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BRITISH COLUMBIA

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Applications of Physics 12

JUNE 2001

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. . (5)

Question 9:

9. . (5)

Question 2:

2. . (5)

Question 10:

10. . (6)

Question 3:

3. . (5)

Question 11:

11. . (5)

Question 4:

4. . (6)

Question 12:

12. . (4)

Question 5:

5. . (4)

Question 6:

6. . (5)

Question 7:

7. . (5)

Question 8:

8. . (5)

APPLICATIONS OF PHYSICS 12

JUNE 2001

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

1. This examination consists of **two** parts:

		Value	Suggested Time
PART A:	30 multiple-choice questions worth two marks each	60	60
PART B:	12 written-response questions	60	60
	Total:	**120 marks**	**120 minutes**

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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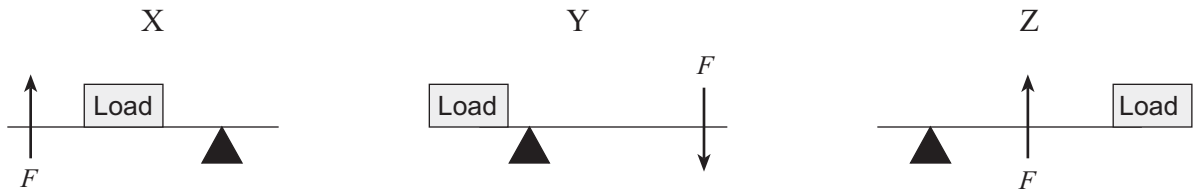
PART A: MULTIPLE CHOICE

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. Three levers (X, Y, and Z) are shown below.



Which class is each lever?

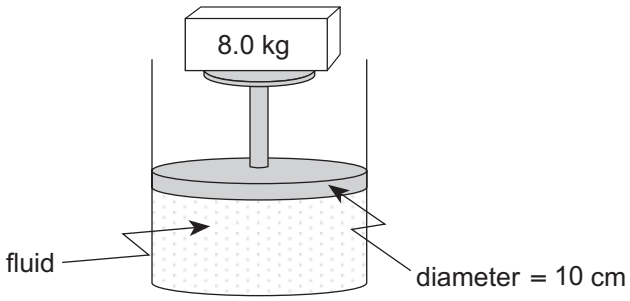
	X	Y	Z
A.	First	Second	Third
B.	First	Third	Second
C.	Second	First	Third
D.	Third	First	Second

2. Using a system of pulleys, a mechanic is able to lift a 180 kg engine out of a truck. The mechanic needs to use a force of 619 N. If the efficiency of the pulley is 95%, and the engine needs to be lifted 1.5 m, what distance does the rope of the pulley need to be pulled?

A. 1.6 m
B. 4.1 m
C. 4.3 m
D. 4.5 m

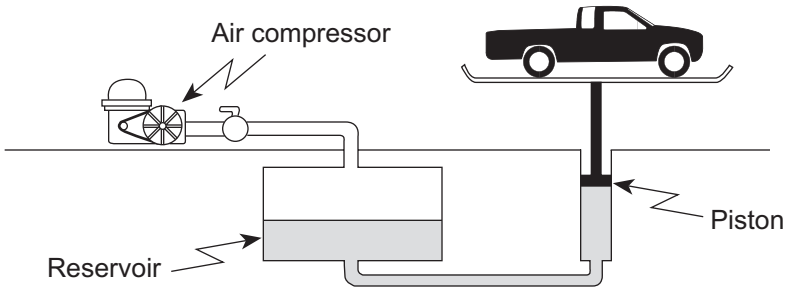
OVER

3. What pressure exists in the enclosed fluid?



A. 0.10 Pa
B. 1.0 Pa
C. 1.0 kPa
D. 10 kPa

4. The load on the piston shown in the diagram below is 8 000 lbs. The diameter of the piston is 10 inches and the surface area of the reservoir of oil is 3.3 sq ft.



What minimum pressure must the air compressor be able to deliver to support the load on the piston?

A. 17 psi
B. 31 psi
C. 100 psi
D. 340 psi

5. The change in momentum of an object is the same as the

A. energy of the object.
B. impulse on the object.
C. force acting on the object.
D. change in velocity of the object.

6. If a moving car, A, collides head-on with another car, B, moving in the opposite direction, the law of conservation of momentum states that

   A. the momenta of A and B are reversed by the collision.
   B. the combined momentum of A and B remains unchanged.
   C. the initial and final momentum of each car remains unchanged.
   D. the final momentum of A is equal in magnitude to the final momentum of B.

7. A wheel is rolling along without slipping in such a way that its axle has a linear speed of 12 m/s along the ground. If the radius of the wheel is 0.6 m, what is the angular velocity of the wheel?

   A. 1.9 rad/s
   B. 20 rad/s
   C. 45 rad/s
   D. 75 rad/s

8. When a spinning ice skater draws in his outstretched arms, his

   A. moment of inertia increases.
   B. moment of inertia decreases.
   C. angular momentum increases.
   D. angular momentum decreases.

9. A 2 hp water pump is able to pump water from a lake to a cabin that is situated 7 m vertically above. If the pump can lift 10 kg of water every second, how efficient is it?

   A. 2.9%
   B. 4.7%
   C. 35%
   D. 46%

10. A Bourdon tube indicates pressure by a pointer that is mechanically moved because the tube changes its

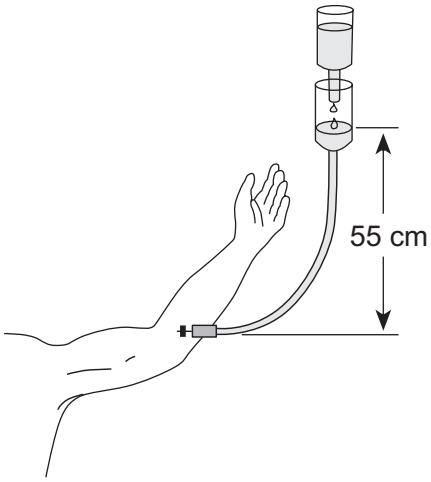
    A. total length.
    B. internal volume.
    C. cross-sectional area.
    D. amount of curvature.

OVER

11. A student is calibrating a linear strain gauge. When a force of 10 N is applied, a value of 80 mA is indicated on an attached ammeter. When a force of 20 N is applied, 130 mA is indicated. What would the ammeter read for an applied force of 30 N?

A. 180 mA
B. 200 mA
C. 210 mA
D. 240 mA

12. An IV (intravenous) tube is used to give a patient a glucose and water solution as shown in the diagram. The glucose solution has a density $\rho = 1.05 \times 10^3 \text{ kg/m}^3$. The height is adjusted to 55 cm so that the solution has enough pressure to enter the vein. What is the **absolute pressure** of the blood in the vein?



A. 5.7×10^3 Pa
B. 9.6×10^4 Pa
C. 1.0×10^5 Pa
D. 1.1×10^5 Pa

13. A thermocouple acting linearly in the 0 to 50° C range has a calibration constant of 1.3 mV/C°. What temperature would a voltage reading of 38 mV indicate? (Assume that 0° C gives a 0 mV reading.)

A. 29° C
B. 38° C
C. 39° C
D. 49° C

14. A platinum resistance thermometer has a resistance that changes with temperature following the relation:

$$R_T = R_0\left(1 + AT + BT^2\right)$$

where R_0 = resistance at $0\,^\circ\text{C} = 100\ \Omega$,
T = temperature in $^\circ\text{C}$, and
A, B = polynomial coefficients (constants of proportionality).

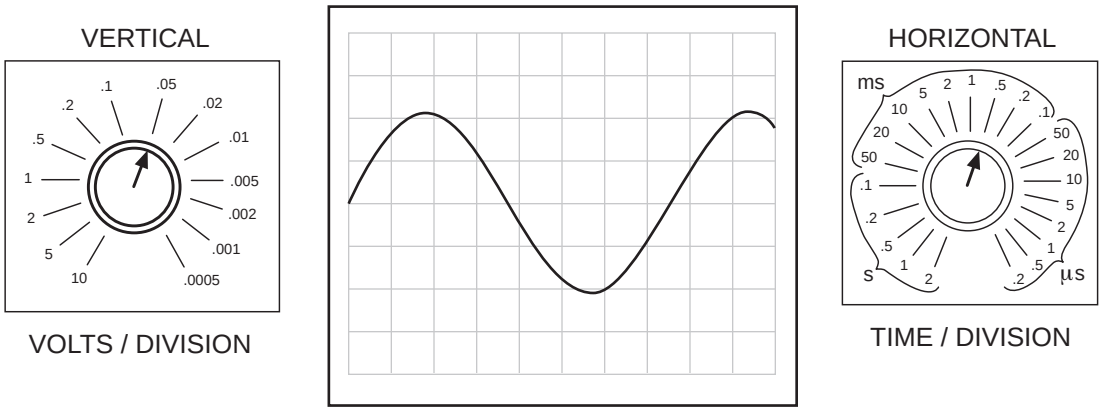
If $R_{100} = 172\ \Omega$, and $R_{200} = 241\ \Omega$, determine the value for coefficient B.

A. -1.50×10^{-6}
B. 1.50×10^{-6}
C. -7.35×10^{-3}
D. 7.35×10^{-3}

15. An example of a longitudinal wave is a

A. light wave.
B. radio wave.
C. water wave.
D. sound wave.

16. In the diagram of an oscilloscope shown, what is the period of the wave?



A. 0.5 ms
B. 1.9 ms
C. 3.8 ms
D. 5.0 ms

OVER

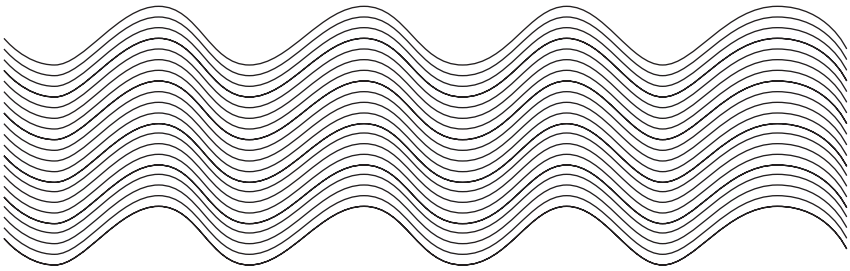
17. A baby's heart beats 144 times in one minute. What is the frequency of the heartbeat?

A. 6.94×10^{-3} Hz
B. 0.417 Hz
C. 2.40 Hz
D. 144 Hz

18. Ultrasonic sound is used to locate a school of fish. The speed of sound in the ocean is 1 450 m/s and the reflected sound wave reaches the ship 0.10 s after it is sent. How far is the school of fish from the ship?

A. 72.5 m
B. 145 m
C. 7 250 m
D. 14 500 m

19. The diagram below shows coherent, monochromatic light waves from a laser.



In terms of being coherent and monochromatic, they are

	COHERENT	MONOCHROMATIC
A.	in phase	same amplitude
B.	in phase	same wavelength
C.	parallel	same amplitude
D.	parallel	same wavelength

20. One watt is equal to

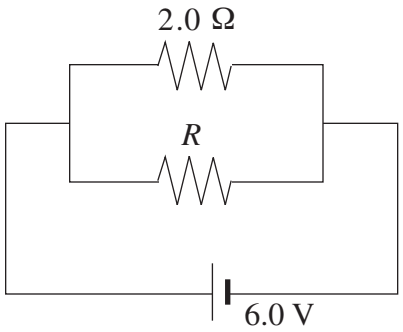
A. $1\ \text{A} \cdot 1\ \text{V}$

B. $\dfrac{1\ \text{A}}{1\ \text{V}}$

C. $\dfrac{1\ \text{V}}{1\ \text{A}}$

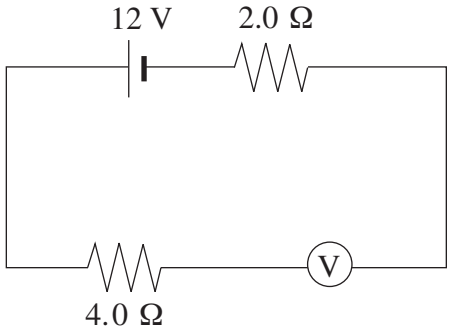
D. $\dfrac{1\ \Omega \cdot 1\ \text{V}}{1\ \text{A}}$

21. In the simple circuit shown, the power produced in the resistor R is one quarter that produced in the $2.0\ \Omega$ resistor. The resistance R is



A. $0.5\ \Omega$
B. $8.0\ \Omega$
C. $18\ \Omega$
D. $32\ \Omega$

22. A student mistakenly places a voltmeter in series in a circuit, as shown, in order to read the current. In this location, the voltmeter reading will be closest to



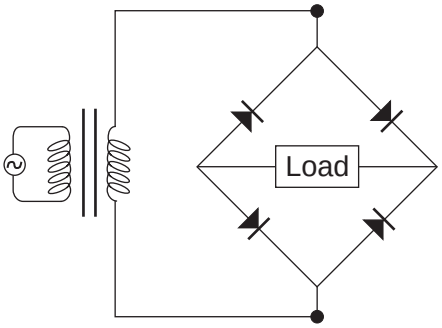
A. 0 V
B. 4.0 V
C. 6.0 V
D. 12 V

OVER

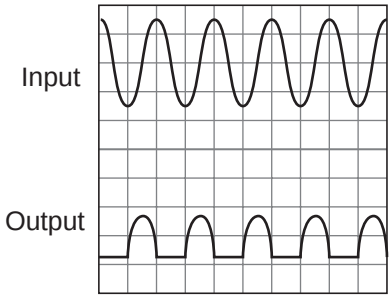
23. Four 20 Ω resistors are connected in parallel and the combination is connected to a 20 V power source. What is the current drawn from the power source?

A. 0.25 A
B. 1.0 A
C. 4.0 A
D. 100 A

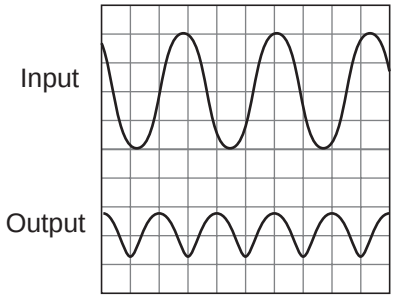
24. For the circuit shown below, which diagram of a dual trace oscilloscope shows the correct output for the given input signal?



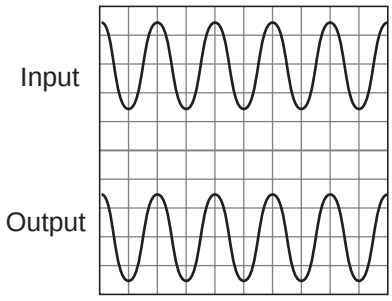
A.



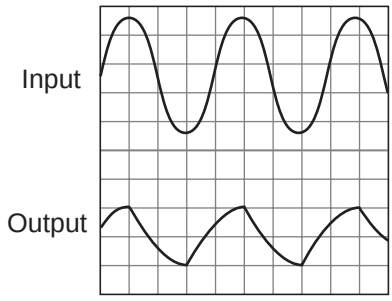
B.



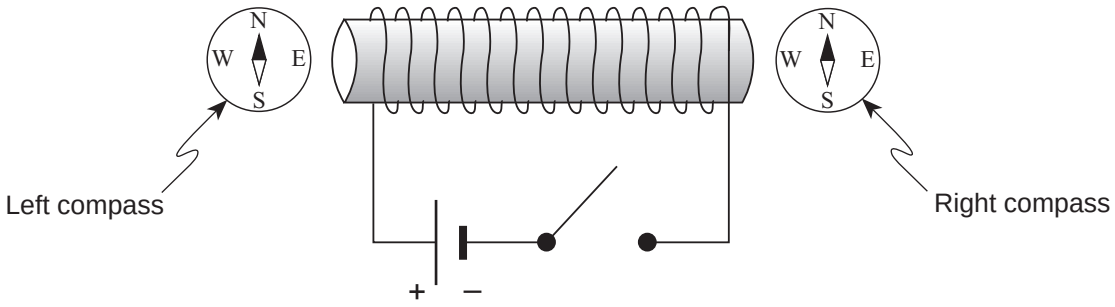
C.



D.



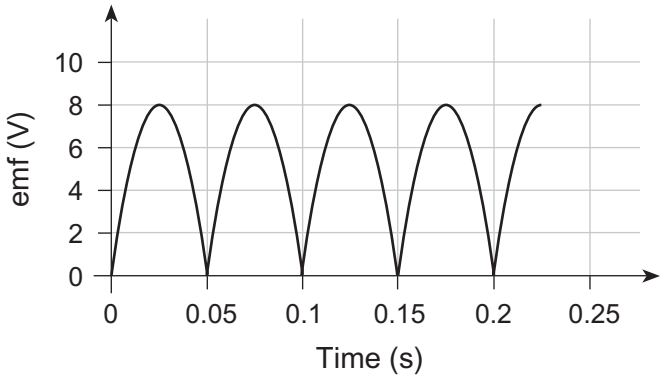
25. The diagram below shows a solenoid connected to a battery with an open switch and a compass placed next to each open end of the solenoid. The earth's magnetic field causes the compasses to point up the page when the switch is open.



When the switch is closed, in what direction will the compasses point?

	LEFT-END COMPASS	RIGHT-END COMPASS
A.	East	East
B.	East	West
C.	West	East
D.	West	West

26. The graph below shows the emf produced by a simple generator made with only one loop in the coil and a permanent magnet producing the stationary field.



What is the period of one rotation of the generator and does the generator have solid-slip rings or a split-ring commutator?

	PERIOD	COMMUTATOR TYPE
A.	0.05 s	Solid slip ring
B.	0.10 s	Solid slip ring
C.	0.05 s	Split ring
D.	0.10 s	Split ring

OVER

27. The windings of a motor have a resistance of $6.0\ \Omega$. The motor runs on 120 V ac, and when running generates a back voltage of 105 V. What current does the motor draw when running?

A. 2.5 A
B. 5.3 A
C. 17.5 A
D. 20 A

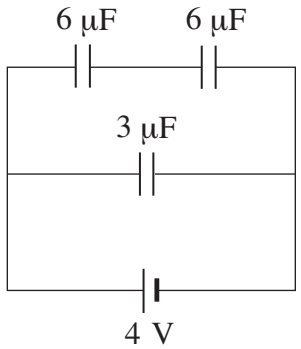
28. A $4.0\ \mu F$ capacitor is fully charged by a 50 V battery. The battery is removed and the capacitor is discharged through a $2.0\ M\Omega$ resistor for 8.0 seconds. What is the voltage across the capacitor?

A. 0 V
B. 18 V
C. 32 V
D. 37 V

29. A circuit to rectify ac current contained a capacitor and a transformer. The probable function of the capacitor was to

A. increase the voltage.
B. smooth out the level of the output dc voltage.
C. store energy for the rectifier circuit to work during power outages.
D. even out the level of the ac input voltage before the current entered the transformer.

30. What is the total energy stored in the three capacitors shown below?



A. 1.2×10^{-5} J
B. 1.9×10^{-5} J
C. 4.8×10^{-5} J
D. 1.2×10^{-4} J

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.**

OVER

1. a) Explain the difference between ideal mechanical advantage (IMA) and actual mechanical advantage (AMA). **(2 marks)**

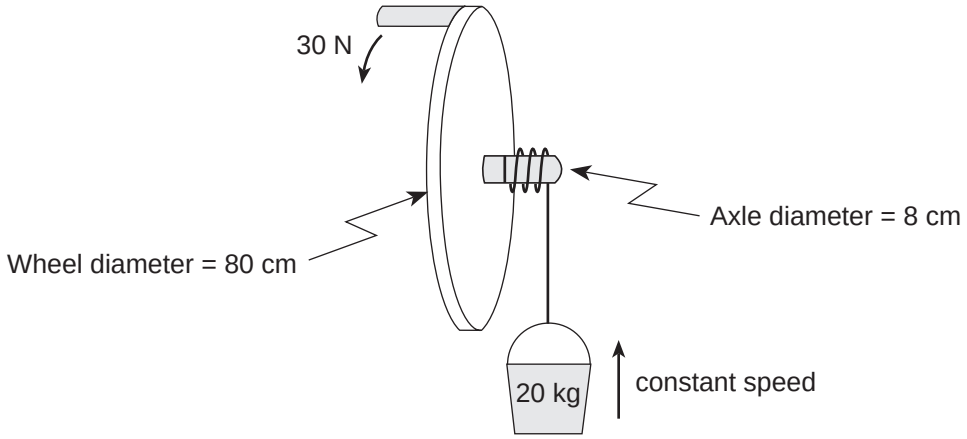
_____

_____

_____

_____

b) Determine the ideal mechanical advantage (IMA) and the actual mechanical advantage (AMA) for the situation shown below. **(3 marks)**



ANSWER:

ideal mechanical advantage: _____

actual mechanical advantage: _____

2. An ideal transformer is rated at 10 000 watts. The ratio of secondary to primary turns is 0.10. The primary voltage is 2 200 V. If the transformer is operated at its rated capacity,

a) determine the secondary voltage. **(3 marks)**

ANSWER:

secondary voltage: _____

b) determine the primary current. **(2 marks)**

ANSWER:

primary current: _____

OVER

3. An automatic rifle fires 30 g bullets with a muzzle velocity of 600 m/s. A person holding the rifle can exert a maximum force of 220 N without losing his balance.

   What is the maximum number of bullets per second that can be fired by this rifle? **(5 marks)**

ANSWER:

maximum number of bullets: _____

4. A wheel of moment of inertia $20\ \text{kg} \cdot \text{m}^2$ is rotated from rest by a constant torque and gains 360 J in 10 s.

a) Calculate the angular velocity after 10 s. **(3 marks)**

ANSWER:

angular velocity: _____

b) Calculate the torque. **(3 marks)**

ANSWER:

torque: _____

OVER

5. Describe the energy conversions that occur in a moving coil meter (ammeter) that is being used to measure current in a circuit. **(4 marks)**

6. Explain how a piezoelectric accelerometer indicates changes in motion. **(5 marks)**

OVER

7. a) Draw a circuit diagram showing how a galvanometer may be modified for use as a practical ammeter. **(2 marks)**

b) Explain the modification(s) made in part a). **(3 marks)**

8. Explain why some concert halls can have acoustic “dead spots”. **(5 marks)**

9. Describe **two** practical methods which could be used to measure the speed of sound. Include the major source of error for one of the methods.

a) Method 1: **(2 marks)**

_____

_____

_____

b) Method 2: **(2 marks)**

_____

_____

_____

c) Source of error for method ____ : **(1 mark)**

_____

_____

10. a) What is the speed of light in flint glass which has an index of refraction of 1.65?

(3 marks)

ANSWER:

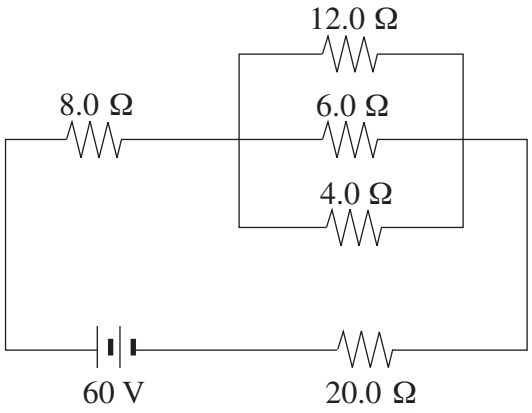
speed of light in flint glass: _____

b) What is the critical angle of flint glass in air? **(3 marks)**

ANSWER:

critical angle: _____

11. Consider the following circuit:



a) Determine the equivalent resistance. **(2 marks)**

ANSWER:

equivalent resistance: _____

b) Determine the current through the $4.0\ \Omega$ resistor. **(3 marks)**

ANSWER:

current through resistor: _____

12. A magnet and a similarly shaped aluminum bar are dropped down identical copper tubes. It is observed that the magnet took significantly longer to fall through its tube. Explain this occurrence using principles of physics. **(4 marks)**

END OF EXAMINATION

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TABLE OF CONSTANTS

Speed of light in vacuum	c	$= 3.00 \times 10^8$ m/s
Acceleration due to gravity at the surface of Earth (for the purposes of this examination)	g	$= 9.80$ m/s^2 $= 32.2$ ft/s^2
Atmospheric pressure at sea level		$= 1.013 \times 10^5$ Pa $= 14.70$ lb/in^2
Density of air (0°C, 1 atm pressure)		$= 1.29$ kg/m^3
Speed of sound in air (20°C)		$= 343$ m/s
Density of water (4°C)		$= 1.00 \times 10^3$ kg/m^3 $= 62.4$ lb/ft^3
Elementary charge unit	e	$= 1.6 \times 10^{-19}$ C
Specific heat capacity of water		$= 4\,186$ J/(kg·C°)

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 N/m^2 = 1.450×10^{-4} lb/in^2
1 lb/in^2 = 6.895×10^3 Pa
1 atm = 1.013×10^5 Pa = 1.013 bar = 14.70 lb/in^2 = 760 torr

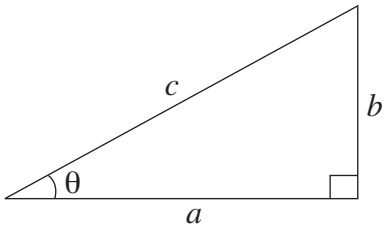
Volume

1 litre = 10^{-3} m^3 = 1 000 cm^3 = 0.03531 ft^3
1 ft^3 = 0.02832 m^3 = 7.481 U.S. gallons
1 U.S. gallon = 3.785×10^{-3} m^3 = 0.1337 ft^3

Angle

1 radian = 57.30°
1° = 0.01745 radian

For Right-angled Triangles:

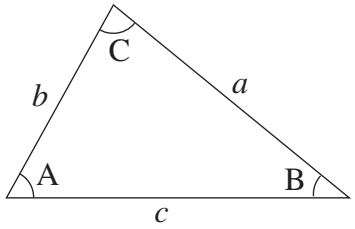


$$a^2 + b^2 = c^2$$

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

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

For All Triangles:



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

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

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

Circle:

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

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

FORMULAE

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

$\theta = \theta_0 t + \frac{1}{2} \alpha t^2$
$\omega = \omega_0 + \alpha t$

$\tau = F \cdot d$

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

$F_{net} = ma$
$p = mv$
$F \Delta t = \Delta p$

$\tau_{net} = I\alpha$
$L = I\omega$
$\tau \Delta t = \Delta L$

$F_f = \mu F_N$
$F = Kx$

$W = F \cdot d$

$W = \tau \cdot \theta$

$E_k = \frac{1}{2} m v^2$
$E_p = mgh$
$E_p = \frac{1}{2} k x^2$
$E_H = mc\Delta T$

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

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

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

$\Delta P = \rho g h$

$W = \Delta(PV)$

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

$n = \frac{c}{v}$
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

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

$V = \frac{\Delta Ep}{Q}$
$P = IV$

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

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

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

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

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ROUGH WORK FOR GRAPHING

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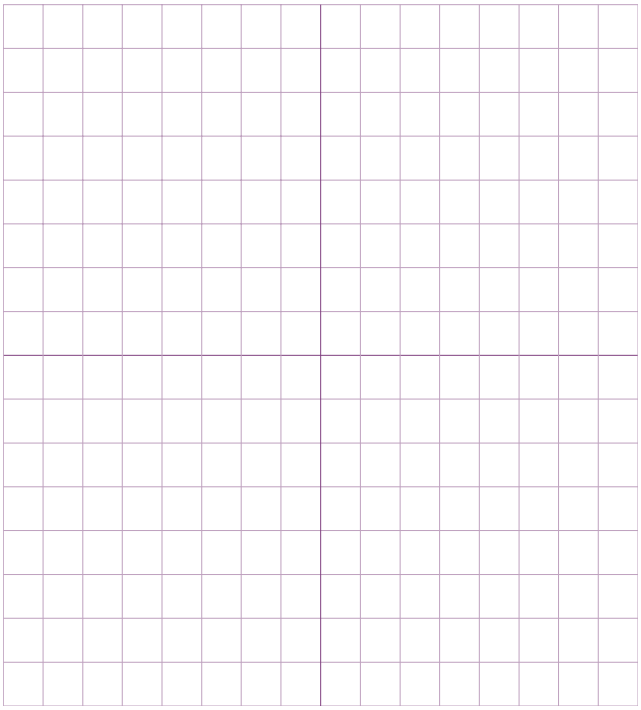

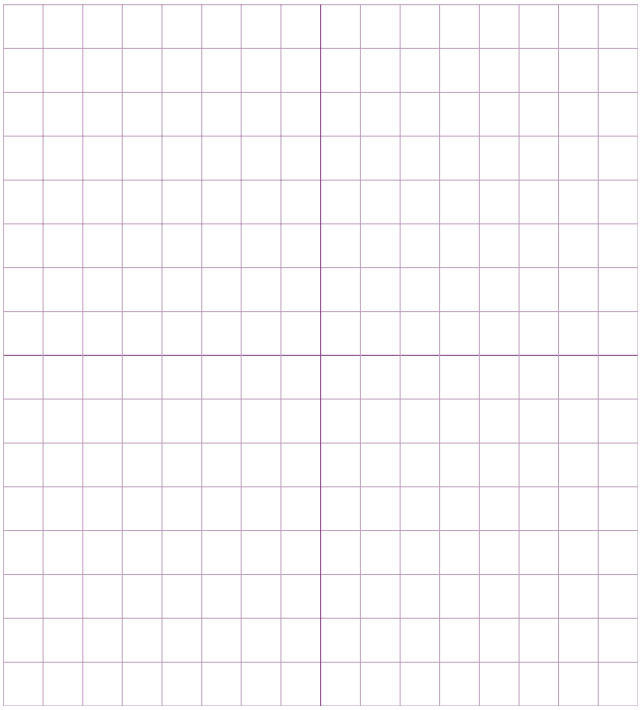

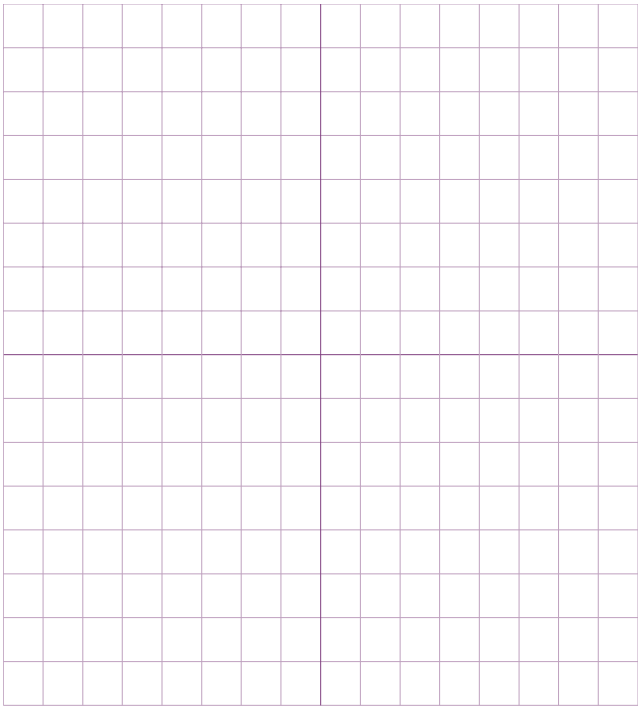

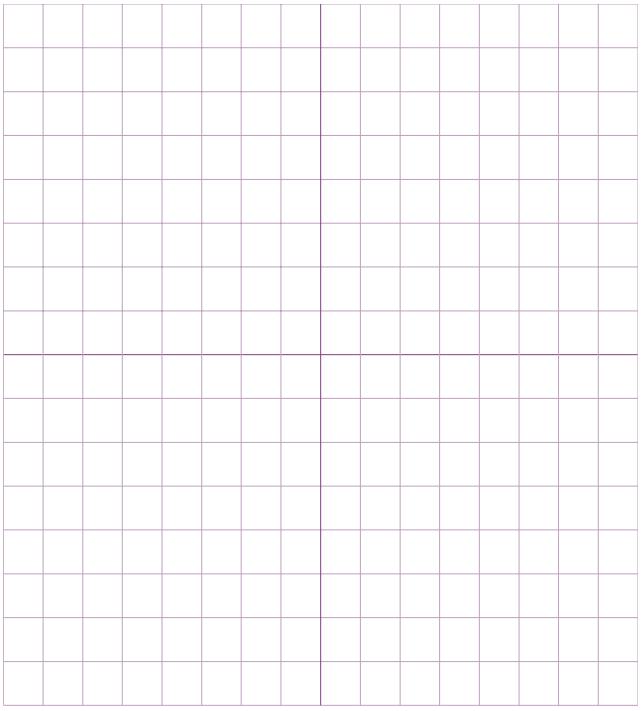

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ROUGH WORK FOR GRAPHING

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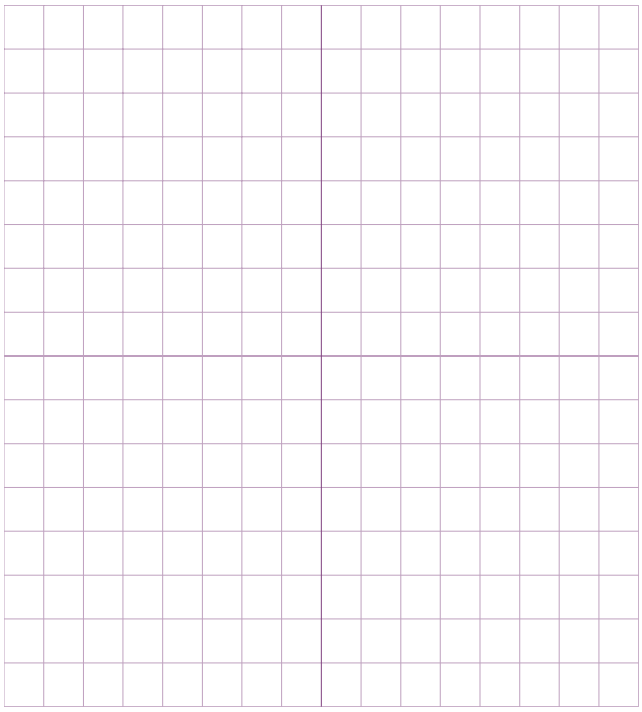

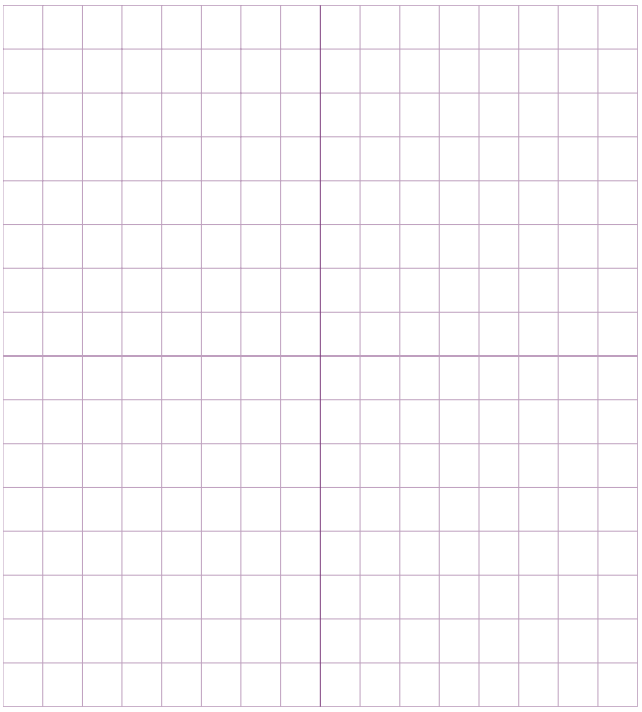

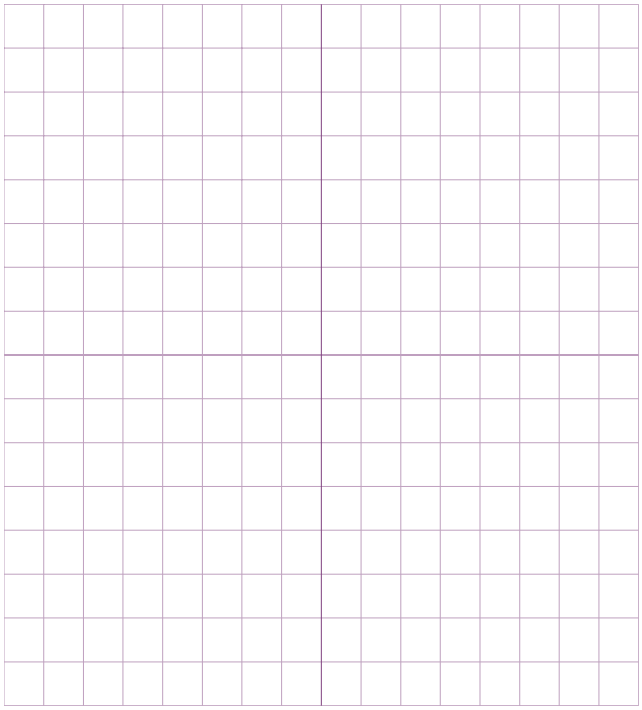

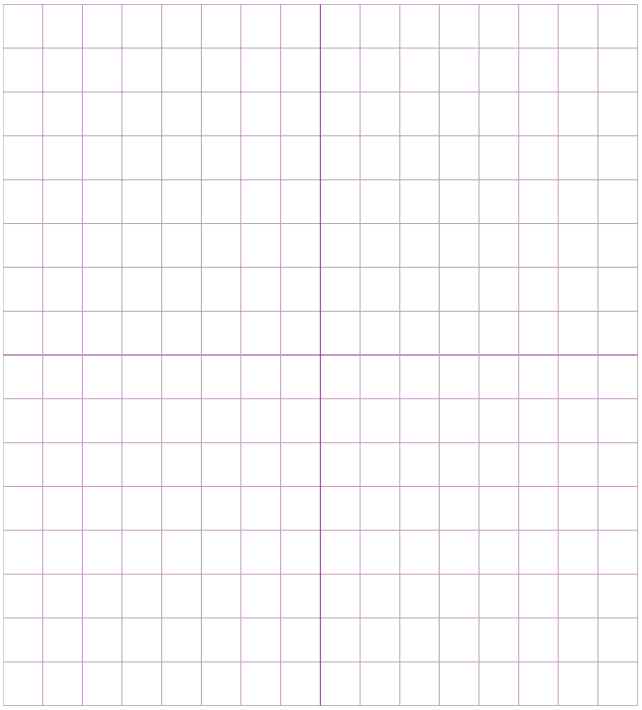

ROUGH WORK FOR MULTIPLE-CHOICE

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ROUGH WORK FOR MULTIPLE-CHOICE