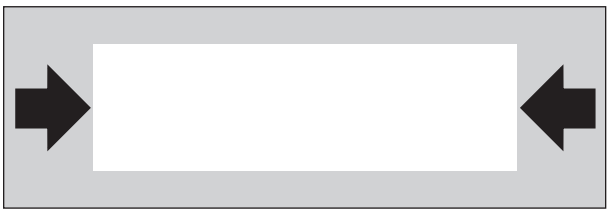
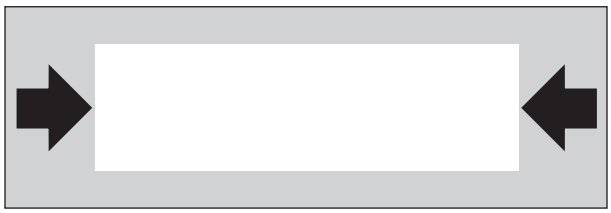
Insert Personal Education Number (PEN) here.



Insert **only** pre-printed PEN label here.



STUDENT INSTRUCTIONS

1. Insert 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.

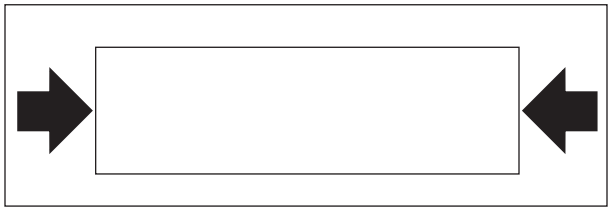
5. At the end of the examination, place your Response Form inside the front cover of this booklet and return the booklet and your Response Form to the supervisor.

APPLICATIONS OF PHYSICS 12

JUNE 2000

COURSE CODE = APH

Insert **only** hand-printed PEN here.



Ministry use only.

BRITISH COLUMBIA

Question 1:

1. . (4)

Question 9:

9. . (4)

Question 2:

2. . (4)

Question 3:

3. . (4)

Question 4:

4. . (3)

Question 5:

5. . (4)

Question 6:

6. . (5)

Question 7:

7. . (3)

Question 8:

8. . (5)

APPLICATIONS OF PHYSICS 12

JUNE 2000

COURSE CODE = APH

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:	36 multiple-choice questions worth one mark each	36	60
PART B:	9 written-response questions	36	60
	Total:	**72 marks**	**120 minutes**

2. The last **three** pages inside the back cover contain the **Table of Constants**, **Conversion Factors**, **Mathematical Equations**, **Formulae,** 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: 36 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. A person uses a pulley system to raise a load. When 2.0 metres of rope is pulled downward using a force of 100 N, it is noticed that the load rises only 20 cm. What is the maximum weight of the load?

   A. 10 N
   B. 50 N
   C. 500 N
   D. 1 000 N

2. Which of the following combinations would produce the highest pressure?

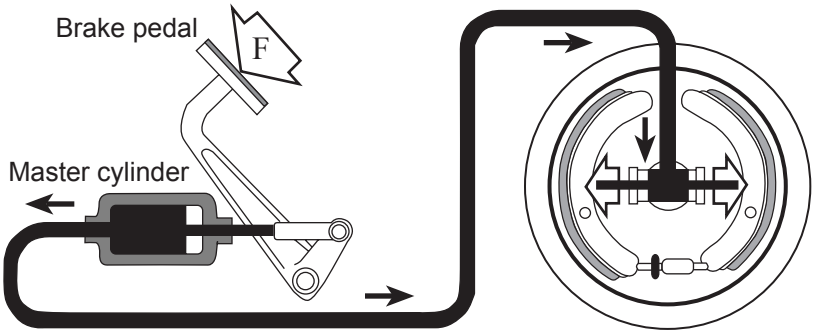
   A. A large force exerted on a large surface area.
   B. A large force exerted on a small surface area.
   C. A small force exerted on a large surface area.
   D. A small force exerted on a small surface area.

3. The pistons of a hydraulic lift have areas of $10\ cm^2$ and $60\ cm^2$. A force of 180 N is exerted on the small piston and it moves through a distance of 9.0 cm. Determine the force exerted by the large piston and the distance it moves.

	FORCE	DISTANCE
A.	30 N	1.5 cm
B.	30 N	54 cm
C.	1 080 N	1.5 cm
D.	1 080 N	54 cm

OVER

4. When a driver applies force to the brake pedal, force is exerted on the master cylinder which then causes pressure to be exerted on all four brake cylinders. The diagram below shows the operation for one wheel.



A test vehicle being designed requires twice as much braking force in the front brake cylinders as compared to the rear brake cylinders. The distance to the rear cylinders is four times the distance to the front cylinders from the master cylinder.

How do the cross-sectional areas of the front cylinders compare to those of the rear cylinders?

A. half
B. twice
C. four times
D. eight times

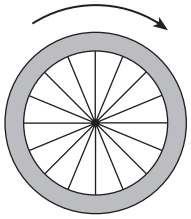
5. If an object's speed and direction remain constant, the

A. net force on the object must be zero.
B. momentum of the object must be zero.
C. impulse on the object must be constant.
D. net force on the object must be constant.

6. A freight car of mass 3 000 kg is moving with a speed of 8.0 m/s when it hits and couples with a stationary 4 000 kg freight car. The final speed of the two freight cars together is

A. 3.4 m/s
B. 4.6 m/s
C. 6.0 m/s
D. 8.0 m/s

7. The direction of the angular momentum vector for the rotating object shown below is



A. clockwise.
B. into the page.
C. out of the page.
D. counterclockwise.

8. Two flywheels, A and B, have the same mass. The radius of flywheel A is one half that of flywheel B. The moment of inertia of A is

A. one fourth that of B.
B. one half that of B.
C. twice that of B.
D. four times that of B.

9. The angular displacement of a flywheel that moves through 8 revolutions is

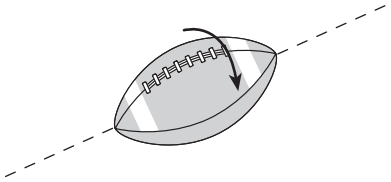
A. 8.0 radians.
B. 16 radians.
C. 25 radians.
D. 50 radians.

10. What is the angular momentum of a young skater who makes 10 complete spins in 1.8 seconds? The moment of inertia of the skater is approximately $0.72\ \text{kg} \cdot \text{m}^2$.

A. $4.0\ \text{kg} \cdot \text{m}^2/\text{s}$
B. $13\ \text{kg} \cdot \text{m}^2/\text{s}$
C. $25\ \text{kg} \cdot \text{m}^2/\text{s}$
D. $45\ \text{kg} \cdot \text{m}^2/\text{s}$

OVER

11. In order to throw an effective pass with a football, the quarterback gives the ball a spin along its length. If a football is given a spin of 65 rad/s in a time of 0.15 second, what is the average torque applied to the ball? The moment of inertia of the football is 1.9×10^{-3} kg $\cdot$ m^2.



A. 0.019 N $\cdot$ m
B. 0.12 N $\cdot$ m
C. 0.82 N $\cdot$ m
D. $5\,100$ N $\cdot$ m

12. A 19 kg tire with a radius of 34 cm is given a quick push that causes the tire to roll. The tire travels 6.8 m in 3.2 seconds. The moment of inertia of the tire is 7.8 kg $\cdot$ m^2. What angular impulse was given to the tire?

A. 15 kg $\cdot$ m^2/s
B. 17 kg $\cdot$ m^2/s
C. 40 kg $\cdot$ m^2/s
D. 49 kg $\cdot$ m^2/s

13. Hydroelectric power is generated from energy contained in lakes. The form of energy in the lake is

A. kinetic energy.
B. thermal energy.
C. potential energy.
D. mechanical energy.

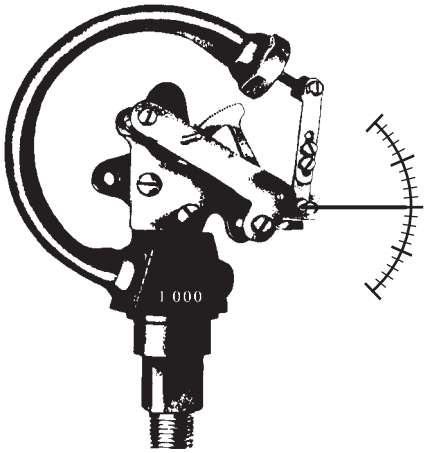
14. The efficiency of an air conditioner is 23%. The air conditioner draws a current of 4.0 A from a 120 V line. What quantity of heat can it extract in a 5 minute time period?

A. 110 J
B. 550 J
C. 33 000 J
D. 140 000 J

15. A water pump that is 30% efficient is able to raise 20 kg of water every second to a reservoir situated 12 m above ground level. What is the output power rating of this pump?

A. 0.95 hp
B. 1.1 hp
C. 3.2 hp
D. 11 hp

16. The type of gauge illustrated in the diagram below is



A. a Pitot tube.
B. a strain gauge.
C. a Bourdon tube.
D. an anemometer.

17. A strain gauge, with a sensitivity of $0.45\ \text{N}/\Omega$, is connected to a constant 6.0 V source. With no load, an ammeter connected to the gauge reads 19 mA. What load is required for a current of 14 mA?

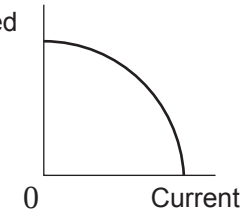
A. 51 N
B. 82 N
C. 140 N
D. 190 N

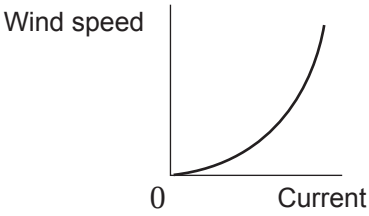
18. A force transducer can be used to measure pressure provided that

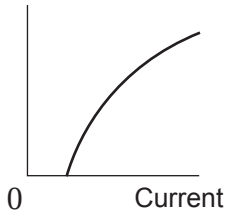
A. all measurements can be made at the same time.
B. the time during which the force is applied is known.
C. the direction of the force is not perpendicular to the surface.
D. the area over which the force is applied is known and constant.

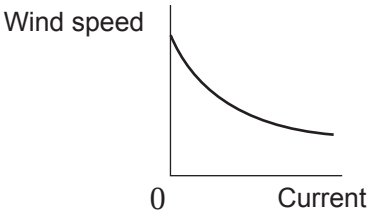
OVER

19. A small turbine is used to indicate wind speed. As the turbine rotates, a small current is generated; higher wind speeds generating higher currents. Which of the graphs below shows a possible relationship between wind speed and current?

A. 

B. 

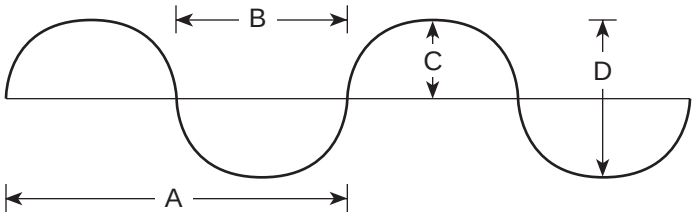
C. 

D. 

20. To change a galvanometer into an ammeter, connect a

A. large resistance in series with the galvanometer.
B. small resistance in series with the galvanometer.
C. large resistance in parallel with the galvanometer.
D. small resistance in parallel with the galvanometer.

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

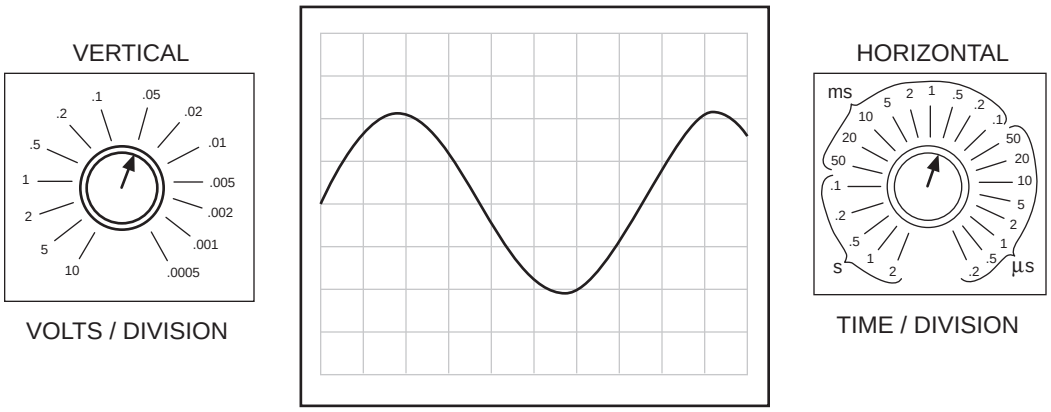


A. A
B. B
C. C
D. D

22. The crest of a wave passes under a student sitting at the end of a pier. The student notices that it takes $4.5\ \text{s}$ for the wave to reach the beginning of the pier 12 m away. If 8 complete waves passed under the student during that time, what is the frequency of the waves?

A. 0.56 Hz
B. 0.67 Hz
C. 1.5 Hz
D. 1.8 Hz

23. In the diagram of an oscilloscope shown, the period of the wave is



A. 0.11 ms
B. 0.22 ms
C. 1.9 ms
D. 3.8 ms

24. In a water tank waves $2.8\ \text{m}$ long are produced with a frequency of $3.0\ \text{Hz}$. If the frequency is increased to $8.0\ \text{Hz}$, what is the wavelength of the waves produced?

A. 1.1 m
B. 1.8 m
C. 2.8 m
D. 7.5 m

25. Standing waves are produced by the interference of a 100 Hz sound wave being reflected perpendicularly off a barrier. The distance from the second node to the fifth node is 60 cm. The wavelength of the original wave is

A. 15 cm.
B. 20 cm.
C. 30 cm.
D. 40 cm.

OVER

26. The correct order for gamma radiation, radio waves, and visible light in terms of frequency is

	LOWEST FREQUENCY	MIDDLE FREQUENCY	HIGHEST FREQUENCY
A.	radio	gamma	visible
B.	radio	visible	gamma
C.	gamma	visible	radio
D.	visible	radio	gamma

27. In an optical fibre bending around a corner, the light

A. travels down the centre of the fibre.
B. travels along the inner surface of the fibre.
C. continually defracts down the centre of the fibre.
D. reflects internally in a succession of straight-line paths.

28. Which of the following is equivalent to voltage V?

A. JC

B. $\frac{J}{C}$

C. $\frac{C}{J}$

D. JA

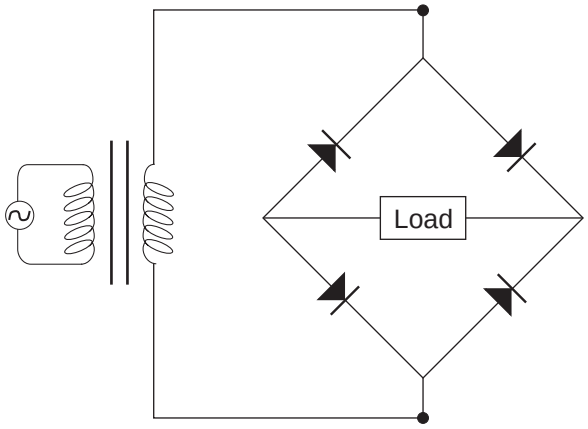
29. The operation of a ground fault circuit interrupter (GFCI) is based on the detection of

A. any current in the ground wire.
B. high current in the hot (live) wire.
C. a difference in current between hot (live) and neutral wires.
D. a difference in current between hot (live) and ground wires.

30. In order to be useful within a given circuit, which of the following devices is only connected in series?

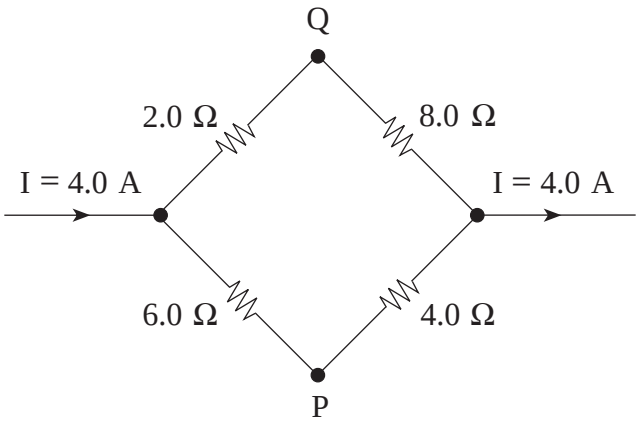
A. battery
B. ammeter
C. capacitor
D. voltmeter

31. The circuit shown is a



A. full wave rectifier circuit.
B. half wave rectifier circuit.
C. filtered full wave rectifier circuit.
D. filtered half wave rectifier circuit.

32. Consider the following circuit branch.

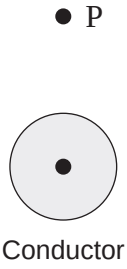


What is the voltage between points P and Q?

A. 4 V
B. 8 V
C. 16 V
D. 24 V

OVER

33. Consider the following diagram of a conductor which is carrying a conventional current directly out of the page.



Which arrow represents the direction of the magnetic field at point P?

A.

B.

C. 

D. 

34. The following equation is used to describe the voltage across a capacitor:

$$V = (100\,V)\,e^{\frac{-t}{0.2s}}$$

The "100 V" represents the

A. final voltage that the capacitor will be charged to.
B. maximum voltage that can be applied to the capacitor.
C. voltage across the capacitor before it starts to discharge.
D. voltage across the capacitor when the time constant is reached.

35. Three capacitors, each having a capacitance of $2.0\ \mu F$ are connected in parallel. What is the equivalent capacitance of this combination?

A. $0.67\ \mu F$
B. $1.5\ \mu F$
C. $2.0\ \mu F$
D. $6.0\ \mu F$

36. The charging circuit of an electronic flash stores 12 J of energy and is provided with 300 V input voltage. The resistance of the charging circuit is $9.0\ k\Omega$. What is the time constant for the flash?

A. 0.40 s
B. 1.2 s
C. 2.4 s
D. 2.5 s

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

PART B: WRITTEN RESPONSE

Value: 36 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 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)**

ANSWER:

average force of friction: _____

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)**

ANSWER:

turns ratio: _____

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

ANSWER:

current: _____

OVER

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)**

ANSWER:

impulse: _____

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

ANSWER:

change in kinetic energy: _____

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

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

OVER

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

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)**

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)**

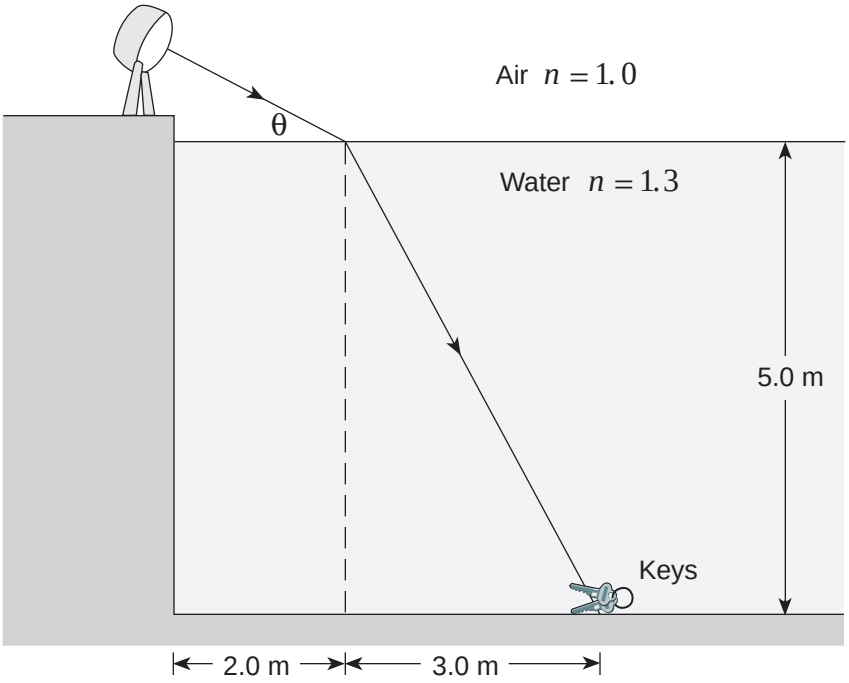
ANSWER:

lowest resonant frequency: _____

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

OVER

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.



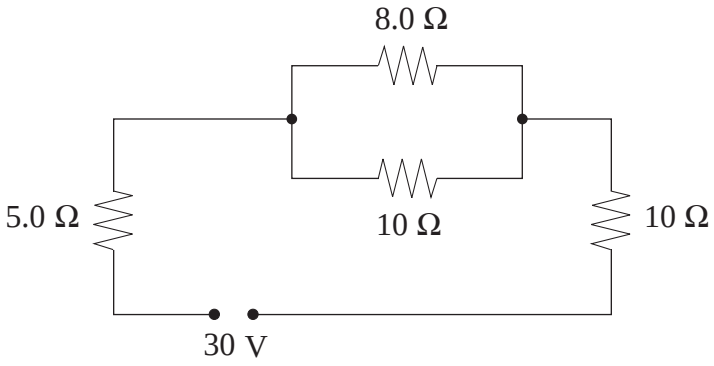
(Diagram not drawn to scale.)

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

ANSWER:

angle: _____

8. Consider the following diagram.



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

ANSWER:

power consumed: _____

OVER

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

END OF EXAMINATION

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

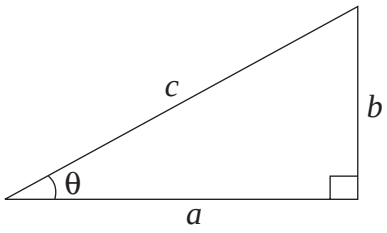
Volume

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:

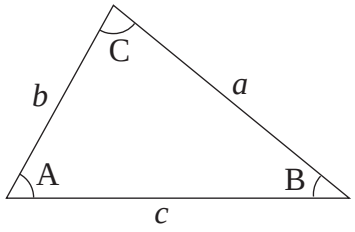


$$a^2 + b^2 = c^2$$

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

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

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

Circle:

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

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

FORMULAE

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

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

$\tau = F \cdot d$

$I_{disk} = \frac{1}{2} mr^2$

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

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

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

$W = F \cdot d$

$W = \tau \cdot \theta$

$E_k = \frac{1}{2} mv^2$
$E_p = mgh$
$E_p = \frac{1}{2} kx^2$
$E_H = mc\Delta T$

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

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

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

$\Delta P = \rho gh$

$W = \Delta(PV)$

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

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

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

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

$P = IV$

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

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

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

$\tau = RC$

$E_p = \frac{1}{2} CV^2$

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ROUGH WORK FOR GRAPHING

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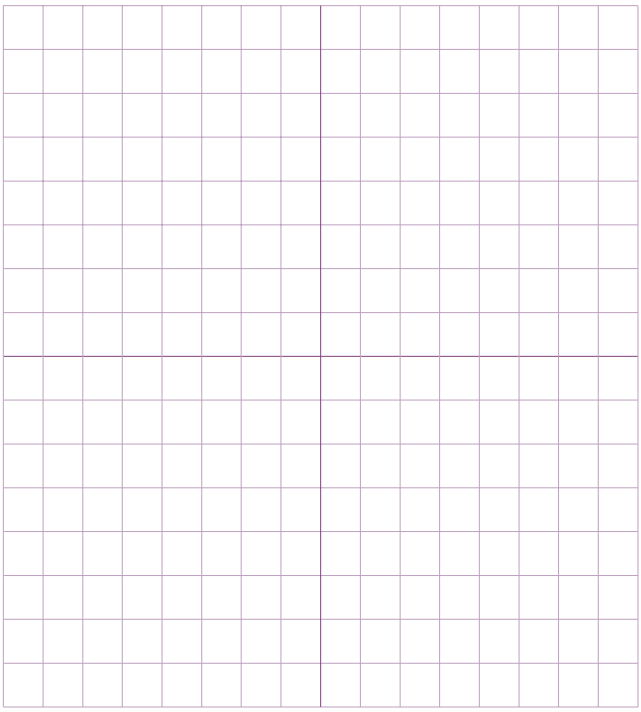

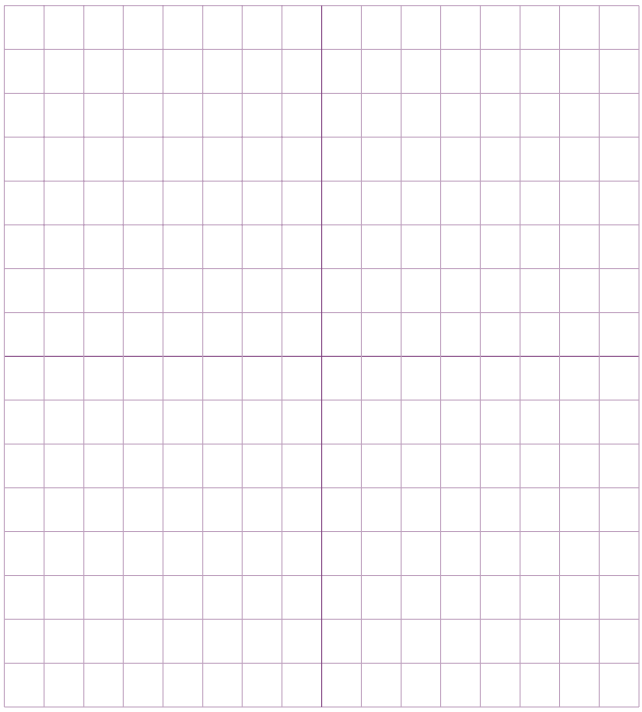

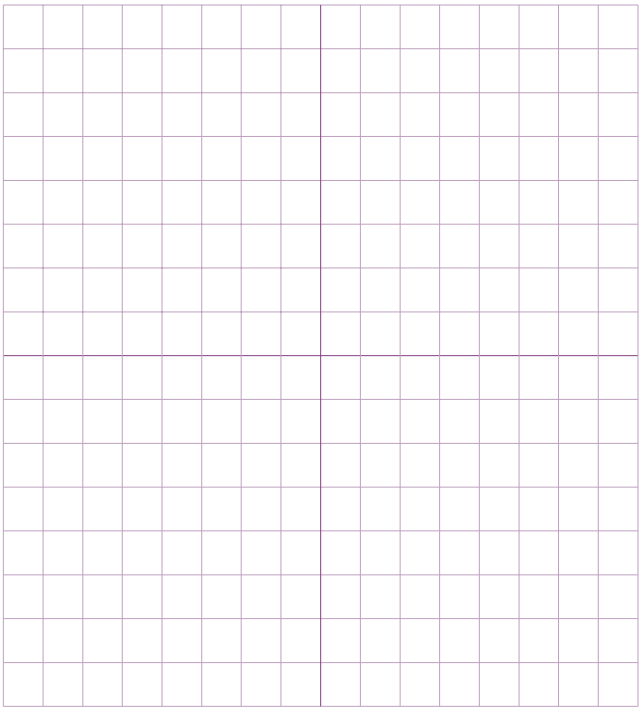

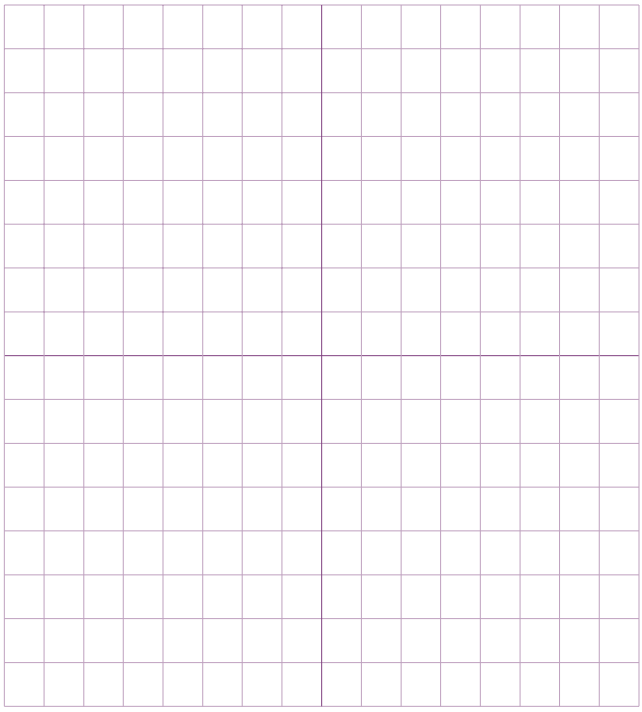

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ROUGH WORK FOR GRAPHING

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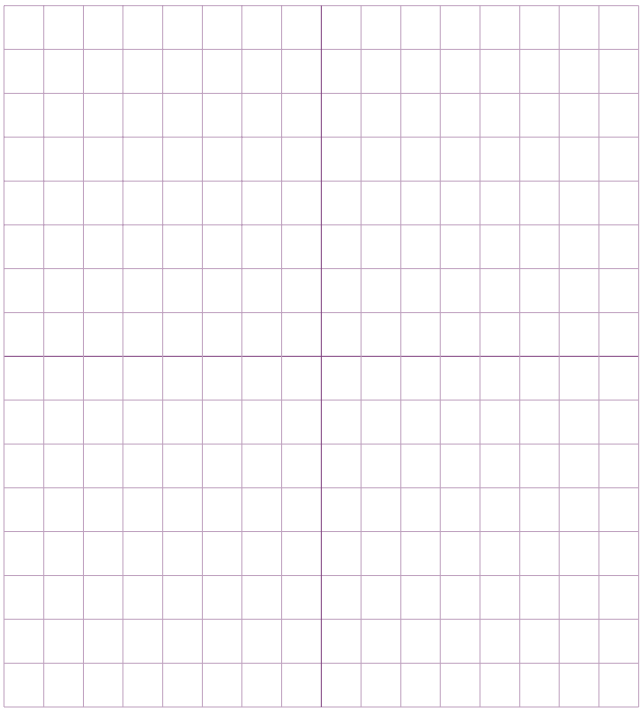

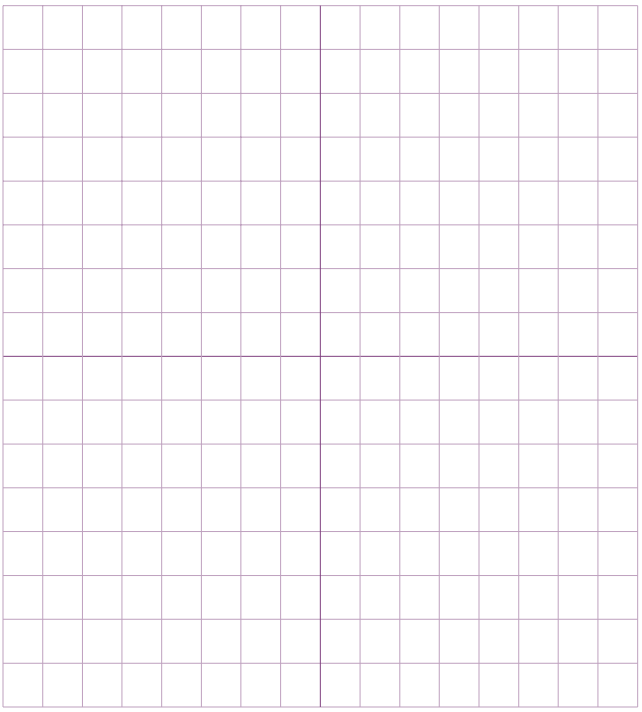

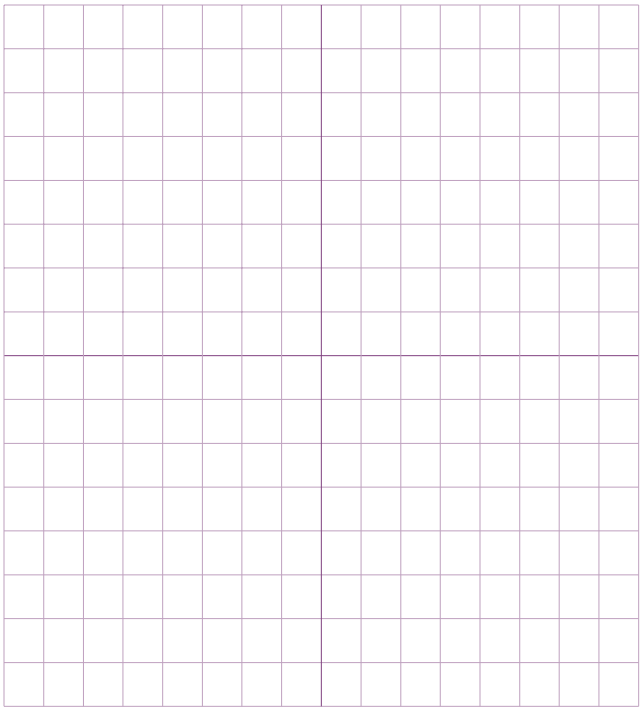

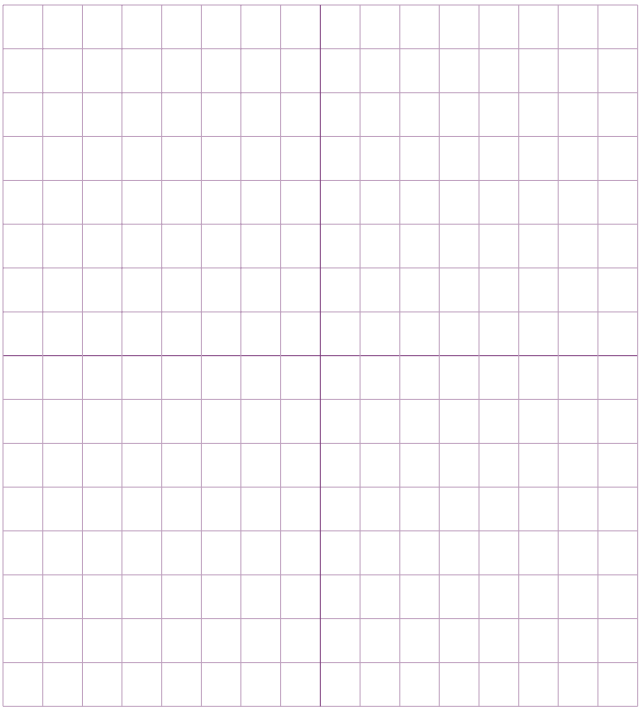

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ROUGH WORK FOR MULTIPLE-CHOICE

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ROUGH WORK FOR MULTIPLE-CHOICE