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**Applications  
of Physics 12**

**JUNE 2002**

**Course Code = PHA**

### Student Instructions

1. Place the stickers with your Personal Education Number (PEN) in the allotted spaces above. **Under no circumstance is your name or identification, other than your Personal Education Number, to appear on this booklet.**
2. Ensure that in addition to this examination booklet, you have an **Examination Response Form**. Follow the directions on the front of the Response Form.
3. **Disqualification** from the examination will result if you bring books, paper, notes or unauthorized electronic devices into the examination room.
4. When instructed to open this booklet, **check the numbering of the pages** to ensure that they are numbered in sequence from page one to the last page, which is identified by **END OF EXAMINATION**.
5. At the end of the examination, place your Response Form inside the front cover of this booklet and return the booklet and your Response Form to the supervisor.

Question 1:  
1.  .   
(4)

Question 9:  
9.  .   
(5)

Question 2:  
2.  .   
(6)

Question 10:  
10.  .   
(6)

Question 3:  
3.  .   
(4)

Question 11:  
11.  .   
(5)

Question 4:  
4.  .   
(5)

Question 12:  
12.  .   
(4)

Question 5:  
5.  .   
(6)

Question 6:  
6.  .   
(6)

Question 7:  
7.  .   
(5)

Question 8:  
8.  .   
(4)

# **APPLICATIONS OF PHYSICS 12**

**JUNE 2002**

COURSE CODE = PHA

## GENERAL INSTRUCTIONS

1. Aside from an approved calculator, electronic devices, including dictionaries and pagers, are **not** permitted in the examination room.
2. All multiple-choice answers must be entered on the Response Form using an **HB pencil**. Multiple-choice answers entered in this examination booklet will **not** be marked.
3. For each of the written-response questions, write your answer in the space provided in this booklet. Rough-work space has been incorporated into the space allowed for answering each written-response question. You may not need all of the space provided to answer each question.
4. Ensure that you use language and content appropriate to the purpose and audience of this examination. Failure to comply may result in your paper being awarded a zero.
5. This examination is designed to be completed in **two hours**. *Students may, however, take up to 30 minutes of additional time to finish.*

## APPLICATIONS OF PHYSICS 12 PROVINCIAL EXAMINATION

- |  | Value                   | Suggested Time     |
|--|-------------------------|--------------------|
| 1. This examination consists of <b>two</b> parts:            |                         |                    |
| PART A: 30 multiple-choice questions<br>worth two marks each | 60                      | 60                 |
| PART B: 12 written-response questions                        | 60                      | 60                 |
|  | <b>Total: 120 marks</b> | <b>120 minutes</b> |
2. The last **five** pages inside the back cover contain the **Table of Constants, Conversion Factors, Mathematical Equations, Formulae, Rough Work for Graphing** and **Rough Work for Multiple-Choice**. These pages may be detached for convenient reference prior to writing this examination.
3. Calculators should be set to degree mode.
4. **A calculator is essential for the Applications of Physics 12 Provincial Examination.** The calculator must be a hand-held device designed primarily for mathematical computations involving logarithmic and trigonometric functions and may be capable of performing graphing functions. Computers, calculators with a QWERTY keyboard, and electronic writing pads will not be allowed. Students must not bring any external devices to support calculators such as manuals, printed or electronic cards, printers, memory expansion chips or cards, or external keyboards. Students may have more than one calculator available during the examination. Calculators may not be shared and must not have the ability to either transmit or receive electronic signals. In addition to an approved calculator, students will be allowed to use rulers, compasses, and protractors during the examination.
5. a) Numerical final answers must include appropriate **units**.  
b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.  
c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.
6. You are expected to communicate your knowledge and understanding in a clear and logical manner. With respect to questions requiring you to “explain” an answer, the explanation may be demonstrated by using calculations. Partial marks will be awarded for steps and assumptions leading to a solution. Full marks will **not** be awarded for providing **only** a final answer.

If you are unable to determine the value of a quantity required in order to proceed, you may assume a reasonable value and continue toward the solution. Such a solution, however, may not be eligible for full marks.

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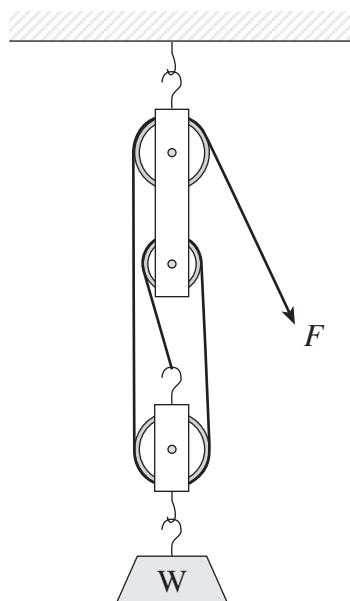
## PART A: MULTIPLE CHOICE

Value: 60 marks

Suggested Time: 60 minutes

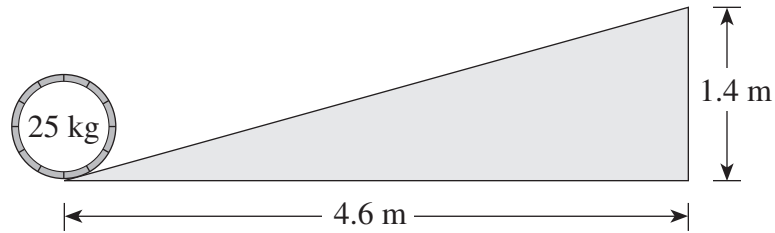
**INSTRUCTIONS:** For each question, select the **best** answer and record your choice on the Response Form provided. Using an HB pencil, completely fill in the circle that has the letter corresponding to your answer.

1. The mechanical advantage of the block-and-tackle shown is



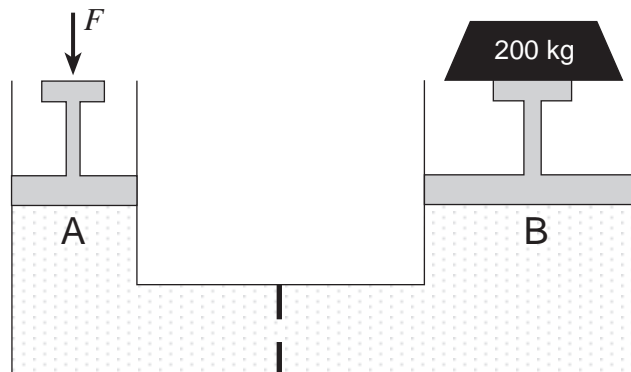
- A. 1  
B. 2  
C. 3  
D. 4
2. One pascal (Pa) is equal to
- A.  $1 \text{ N} \cdot \text{m}$   
B.  $1 \text{ N} \cdot \text{m}^2$   
C.  $1 \text{ N/m}$   
D.  $1 \text{ N/m}^2$

3. A 25 kg barrel is rolled up a ramp to a loading platform as shown below.



What is the mechanical advantage of the ramp?

- A. 0.30
  - B. 3.3
  - C. 3.4
  - D. 7.6
4. In the situation shown below, piston A has a diameter of 2 inches, and piston B has a diameter of 5 inches.



What force  $F$  is necessary to support the 200 kg load?

- A. 310 N
  - B. 780 N
  - C. 2 000 N
  - D. 12 000 N
5. A transformer has maximum efficiency with a core that is made of
- A. air.
  - B. iron.
  - C. gold.
  - D. copper.



6. A coil of wire is in a changing magnetic field. If the number of turns of wire in the coil is doubled, the induced voltage will be
- halved.
  - the same.
  - doubled.
  - quadrupled.
7. A transformer has a primary coil consisting of 1 600 turns of wire and a secondary coil consisting of 200 turns of wire. For an input voltage of 120 V and an input current of 160 mA, the output voltage and current would be

	VOLTAGE (V)	CURRENT (mA)
A.	15	20
B.	15	1 280
C.	960	20
D.	960	1 280

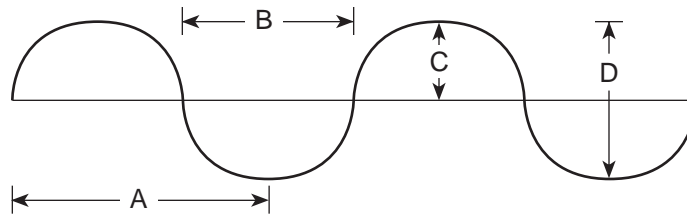
8. A 1 000 kg car travelling east at 20 m/s collides with a 1 500 kg car travelling west at 10 m/s. The cars stick together after the collision. What is their common speed after the collision?
- 2.0 m/s
  - 8.0 m/s
  - 14.0 m/s
  - 15.0 m/s
9. A 45 kg child sliding on ice at 3.7 m/s east, collides with her stationary 35 kg younger sister. As a result the younger sister starts to slide at 2.5 m/s at  $30^\circ$  south of east. What is the change in the total kinetic energy of the two sisters as a result of the collision?
- 0 J
  - 86 J
  - 130 J
  - 200 J

**OVER**

10. A truck collides with a stationary compact car. The car recoils and rotates. The rotation is due to the
- A. truck's mass being much larger than the car's mass.
  - B. moment of inertia of the truck being greater than that of the car.
  - C. impulse given the car was much bigger than the impulse given the truck.
  - D. center-of-mass of the truck not colliding with the center-of-mass of the car.
11. A string is wrapped around the axle of a yo-yo. The radius of the axle is 2.5 mm and the moment of inertia of the yo-yo is  $1.2 \times 10^{-3} \text{ kg} \cdot \text{m}^2$ . If the string is pulled with a force  $F$ , the resulting angular acceleration of the yo-yo is  $2.0 \text{ rad/s}^2$ . Determine the magnitude of the force  $F$ .
- A.  $2.4 \times 10^{-3} \text{ N}$
  - B.  $6.0 \times 10^{-3} \text{ N}$
  - C. 0.96 N
  - D. 4.2 N
12. A torque of  $50 \text{ N} \cdot \text{m}$  acts on a wheel having a moment of inertia of  $150 \text{ kg} \cdot \text{m}^2$ . If the wheel starts from rest, how long will it take the wheel to make one revolution?
- A. 0.33 s
  - B. 2.0 s
  - C. 3.0 s
  - D. 6.1 s
13. Energy from radioactive elements is converted into electrical energy in a
- A. photovoltaic cell.
  - B. nuclear power plant.
  - C. hydroelectric generator.
  - D. thermal electric generator.
14. A simple pressure gauge consists of a thin-walled curved tube. An increase in internal pressure tends to straighten the tube. This device is called a(n)
- A. Pitot tube.
  - B. strain gauge.
  - C. anemometer.
  - D. Bourdon tube.

15. A strain gauge has a calibration constant of  $0.80 \text{ N/mA}$ . If the gauge indicates  $120 \text{ mA}$  when a  $3.0 \text{ kg}$  mass is placed on it, what would the gauge indicate for  $5.0 \text{ kg}$ ?
- A.  $61 \text{ mA}$   
 B.  $140 \text{ mA}$   
 C.  $190 \text{ mA}$   
 D.  $200 \text{ mA}$
16. Determine the voltage generated from a thermocouple having a sensitivity of  $40 \mu\text{V}/\text{C}^\circ$  when its junctions are at temperatures of  $30^\circ\text{C}$  and  $80^\circ\text{C}$ .
- A.  $2.0 \text{ mV}$   
 B.  $2.2 \text{ mV}$   
 C.  $3.2 \text{ mV}$   
 D.  $4.4 \text{ mV}$

17. In the diagram shown, the amplitude is indicated by the letter

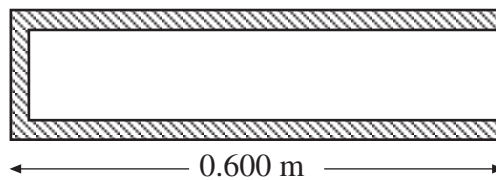


- A. A  
 B. B  
 C. C  
 D. D
18. A bat emits ultrasonic waves in order to help locate a moth that is  $3.3 \text{ m}$  away. These waves have a frequency of  $5.5 \times 10^4 \text{ Hz}$ . If the waves travel at  $360 \text{ m/s}$ , what is their wavelength?
- A.  $6.5 \text{ mm}$   
 B.  $9.2 \text{ mm}$   
 C.  $150 \text{ m}$   
 D.  $500 \text{ m}$

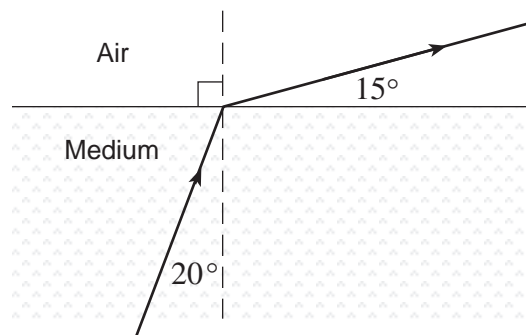
**OVER**

19. If a car is stuck in the snow, it can be rocked back and forth with increasing amplitude, helping to get the car out of the snow. This is an example of
- A. refraction.
  - B. resonance.
  - C. defraction.
  - D. polarization.

20. What is the lowest resonant frequency for a closed pipe with a length of 0.600 m? The speed of sound is 342 m/s.

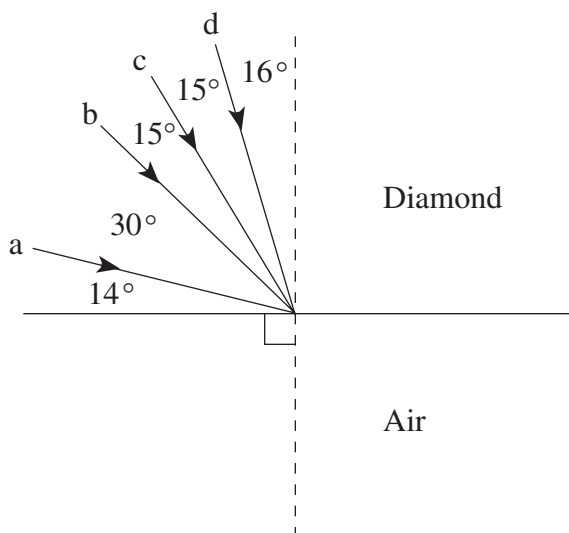


- A. 143 Hz
  - B. 205 Hz
  - C. 285 Hz
  - D. 570 Hz
21. The diagram below shows a light ray travelling from an unknown medium into air. What is the index of refraction of the medium?

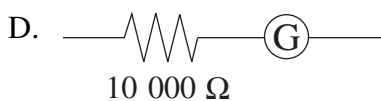
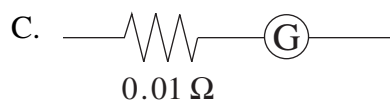
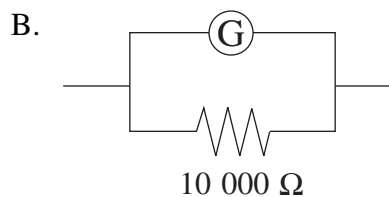
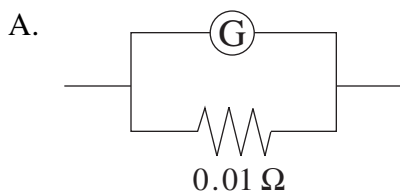


- A. 0.29
- B. 1.3
- C. 2.8
- D. 3.6

22. The diagram represents a block of diamond. If the critical angle for the diamond is  $24^\circ$ , which of the light rays shown will reflect internally?

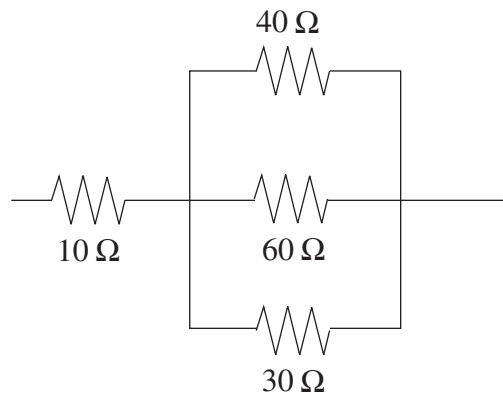


- A. a only  
 B. a, b and c  
 C. b, c and d  
 D. d only
23. The voltage difference between the black wire and the red wire entering your house is
- A. 0 V  
 B. 60 V  
 C. 120 V  
 D. 240 V
24. A galvanometer with an internal resistance of  $10\ \Omega$  is to be used as a voltmeter. Which of the schematic diagrams below shows how the galvanometer could be converted into a practical voltmeter?



OVER

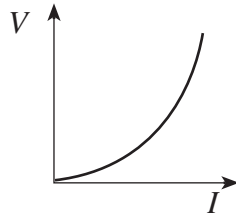
25. Resistances of  $2.0\ \Omega$ ,  $4.0\ \Omega$ , and  $6.0\ \Omega$  are connected in series with a  $24\ \text{V}$  battery. The potential difference across the  $2.0\ \Omega$  resistor is
- A.  $4.0\ \text{V}$
  - B.  $8.0\ \text{V}$
  - C.  $12\ \text{V}$
  - D.  $24\ \text{V}$
26. The voltage drop across the  $10\ \Omega$  resistor is  $2.7\ \text{volts}$  and the current through the  $40\ \Omega$  is  $90\ \text{mA}$ .



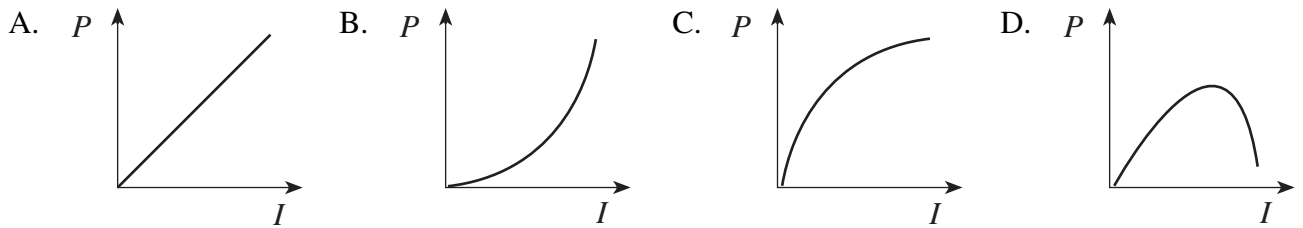
What is the current through the  $60\ \Omega$  resistor?

- A.  $60\ \text{mA}$
- B.  $90\ \text{mA}$
- C.  $140\ \text{mA}$
- D.  $270\ \text{mA}$

27. A current  $I$  in a lamp varies with voltage  $V$  as shown in the diagram below.



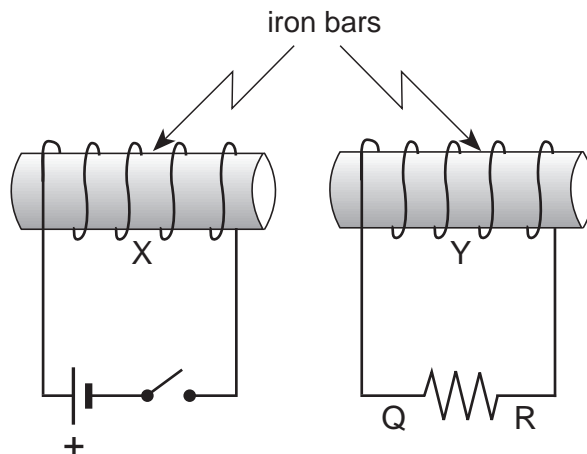
The variation of power  $P$  with current  $I$  is best shown by which of the following graphs?



28. The purpose of a commutator in a dc electric motor is to

- A. produce a magnetic field.
- B. increase the load the motor can carry.
- C. reverse the direction of the current in the armature.
- D. provide a neutral pivot point for the armature to rotate about.

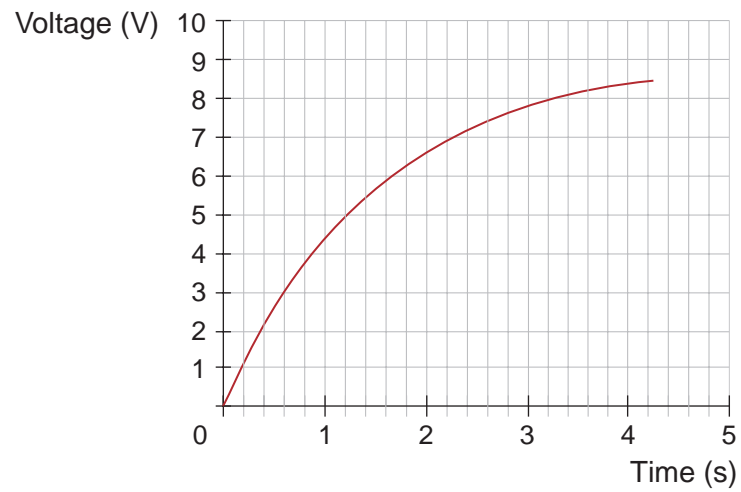
29. In the diagram shown, the switch is closed and current flows through solenoid X. Which of the following statements is correct for the current through the resistor?



- A. A steady current flows from Q to R.
- B. A steady current flows from R to Q.
- C. A momentary current flows from Q to R.
- D. A momentary current flows from R to Q.

**OVER**

30. An RC circuit contains a  $1.5 \mu\text{F}$  capacitor. The graph below shows the voltage across the capacitor as it is charged from a 9.0 volt battery. What value of resistance is in the circuit?



- A.  $0.50 \text{ M}\Omega$
- B.  $1.0 \text{ M}\Omega$
- C.  $1.3 \text{ M}\Omega$
- D.  $6.0 \text{ M}\Omega$

**This is the end of the multiple-choice section.**  
**Answer the remaining questions directly in this examination booklet.**



## PART B: WRITTEN RESPONSE

Value: 60 marks

Suggested Time: 60 minutes

### INSTRUCTIONS:

1. Rough-work space has been incorporated into the space allowed for answering each written-response question. You may not need all of the space provided to answer each question.
2.
  - a) Numerical final answers must include appropriate **units**.
  - b) Marks will not be deducted for answers expressed to **two** or **three** significant figures.
  - c) In this examination the zero in a number such as 30 shall be considered to be a significant zero.
3. You are expected to communicate your knowledge and understanding of physics principles in a clear and logical manner. Partial marks will be awarded for steps and assumptions leading to a solution.
4. If you are unable to determine the value of a quantity required in order to proceed, you may assume a reasonable value and continue toward the solution. Such a solution, however, may not be eligible for full marks.
5. **Full marks will NOT be awarded for providing only a final answer.**

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)**

ANSWER:

efficiency of wheel-and-axle: \_\_\_\_\_

b) Calculate the actual mechanical advantage of the wheel-and-axle.

**(1 mark)**

ANSWER:

actual mechanical advantage: \_\_\_\_\_

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)**

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3. A ballet dancer spins with  $2.4 \text{ rev/s}$  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)**

ANSWER:

new rate of spin: \_\_\_\_\_

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)**

ANSWER:

overall efficiency: \_\_\_\_\_

**OVER**

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

Pitot tube: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Anemometer: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

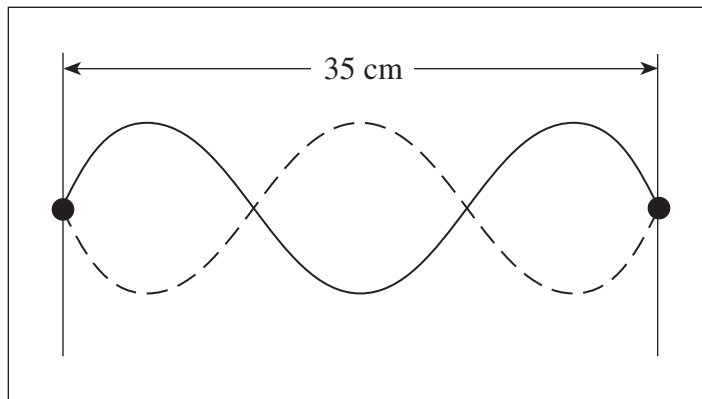
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



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)**

ANSWER:

wavelength: \_\_\_\_\_



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)**

ANSWER:

speed of sound in water: \_\_\_\_\_

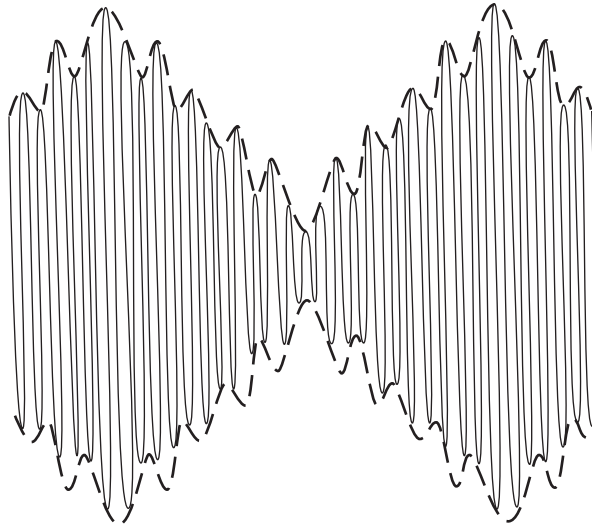
**OVER**

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

Original signal



Modulated signal



a) What type of modulation does the diagram show? (2 marks)

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b) Discuss advantages and disadvantages of this type of modulation for radio transmission. (3 marks)

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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)**

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

**(4 marks)**

First use

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Second use

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**END OF EXAMINATION**

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## TABLE OF CONSTANTS

Speed of light in vacuum .....	$c = 3.00 \times 10^8 \text{ m/s}$
Acceleration due to gravity at the surface of Earth (for the purposes of this examination) .....	$g = 9.80 \text{ m/s}^2 = 32.2 \text{ ft/s}^2$
Atmospheric pressure at sea level.....	$= 1.013 \times 10^5 \text{ Pa} = 14.70 \text{ lb/in}^2$
Density of air ( $0^\circ \text{C}$ , 1 atm pressure) .....	$= 1.29 \text{ kg/m}^3$
Speed of sound in air ( $20^\circ \text{C}$ ).....	$= 343 \text{ m/s}$
Density of water ( $4^\circ \text{C}$ ).....	$= 1.00 \times 10^3 \text{ kg/m}^3 = 62.4 \text{ lb/ft}^3$
Elementary charge unit.....	$e = 1.6 \times 10^{-19} \text{ C}$
Specific heat capacity of water .....	$= 4186 \text{ J}/(\text{kg} \cdot \text{C}^\circ)$

### CONVERSION FACTORS

#### *Length*

1 in = 2.54 cm  
 1 ft = 0.3048 m  
 1 mi = 5 280 ft = 1.609 km  
 1 m = 3.281 ft  
 1 km = 0.6214 mi

#### *Mass*

1 slug = 14.59 kg

#### *Force*

1 lb = 4.448 N  
 1 N =  $10^5$  dynes = 0.2248 lb

#### *Work and Energy*

1 J = 0.7376 ft · lb =  $10^7$  ergs  
 1 kcal = 4 186 J  
 1 Btu = 1 055 J

#### *Power*

1 hp = 550 ft · lb/s = 745.7 W  
 1 W = 0.7376 ft · lb/s

#### *Pressure*

1 Pa =  $1 \text{ N/m}^2 = 1.450 \times 10^{-4} \text{ lb/in}^2$   
 1 lb/in<sup>2</sup> =  $6.895 \times 10^3 \text{ Pa}$   
 1 atm =  $1.013 \times 10^5 \text{ Pa} = 1.013 \text{ bar} =$   
 $14.70 \text{ lb/in}^2 = 760 \text{ torr}$

#### *Volume*

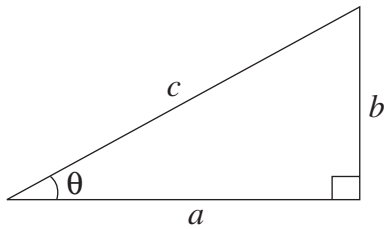
1 litre =  $10^{-3} \text{ m}^3 = 1\,000 \text{ cm}^3 = 0.03531 \text{ ft}^3$   
 1 ft<sup>3</sup> =  $0.02832 \text{ m}^3 = 7.481 \text{ U.S. gallons}$   
 1 U.S. gallon =  $3.785 \times 10^{-3} \text{ m}^3 = 0.1337 \text{ ft}^3$

#### *Angle*

1 radian =  $57.30^\circ$   
 $1^\circ = 0.01745 \text{ radian}$

## MATHEMATICAL EQUATIONS

### For Right-angled Triangles:

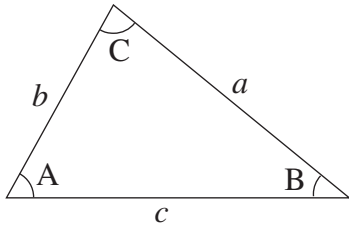


$$a^2 + b^2 = c^2$$

$$\sin \theta = \frac{b}{c} \quad \cos \theta = \frac{a}{c} \quad \tan \theta = \frac{b}{a}$$

$$\text{area} = \frac{1}{2} ab$$

### For All Triangles:



$$\text{area} = \frac{1}{2} \text{base} \times \text{height}$$

$$\text{Sine Law: } \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

$$\text{Cosine Law: } c^2 = a^2 + b^2 - 2ab \cos C$$

### Circle:

$$\text{Circumference} = 2\pi r$$

$$\text{Area} = \pi r^2$$



## FORMULAE

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

$$v = v_0 + a t$$

$$\theta = \omega_0 t + \frac{1}{2} \alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\tau = F \cdot d$$

$$I_{disk} = \frac{1}{2} m r^2$$

$$F_{net} = m a$$

$$p = m v$$

$$F \Delta t = \Delta p$$

$$\tau_{net} = I \alpha$$

$$L = I \omega$$

$$\tau \Delta t = \Delta L$$

$$F_f = \mu F_N$$

$$F = k x$$

$$W = F \cdot d$$

$$W = \tau \cdot \theta$$

$$E_k = \frac{1}{2} m v^2$$

$$E_p = m g h$$

$$E_p = \frac{1}{2} k x^2$$

$$E_H = m c \Delta T$$

$$E_k = \frac{1}{2} I \omega^2$$

$$P = \frac{W}{t}$$

$$P = \frac{F}{A}$$

$$\Delta P = \rho g h$$

$$W = \Delta(PV)$$

$$f = \frac{1}{T}$$

$$v = f \lambda$$

$$n = \frac{c}{v}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$I = \frac{Q}{t}$$

$$V = \frac{\Delta E_p}{Q}$$

$$R = \rho \frac{L}{A}$$

$$V = IR$$

$$P = IV$$

$$\frac{V_{out}}{V_{in}} = \frac{N_{out}}{N_{in}} = \frac{I_{in}}{I_{out}}$$

$$C = \frac{Q}{V}$$

$$\tau = RC$$

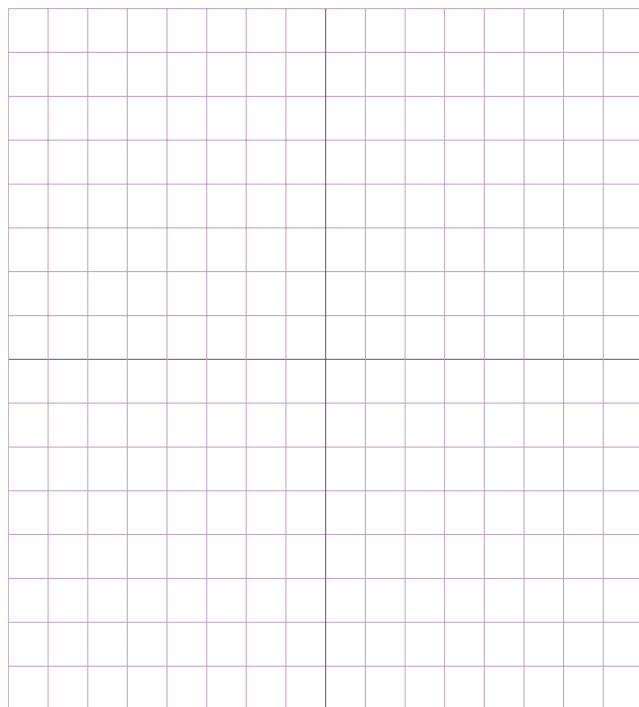
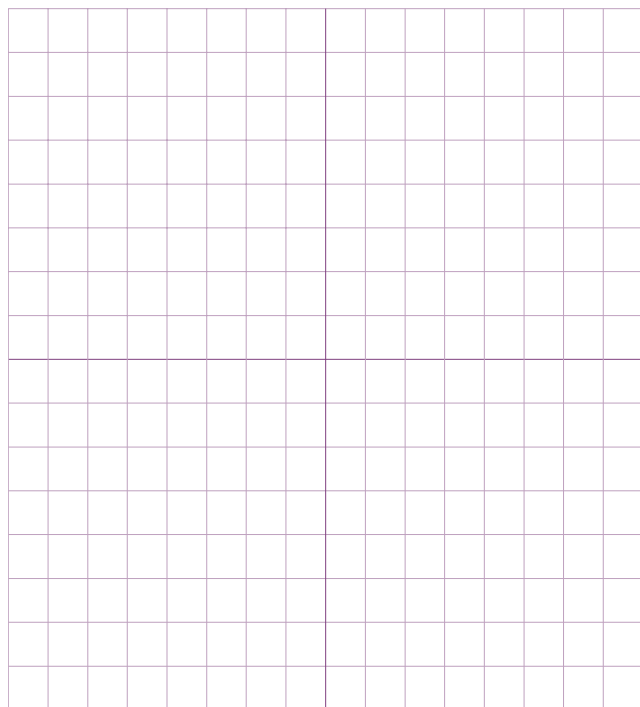
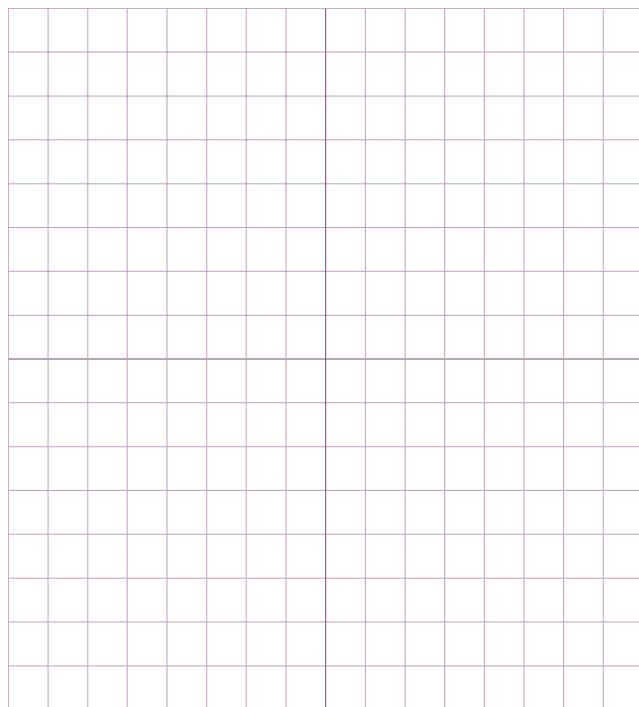
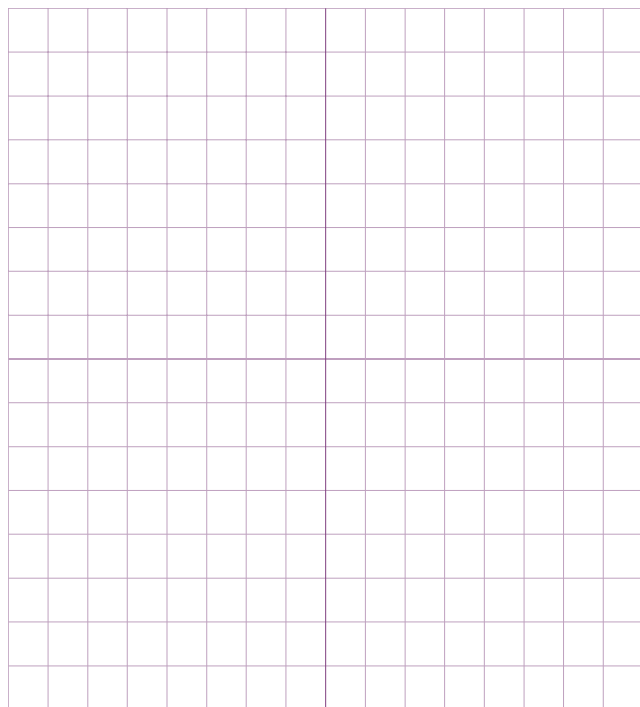
$$V = V_0 e^{-\frac{t}{\tau}}$$

$$E_p = \frac{1}{2} C V^2$$

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**ROUGH WORK FOR GRAPHING**

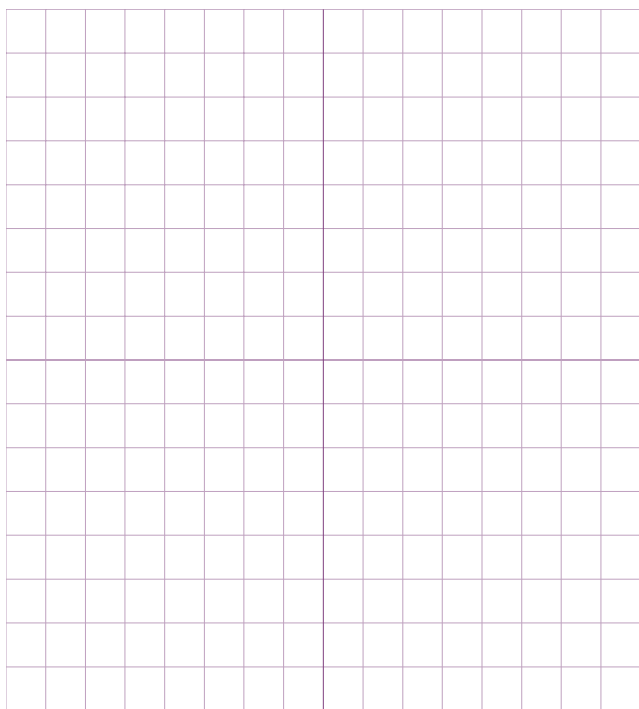
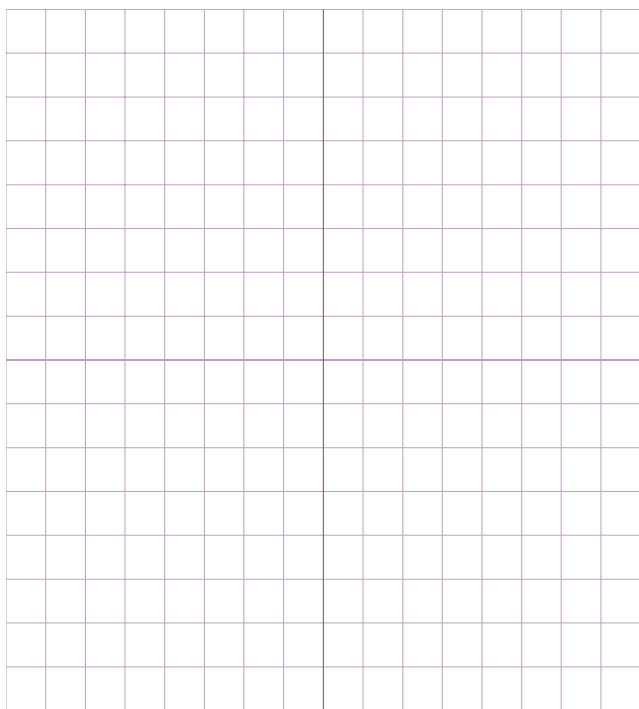
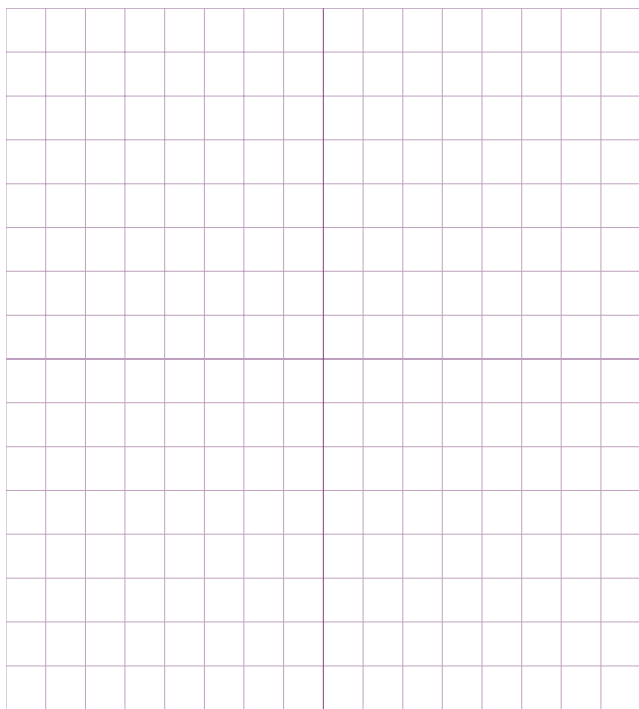
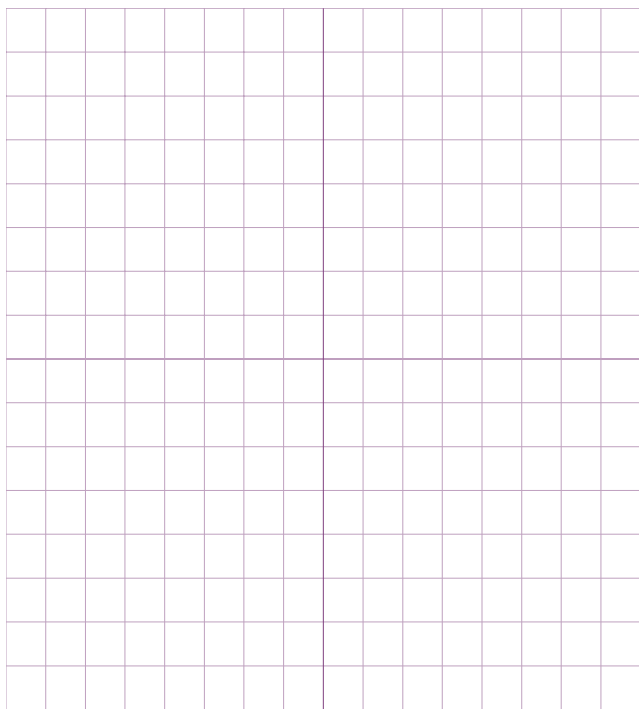
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# ROUGH WORK FOR GRAPHING

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# ROUGH WORK FOR MULTIPLE-CHOICE

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# ROUGH WORK FOR MULTIPLE-CHOICE