ring commutator
1 mark—brushes
1 mark—armature

END OF KEY