Applications of Physics 12

June 1999 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	K	1	A4	19.	A	K	5	H7
2.	C	U	1	A3	20.	C	H	5	I5
3.	A	K	1	B2	21.	B	K	5	I9, 10
4.	C	U	1	B2	22.	A	U	5	I3
5.	A	U	1	C4	23.	B	U	5	I6
6.	D	U	1	C1	24.	D	U	5	I7
7.	C	U	2	D3	25.	A	K	5	J4
8.	A	U	2	D2	26.	D	U	5	J9, 10
9.	D	K	2	E7	27.	C	U	6	J8
10.	B	U	2	E4	28.	D	U	6	K5
11.	C	U	2	E3	29.	B	U	6	K6
12.	B	K	3	F4	30.	B	U	6	K8
13.	B	H	3	F5, M3	31.	A	U	6	K10
14.	C	U	4	G6	32.	B	K	6	L4
15.	D	U	4	G5	33.	C	U	6	L3
16.	A	H	4	H5	34.	D	U	6	M3, K10
17.	A	U	4	H7	35.	C	U	6	M8
18.	C	U	4	H8	36.	B	U	6	M4

Multiple Choice = 36 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	U	4	1	A4
2.	2	H	3	1	C3
3.	3	U	5	2	D7
4.	4	U	4	2	E7, F5
5.	5	H	4	4	G10
6.	6	U	5	5	I10, 11
7.	7	U	3	5	J11
8	8	H	4	6	K8
9.	9	U	4	6	L8

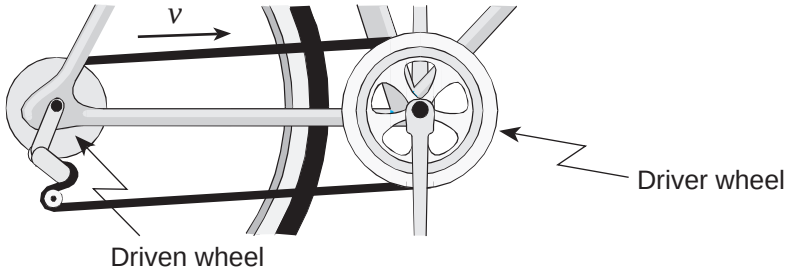
Written Response = 36 marks

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. The driver wheel of a bicycle has 32 teeth.



a) How many teeth should the driven wheel have, if the speed mechanical advantage is to be approximately 3.5? (Force mechanical advantage is $\frac{1}{3.5}$) **(2 marks)**

$$MA_s = \frac{\#\ teeth\ driver}{\#\ teeth\ driven}$$

$$3.5 = \frac{32}{x}$$

$$x = \frac{32}{3.5}$$

$$= 9.0$$

b) The radius of the driver wheel is 12 cm. What should the radius of the driven wheel be? **(2 marks)**

$$\frac{12}{x} = 3.5$$

$$x = 3.4 \text{ cm}$$

or

$$driver\ C = 2\pi r$$

$$= 75.4$$

$$sprocket\ distance = \frac{75.4}{32}$$

$$= 2.36$$

$$driven\ C = 9(2.36)$$

$$= 21.2$$

$$r = \frac{21.2}{2\pi} = 3.4 \text{ cm}$$

2. a) An induction coil uses current that is

❒ ac.

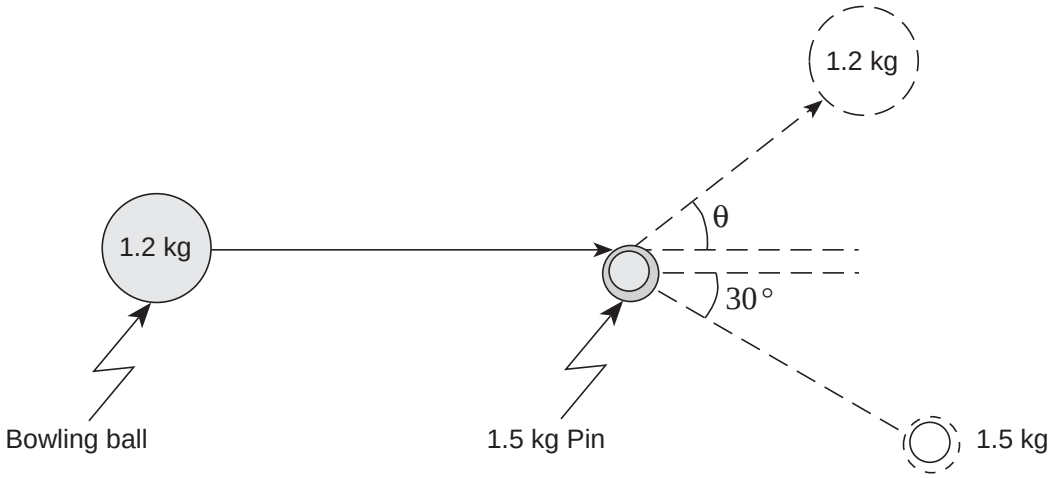
☑ dc.

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

b) Explain how an induction coil uses this current to produce a change in the magnetic field through the primary coil. **(2 marks)**

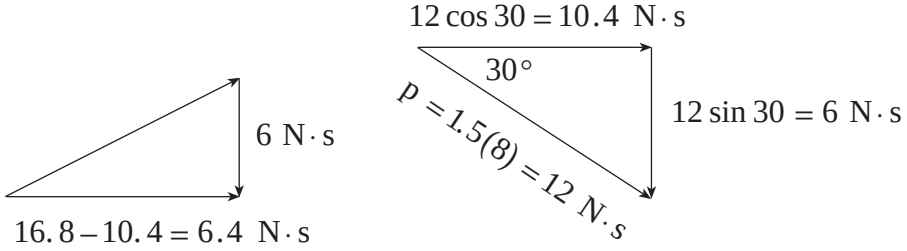
An induction coil is a pulse transformer and operates by switching on and off a large dc current in the primary coil. This induces a changing magnetic field in the primary coil.

3. A 1.2 kg bowling ball moving at 14 m/s strikes a 1.5 kg pin at an angle. The pin moves off at 8 m/s at an angle of $30°$ as shown in the diagram.



What is the velocity (magnitude and direction) of the bowling ball after striking the pin?

(5 marks)



p_{before}

$p = 1.2(14)$

$p = 16.8 \text{ N} \cdot \text{s}$

$p = \sqrt{6.4^2 + 6^2} = 8.78 \text{ N} \cdot \text{s}$

$\theta = \tan^{-1}\left(\frac{6}{6.4}\right) = 43°$

$v = \frac{p}{m} = \frac{8.78}{1.2} = 7.31 \text{ m/s}$

4. The giant blades of a wind turbine turn through two revolutions each second. This turbine turns an electric generator to produce 15 kW of power. The energy conversion is 70% efficient.

a) What total torque is the wind applying to the blades of the turbine? **(2 marks)**

$$0.7 = \frac{P \cdot t}{\tau \cdot \theta} = \frac{15\,000(1)}{\tau(4\pi)}$$

$$\tau = 1\,700 \text{ N} \cdot \text{m}$$

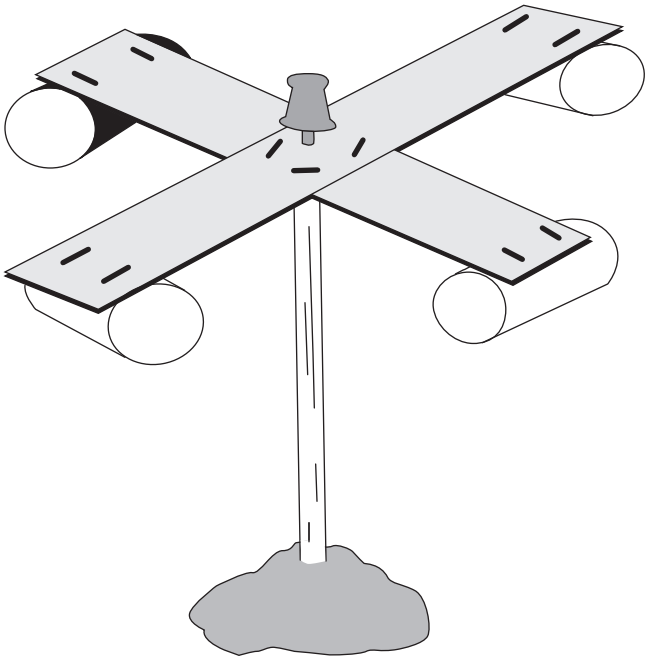
b) How long does it take to generate 77 MJ of energy? **(2 marks)**

$$E = P \cdot t$$

$$t = \frac{77 \times 10^6}{15 \times 10^3}$$

$$= 5\,100 \text{ seconds}$$

5. A student made the device shown below to measure wind speed. The materials used were: rimless paper cups (one painted black), cardboard strips, a wooden dowel, a tack, modelling clay.



Describe and explain the steps you would follow in order to determine wind speed in metres per second. **(4 marks)**

Measure the radius and determine the circumference. (1 mark)

Determine the time for a number of revolutions and divide to determine the time of one revolution. (1 mark)

Calculate the speed of wind. (2 marks)

$$v = \frac{d}{t} = \frac{2\pi r}{T}$$

6. In a pipe closed at one end, resonance produces maximum sound intensity at the following lengths.

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

a) Determine the lowest resonant frequency for a pipe of length 80 cm. **(3 marks)**

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

$$0.80 \text{ m} = \frac{\lambda}{4}$$

$$\lambda = 3.2$$

$$f = \frac{v}{\lambda} = \frac{343}{3.2} = 110 \text{ Hz}$$

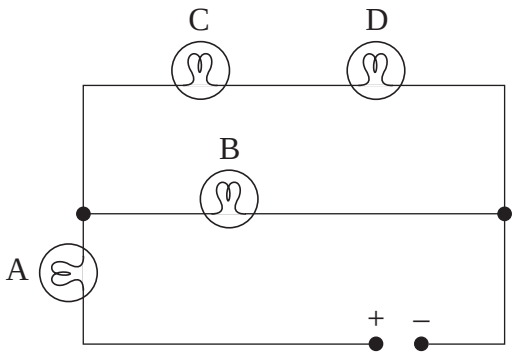
b) For the frequency determined in part a), at what pipe lengths is the sound intensity a minimum? **(2 marks)**

$L = 160$ cm, 320 cm, 480 cm, etc.

7. State how light from a laser differs from light from a typical lamp. **(3 marks)**

Laser light is of one frequency.
Laser light is in phase (in step or coherent).
Laser light does not spread out—remains a narrow beam over a very large distance.

8. Four identical bulbs are connected to a fixed voltage source as shown.



Describe what would happen to the brightness of each of the other three bulbs if bulb D were unscrewed and removed from the socket. Explain the reason for your answer in each case. (Reasonable values for bulb resistance and a voltage source may be assumed in developing your explanation.) **(4 marks)**

Since the top path is open when bulb D goes out, the equivalent resistance increases.
Bulb A—becomes slightly dimmer since increase in circuit resistance lowers current.
Bulb B—becomes slightly brighter since current through it increases.
Bulb C—goes out entirely since the branch it is on is an open circuit.

9. Compare and contrast the operation of an electric motor with that of an electric generator.
(4 marks)

A motor and a generator are almost the same in structure.

In a motor, a voltage is placed across an armature coil in a magnetic field. The voltage causes a current to flow in the coil and a torque is exerted on the coil by the magnetic field. This causes the armature to rotate.

In a generator, mechanical energy turns the armature coil in a magnetic field. A current is induced in the coil as it moves in the field.

END OF KEY