

Applications of Physics 12

June 2002 Provincial Examination

ANSWER KEY / SCORING GUIDE

CURRICULUM:

Organizers

1. Transformers
2. Momentum
3. Energy Conversion
4. Transducers
5. Waves and Vibrations
6. Electricity and Magnetism

Sub-Organizers

- A, B, C
D, E
F
G, H
I, J
K, L, M

PART A: Multiple Choice

Q	K	C	CO	PLO	Q	K	C	CO	PLO
1.	C	U	1	A4	16.	A	U	4	H8
2.	D	K	1	B2	17.	C	K	5	I3
3.	C	U	1	A4	18.	A	U	5	I5
4.	A	U	1	B2	19.	B	U	5	I10
5.	B	U	1	C2	20.	A	H	5	I11, 5
6.	C	U	1	C5	21.	C	U	5	J8
7.	B	U	1	C6, 5	22.	B	U	5	J9
8.	A	U	2	D5, 7	23.	D	K	6	K12
9.	B	H	2	D7	24.	D	U	6	K2
10.	D	K	2	E7	25.	A	U	6	K8
11.	C	U	2	E2	26.	A	U	6	K8
12.	D	H	2	E2	27.	B	H	6	K5
13.	B	K	3	F4	28.	C	K	6	L4
14.	D	K	4	G8	29.	C	U	6	L6, 1
15.	B	U	4	G5	30.	B	U	6	M4

Multiple Choice = 60 marks

PART B: Written Response

Q	B	C	S	CO	PLO
1.	1	H	4	1	A4
2.	2	U	6	2	D3
3.	3	U	4	2	E3
4.	4	U	5	3	F4
5.	5	U	6	4	G9, 10
6.	6	H	6	4	H4
7.	7	U	5	5	I9, 10
8.	8	U	4	5	I13
9.	9	U	5	5	J4
10.	10	U	6	6	K3, L6
11.	11	H	5	6	L6
12.	12	U	4	6	M3

Written Response = 60 marks

Multiple Choice = 60 (30 questions: 2 marks each)

Written Response = 60 (12 questions)

EXAMINATION TOTAL = 120 marks

LEGEND:

Q = Question Number

CO = Curriculum Organizer

PLO = Prescribed Learning Outcome

B = Score Box Number

K = Keyed Response

C = Cognitive Level

S = Score

1. A wheel-and-axle is used to raise a 15 kg pail of water to the top of a well, a distance of 4.5 m. The handle of the wheel-and-axle is turned 70 times to do this. An average effort force of 11.2 N was used to turn the handle in a radius of 19 cm.

a) Calculate the efficiency of the wheel-and-axle. **(3 marks)**

$$\text{Work output} = \text{force} \times \text{distance}$$

$$= 15 \text{ kg} \times 9.8 \text{ N/kg} \times 4.5 \text{ m} = 661.5 \text{ J}$$

$$\text{Work input} = 70 \times \text{force} \times \text{distance} = 70 \times 11.2 \text{ N} \times 2\pi r$$

$$= 70 \times 11.2 \text{ N} \times 2 \times 3.1416 \times .19 \text{ m} = 935.9 \text{ J}$$

$$\text{efficiency} = 661.5 \text{ J} / 935.9 \text{ J} \times 100\%$$

$$= 70.68\% = 71\%$$

b) Calculate the actual mechanical advantage of the wheel-and-axle. **(1 mark)**

$$\text{Actual Mechanical Advantage} = \text{load force} / \text{effort force}$$

$$= (15 \text{ kg} \times 9.8 \text{ N/kg}) / (11.2 \text{ N})$$

$$= 13$$

2. A ball of wax and a rubber ball are thrown at a wall. The two balls have the same initial velocity, shape, and mass. The wax ball sticks to the wall whereas the rubber ball bounces back.

a) How does the force exerted by the rubber ball on the wall compare to the force by the wax ball? (2 marks)

- less than the force from the wax ball
- equal to the force from the wax ball
- greater than the force from the wax ball

b) Using principles of physics, explain your answer to a). (4 marks)

The rubber ball undergoes a greater change in velocity; hence, a greater change in momentum. Since $F\Delta t = \Delta p$, a greater impulse, and thus a greater force, is exerted on the wall.

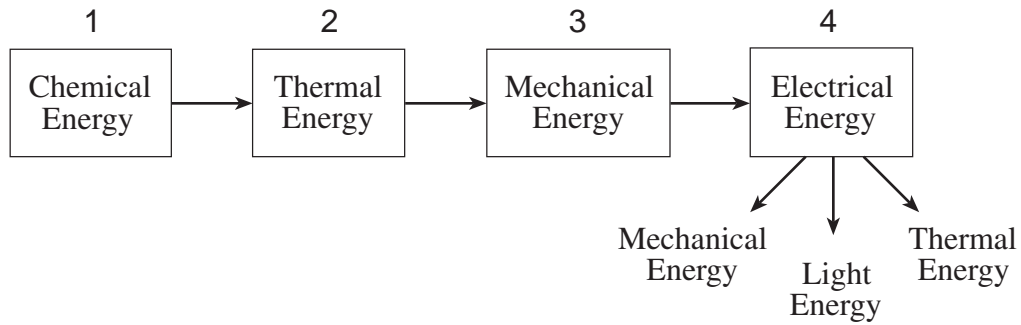
3. A ballet dancer spins with 2.4 rev/s with her arms outstretched and a moment of inertia I . With her arms curved high over her head, her moment of inertia decreases to $0.60I$. What is her new rate of spin? **(4 marks)**

$$I_1 W_1 = I_2 W_2$$

$$W_2 = \frac{I_1}{I_2} W_1 = \frac{I}{0.6I} (2.4 \text{ rev/s})$$
$$= 4.0 \text{ rev/s}$$

4. A portable gasoline generator is used in a camp to supply power for lighting and refrigeration.

- a) Draw a schematic showing all significant energy forms involved when this generator is in operation, with arrows indicating each energy conversion. **(3 marks)**



- b) Estimate the overall efficiency of this system from starting energy form to ending useful energy form(s). Your reasoning should be in a clear, logical sequence. **(2 marks)**

Multiply efficiencies and accept a wide range of answers.

5. a) Briefly describe how a pitot tube and an anemometer measure wind speed. (4 marks)

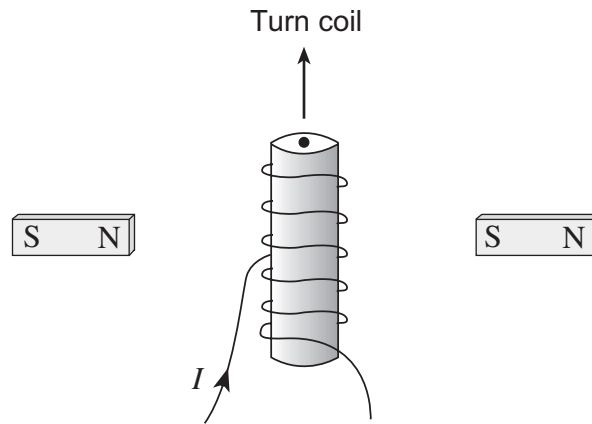
Pitot tube—Air entering the tube transfers its kinetic energy to a pressure sensitive device which is then converted into an electrical signal.

Anemometer—Air spins cups that are on the edge of a wheel that spins. The rate of the spin of the wheel is then converted into an electrical signal.

b) What is an advantage of using a pitot tube for measuring wind speed outside an airplane? (2 marks)

The pitot tube does not have any moving parts outside the airplane.

6. Explain how a moving coil meter is able to indicate electrical current. You may use diagrams in your explanation. **(6 marks)**

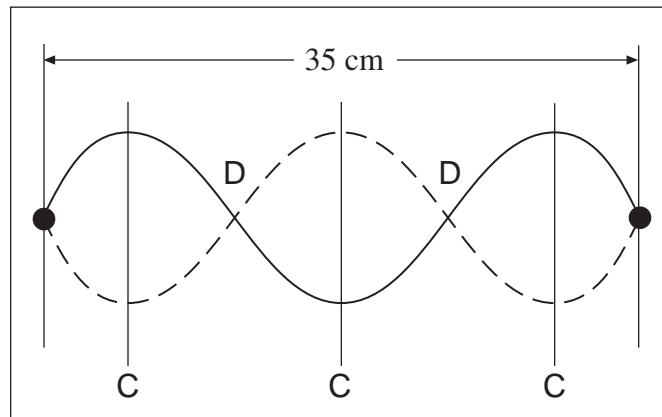


When a current passes through the moving coil meter, a magnetic field is induced in its armature (coil). This magnetic field interacts with an external magnetic field within the meter. This interaction causes a torque that twists the armature. The twisting causes a deflection of a pointer and this deflection is proportional to the amount of current input.

7. A standing wave produced in a string is shown below.

- a) Label all points of maximum constructive interference “C” and destructive interference “D”.

(3 marks)



- b) What is the natural (fundamental) wavelength of this string?

(2 marks)

$$\lambda = 35 \times 2 = 70 \text{ cm}$$

8. A pulse is sent from a ship to the ocean floor 420 m below the ship. The reflected pulse is received at the ship 0.60 s after being sent. What is the speed of sound in the water? **(4 marks)**

$$v = d/t = (420 \times 2)/0.60 = 1\,400 \text{ m/s}$$

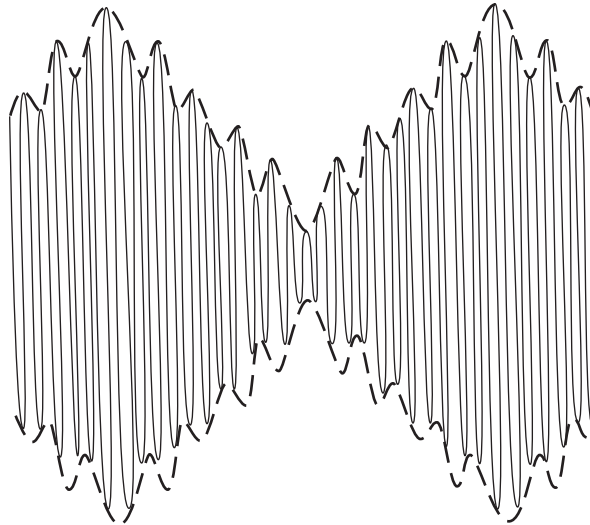
9. The diagrams below show an original signal and a modulation of that signal.

(2 marks)

Original signal



Modulated signal



a) What type of modulation does the diagram show?

(2 marks)

amplitude modulation

b) Discuss advantages and disadvantages of this type of modulation for radio transmission.

(3 marks)

**am is distance
fm is clarity**

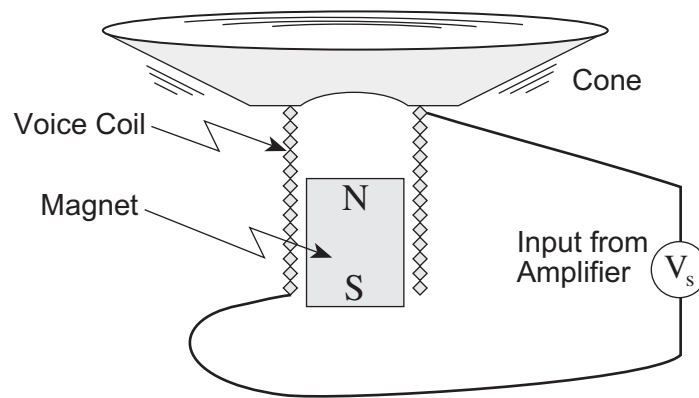
10. a) Which of the following is the correct type of input voltage for a transformer? **(1 mark)**

- Direct current only.
- Alternating current only.
- Either direct or alternating current.

b) Using principles of physics, explain the reason for your choice. **(5 marks)**

The induced current (or voltage) is produced by a changing magnetic field inside its core in accordance with Faraday's Law. Since this changing magnetic field is similarly produced by the primary current, the primary current must also be "changing" or alternating current.

11. The diagram below shows a simplified cross-section of a loudspeaker. The signal from the amplifier acts as a voltage source, V_s , which is attached to the voice coil (solenoid). The voice coil is attached to the 'cone' of the speaker. When the cone moves back and forth, sound is emitted from the speaker.



Using principles of physics, explain how the electrical system causes the cone to vibrate.

(5 marks)

The signal from the amplifier is an alternating current. When the current is increasing the magnetic field inside the coil also increases. According to Lenz's law, the voice coil will move to oppose this increase. When the current reaches a maximum and starts to decrease, the voice coil will move in the opposite direction to oppose this decrease. As the current cycles, the voice coil (and the cone) will move back and forth producing sound.

12. Describe **two** uses for capacitors in practical circuits.

(4 marks)

Capacitors can be used to smooth out voltage surges in a circuit either to protect a sensitive component or to act as a noise filter.

Capacitors can be used to store charge so that it can be periodically released across a component such as in a timing circuit.

Capacitors can be used to produce a system that allows for the discharge of a higher voltage across a component than the voltage source is able to produce (e.g., as in a camera flash).

END OF KEY