SIR ARTHUR LEWIS COMMUNITY COLLEGE

ACADEMIC YEAR (2024/2025) – SEMESTER ONE

END OF SEMESTER ALTERNATE EXAMINATION

COURSE TITLE	**:**	**INTRODUCTORY PHYSICS**
COURST CODE	**:**	**PHY102**
LECTURER	**:**	**BRONDON SCOTT**
DATE	:	
TIME	**:**	
DURATION	**:**	**2 HRS.**
STUDENT ID#	**:**	**…….**

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Write your student ID number on all the work you hand in.
2. This exam consists of THREE sections: A, B and C.
3. Section A consists of thirty (30) multiple choice questions. Answer ALL questions in this section.
4. Section B and C each consist of THREE (3) structured questions. Answer ANY TWO (2) questions from EACH section.
5. Answers must be written on answer sheet(s) provided
6. All working MUST be CLEARLY shown for sections B and C
7. The use of non-programmable calculators is permitted
8. Do not use correction fluid

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

PHY 102 Data and Formula Sheet

- Linear speed, $v = r\omega$
- Centripetal acceleration, $a_c = \omega^2 r$, $a_c = \frac{v^2}{r}$
- Centripetal force, $F_c = ma_c$, $F_c = m\omega^2 r$, $F_c = \frac{mv^2}{r}$
- Period, $T = \frac{2\pi}{\omega}$, $T = \frac{1}{f}$
- Frequency, $f = \frac{1}{T}$
- Speed of a wave, $v = f\lambda$
- Acceleration due to gravity, $g = 10\ ms^{-2}$

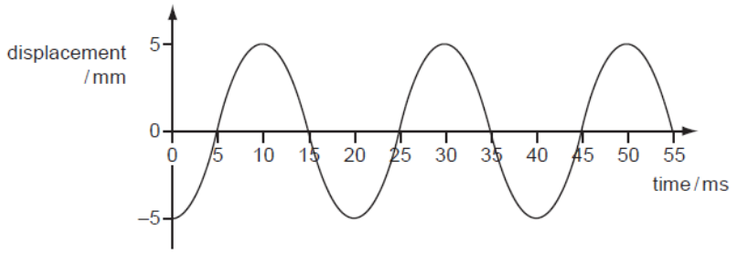
SECTION A

This section of the paper contains twenty (20) multiple choice questions. Attempt all the questions in this section by writing the letter corresponding to the answer of your choice.

1. A sea wave is an example of a:

   A. mechanical and transverse wave
   B. mechanical and longitudinal wave
   C. electromagnetic and transverse wave
   D. electromagnetic and longitudinal wave

2. The graph below shows how a point on a wave varies with time. What is the amplitude and frequency of the wave?



   A. Amplitude = 5 mm; frequency = 40 Hz
   B. Amplitude = 5 mm; frequency = 50 Hz
   C. Amplitude = 10 mm; frequency = 40 Hz
   D. Amplitude = 10 mm; frequency = 50 Hz

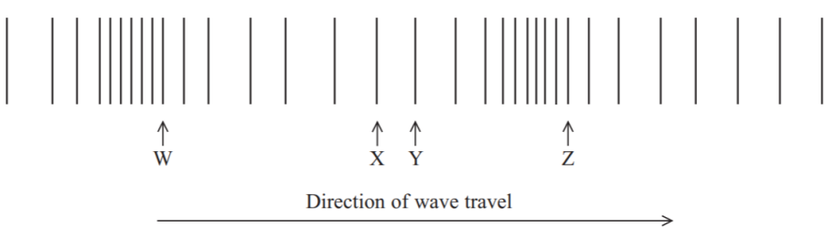
3. What is phase difference between an adjacent crest and trough in a transverse wave?

   A. $\pi/2$ rad B. π rad C. $3\pi/2$ rad D. 2π rad

4. An increase in loudness and a decrease in pitch of a sound wave causes

   A. the amplitude to increase and the frequency to decrease
   B. the frequency to increase and the amplitude to decrease
   C. both the amplitude and frequency to increase
   D. both the amplitude and frequency to decrease

5. The diagram represents a sound wave moving to the right through a uniform medium.

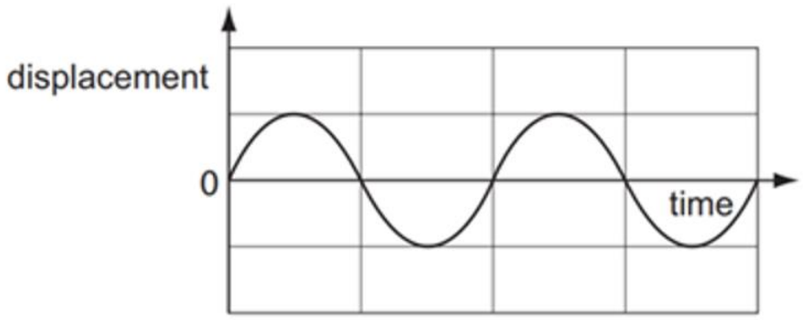


   Points W, X, Y and Z represent the positions of particles of the medium.

   The motion of the particle at W is represented by

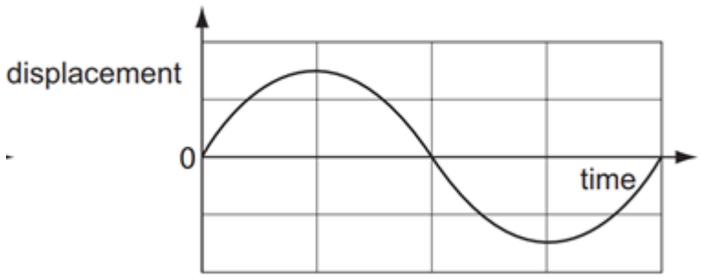
   A.  B.  C.  D. 

6. A displacement-time graph for a longitudinal wave is shown.



A second wave of similar type has twice the amplitude and half the frequency. When drawn on the same axes, what would the second wave look like?

A.



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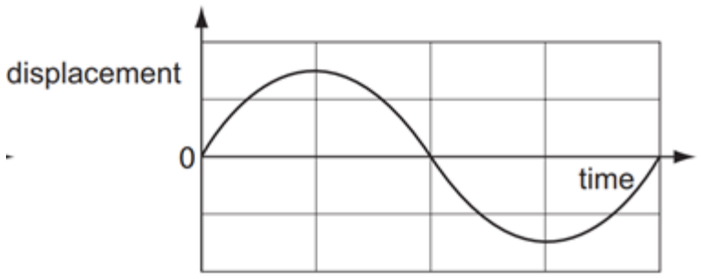

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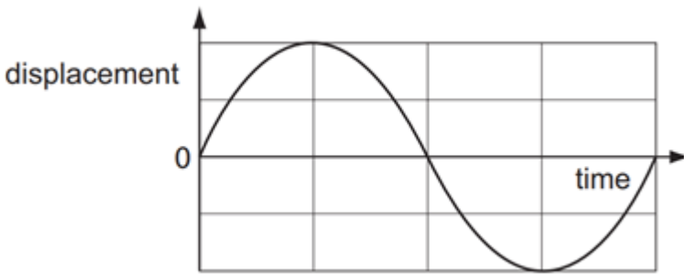
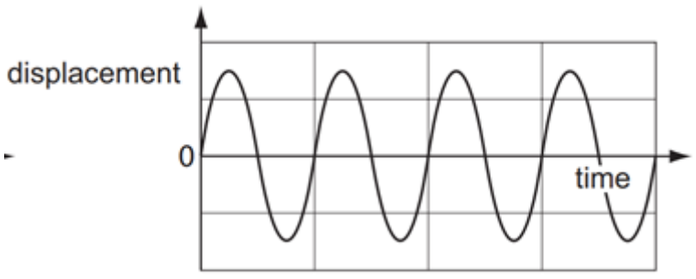


D.



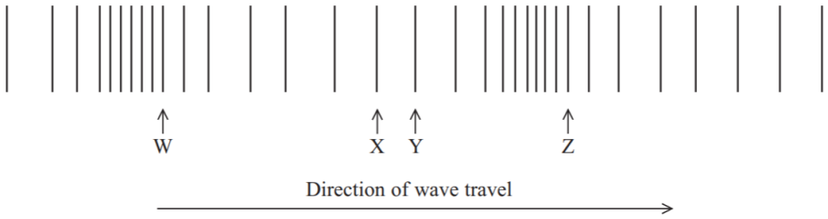
7. The crest of an ocean wave moves at 6 ms^{-1} and the distance between two consecutive wave crests is 8 m. What is the frequency of the wave?

A. 0.75 Hz B. 1.3 Hz C. 6.0 Hz D. 8.0 Hz

8. An earthquake wave travels in an east-west direction in rocks. The rocks are vibrating in a north-south direction. This earthquake wave must be classified as a

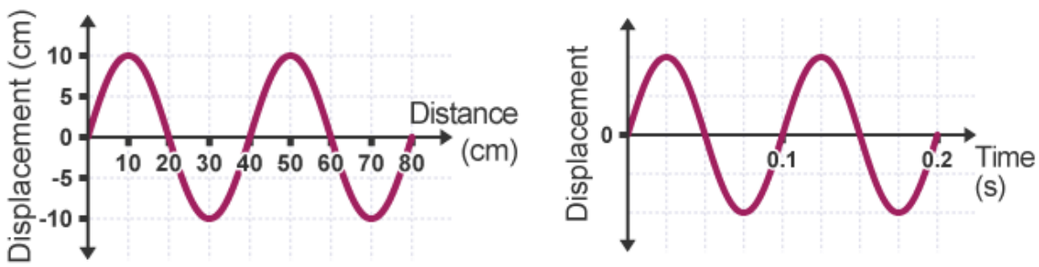
A. longitudinal wave
B. standing wave
C. stationary wave
D. transverse wave

9. The wavelength of the wave shown in the diagram is the distance between points



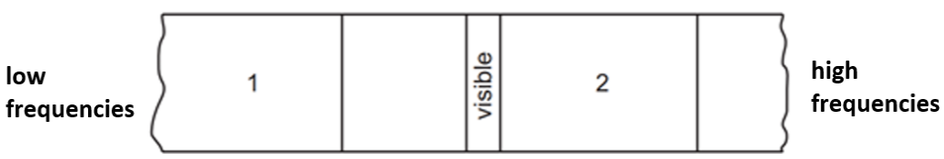
A. W and Y
B. W and Z
C. X and Y
D. Y and Z

10. The diagram shows the displacement-time and displacement-distance graphs of a transverse wave. What is the speed of the wave?



A. 2.0 ms^{-1}
B. 4.0 ms^{-1}
C. 8.0 ms^{-1}
D. 16.0 ms^{-1}

11. The diagram illustrates part of the electromagnetic spectrum.



Which labels are correct for the regions marked 1 and 2?

A.	1 – infrared	2 – X-rays
B.	1 – ultraviolet	2 – microwaves
C.	1 – infrared	2 – ultraviolet
D.	1 – microwaves	2 – ultraviolet

12. Which of the following statements are true?

I X-rays travel faster than sound but slower than light
II The speed of red light in a vacuum is the same as the speed of blue light in a vacuum
III Radio waves are transverse waves

A. I and II only
B. I and III only
C. II and III only
D. I, II and III

13. The diagram below is a photo taken of a pencil in a glass of water.

The appearance of the pencil in the water is a result of

A. diffraction B. refraction C. reflection D. interference

14. Diagram 1 shows a ripple tank experiment in which plane waves pass through a narrow slit in a metal sheet. Diagram 2 shows the same tank with a slit of greater width. In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

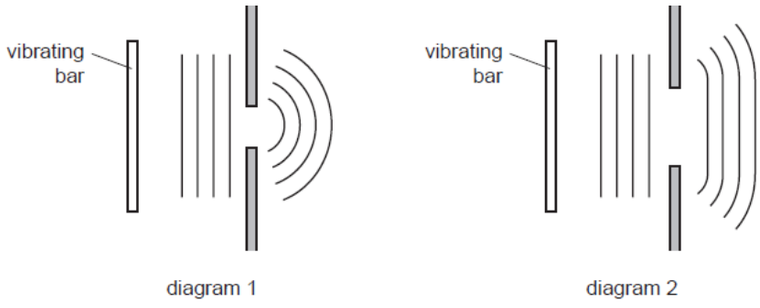


diagram 1 diagram 2

Which action would cause the waves in diagram 1 to spread less and so produce an emergent pattern closer to that shown in diagram 2?

A. Increasing the wavelength of the incident wave
B. Decreasing the wavelength of the incident wave
C. Increasing the amplitude of vibration of the bar
D. Increasing the length of the vibrating bar

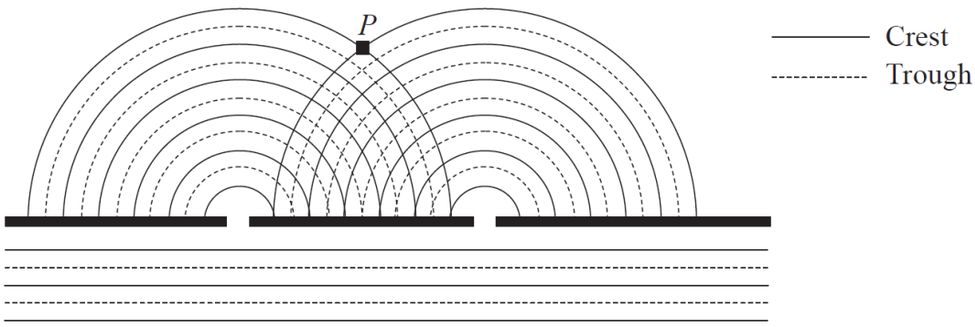
15. A sound wave bounces off a wall to produce an echo. Which of the following wave parameters is not conserved?

A. Wavelength
B. Frequency
C. Wave speed
D. Wave direction

16. In the Young double slit experiment, light and dark fringes are observed on a screen. The wave phenomenon displayed by this pattern is

A. reflection
B. coherence
C. interference
D. refraction

17. The diagram below represents shallow water waves of constant wavelength passing through two small openings in a barrier.



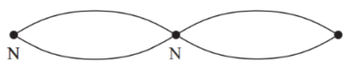
The statement that best describes the interference at point P is:

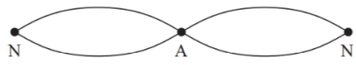
A. It is constructive and causes a longer wavelength.
B. It is constructive and causes an increase in amplitude.
C. It is destructive and causes a shorter wavelength.
D. It is destructive and causes a decrease in amplitude.

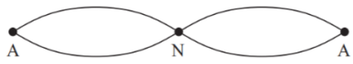
18. Two sound waves have the same frequency and are travelling in the same medium. The two waves can produce a standing wave if they

A. have different amplitudes and travel in opposite directions.
B. have different amplitudes and travel in the same direction.
C. have the same amplitude and travel in opposite directions.
D. have the same amplitude and travel in the same direction.

19. The diagram represents a stationary wave on a string. For a stationary wave on a string, which diagram correctly shows the position of nodes N and/or antinodes A?

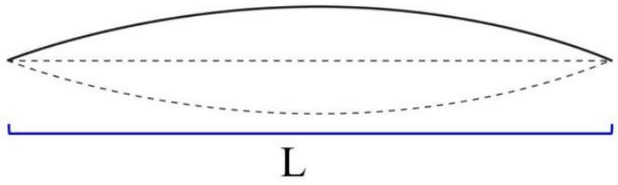
A. 

B. 

C. 

D. 

20. The length of the string, L, used to form the standing wave shown in the diagram below is 4 m. What is the wavelength of the stationary wave?



A. 2 m
B. 4 m
C. 8 m
D. 16 m

SECTION B

This section of consists of THREE (3) structured questions. Choose ANY TWO (2) questions and write solutions on the answer sheet/s provided. DO NOT attempt more than TWO (2) questions in this section.

1. In an experiment, the viscosity, η, of a liquid is determined in terms of the volume, v, passing per second through a capillary tube of radius, r, and length, l, under a pressure difference p, where

$$\eta = \frac{\pi p r^4}{8lv}$$

   a. Assuming the given equation to be homogeneous, show that the SI unit of η is Nsm^{-2}. [4]

   b. If r is 0.75 mm, measured to a precision of ±0.02 mm and p, l and v are measured to an uncertainty of ±2.0%, ±1.5% and ±1.0% respectively, estimate the percentage uncertainty to which η can be determined. [4]

   c. The viscosity of oil as determined by this method is 0.010 Nsm^{-2}. What is the absolute uncertainty in the measurement. [2]

Total 10 marks

2. The apparatus shown in Figure 1 can be used to determine the acceleration due to gravity.

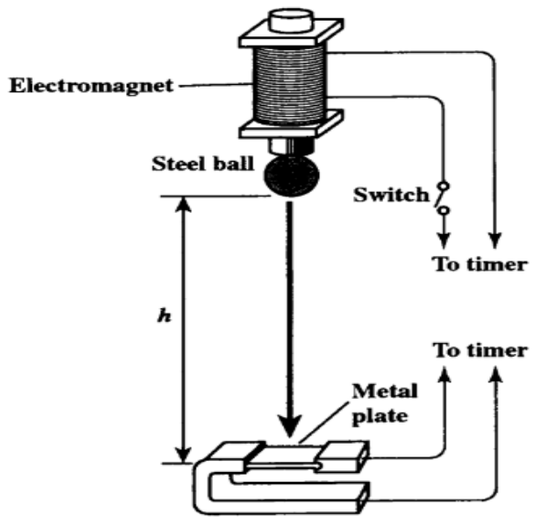


Figure 1

As the electromagnet is turned off, the digital timer starts and the ball drops. When the ball hits the metal plate the timer stops. The ball falls through a distance of 65.0 cm before hitting the metal plate.

The ball was dropped four times and the times were recorded as follows:

Time to fall = 0.361 s; 0.383 s; 0.374 s; 0.365 s.

a. Determine the average of these results and write down the value of the time that should be used in calculations. Include an estimate of the uncertainty in this value.

[3]

b. Assuming the kinetic energy the ball gains in falling is the same as its gravitational potential energy, find the value for the acceleration due to gravity from this experiment with its associated absolute uncertainty.

Recall that kinetic energy = ½ m v^2 and gravitational potential energy = m g h where m is the mass of the ball, v is its speed and h is the ball's height.

[4]

c. Distinguish between 'systematic' and 'random errors'. [1]

d. How might random errors be reduced in this case? [1]

e. Identify one source of a systematic error in this experiment. [1]

Total 10 marks

3.

a. Length, mass and temperature are all SI base quantities. State **two** other SI base quantities. [2]

b. The acceleration due to gravity ***g*** may be determined from an oscillating pendulum using the equation:

$$g = \frac{4\pi^2 l}{T^2}$$

where l is the length of the pendulum and T is the period of oscillation. In an experiment, the measured values for an oscillating pendulum are:

l = 1.50 m ± 2%

and T = 2.48 s ± 3%.

i. Calculate the acceleration of free fall ***g***. [2]
ii. Determine the percentage uncertainty in ***g***. [2]
iii. Use your answers in (b)(i) and (b)(ii) to determine the absolute uncertainty of the calculated value of g. [2]

c. What is the reading of the micrometer screw gauge shown in Figure 2 below? [2]

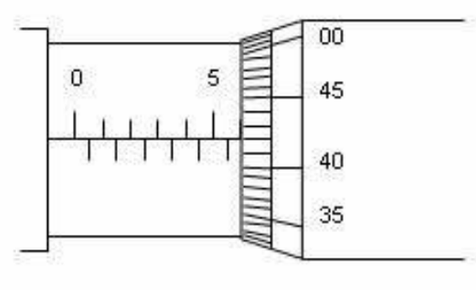


Figure 2

Total 10 marks

SECTION C

This section of consists of THREE (3) structured questions. Choose ANY TWO (2) questions and write solutions on the answer sheet/s provided. DO NOT attempt more than TWO (2) questions in this section.

1. An object of mass 0.85 kg is travelling in a horizontal circular path of radius 0.5 km, with a constant speed of 1.2 m s^{-1}. Calculate:

   a. The angular velocity of the object [2]
   b. The time taken for the object to complete one revolution [3]
   c. The centripetal acceleration of the object [3]
   d. The centripetal force acting on the object [2]

Total 10 marks

2. An object of mass 200 g is attached to a string and spun in a vertical circle of radius 0.50 m with a constant speed of 6 m s^{-1}. Calculate:
   a. The minimum tension in the string [3]
   b. The maximum tension in the string [3]
   c. The speed of the object is gradually increased. If the string breaks when the tension in it exceeds 82 N, calculate the maximum speed of rotation, and state where the object will be when the string breaks. [4]

Total 10 marks

3. a. Explain what is meant by the term ‘resonance’. [2]

   b. A piece of Plasticine® is attached to one end of a spring. The spring is attached to a support that is able to vibrate in a vertical plane. The support begins to vibrate and the mass-spring system is forced to oscillate.
      i Explain what is meant by forced oscillations. [2]
      ii Sketch a graph to show the variation of amplitude of the mass with frequency of vibration of the support. [2]
      iii The Plasticine® is now flattened so that it causes the oscillations to be damped. On the same axes as in b (ii) sketch another graph to show the effect of damping. [2]

   c. State one situation in which resonance is useful. [1]

   d. State one situation in which resonance can be a hazard. [1]

Total 10 marks

END OF EXAMINATION