THE OPEN UNIVERSITY OF SRI LANKA

ADVANCED CERTIFICATE IN SCIENCE
TAF 2523-PHYSICS – 1
FINAL EXAMINATION
DURATION – THREE HOURS

Date: 17.09.2022 **Time: 1.30 pm to 4.30 pm**

Part -A

- The Question paper (Part A) consists of 25 multiple choice questions
- Answer all the questions
- Answers for the all Multiple Choice Questions, by underline the correct answer
- At the end of the examination you should submit the question paper with answer sheet.
- Maximum marks for this part is 50%.

$(g = 10\ ms^{-2})$

(1) MLT^{-1} are the dimensions of

1. Power 2. Momentum 3. Force 4. Couple 5. Velocity

2. The velocity v of a point at time t is given by $v = at + \frac{b}{t+c}$, the dimension of a, b, and c, are respectively

1. LT^{-1}, L^{-1} and T 2. LT^2, L and T 3. LT^{-2}, L and T 4. L, LT, and T^2
5. LT^{-3}, L^{-1} and T^{-1}

3. Two forces, equal in magnitude, have a resultant with its magnitude equal to either of them. The angle between them is

1. 45^0 2. 60^0 3. 90^0 4. 120^0 5. 150^0

4. A monkey is climbing a vertical tree with a velocity of 5 m s^{-1} and a dog is running towards the tree with a velocity of $5\sqrt{3}$ m s^{-1}. The velocity of the dog relative to the monkey is

1. 10 m s^{-1} at 30^0 with horizontal
2. 10 m s^{-1} at 60^0 with horizontal
3. $8\sqrt{3}$ m s^{-1} at 30^0 with horizontal
4. $8\sqrt{3}$ m s^{-1} at 60^0 with horizontal
5. None of the above

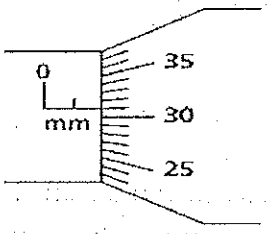
5. The distance travelled by a body falling from rest in the first, second and third second are in the ratio,

1. 1:2:3 2. 1:3:5 3. 1:4:9 4. 1:5: 7 5. None of the above

6. 5.0 $\pm$0.01 mm is a measurement taken by a properly selected measuring instrument. The percentage error associated with the measurement will be,

1) 0.4 % (2) 0.5 % (3) 0.6 % (4) 0.2 % (5) 0.3 %

7. Pitch of the following micrometer screw gauge is 0.5 mm and the circular scale is divided into 50 equal divisions. What will be the reading of the scale?



(1) 0.23 mm (2) 0.38 mm (3) 0.81 mm (4) 1.81 mm (5) 0.31 mm

8. Two objects A and B are moving on a flat surface as shown in the following figure. Velocity of A and B relative to the Earth are 40 m s^{-1} and 60 m s^{-1} respectively. What will be the velocity of B relative to A (V_{BA})?

(1) $\overrightarrow{40\ \text{m s}^{-1}}$ (2) $\overleftarrow{40\ \text{m s}^{-1}}$ (3) $\overrightarrow{20\ \text{m s}^{-1}}$ (4) $\overrightarrow{160\ \text{m s}^{-1}}$ (5) $\overleftarrow{160\ \text{m s}^{-1}}$

9. An elevator is moving upward with a constant speed of 10 m s^{-1}. A man standing in the elevator drops a coin from a height of 2.5 m. The coin reaches the floor of the elevator after a time

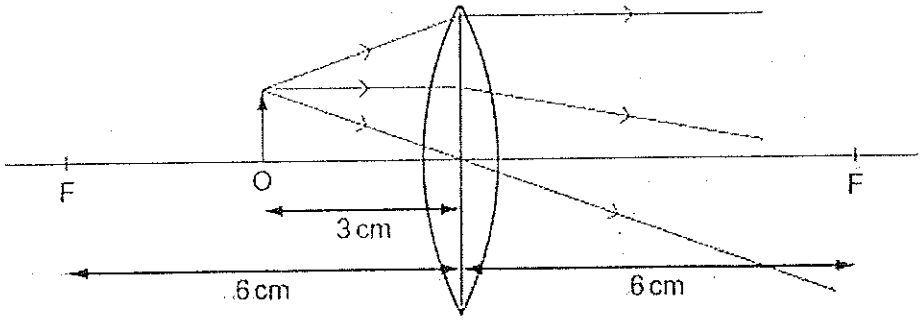
1. $\frac{1}{2}$ s 2. $\frac{1}{\sqrt{2}}$ s 3. $\sqrt{2}$ s 4. 2 s 5. 3 s

10. If the horizontal rang of a projectile is four times its maximum height, the angle of projection is, 1. 30^0 2. 45^0 3. $\sin^{-1}\frac{1}{4}$ 4. $\tan^{-1}\frac{1}{4}$ 5. $\cos^{-1}\frac{1}{4}$

11. The pitch of a sound is determined by its

(1) Frequency (2) speed (3) amplitude (4) wave length (5) velocity

12. The diagram shows an object O placed 3 cm away from a converging lens of focal length 6 cm.



What type of image is produced?

(1) Real, erect and diminished
(2) Virtual, inverted and diminished
(3) Virtual, erect and magnified
(4) Real, inverted and magnified
(5) Real, erect same size

13. An observer is moving towards a stationary source of frequency 250 Hz with a velocity of 40 m/s. If the velocity of sound is 330 m/s, the apparent frequency heard by the observer will be

(1) 320 Hz (2) 300 Hz (3) 280 Hz (4) 260 Hz (5) 360 Hz

14. Transverse are generated in two uniform wires A and B by attaching their free ends to a vibrating source of frequency 600 Hz. The diameter of wire A is one-third that of wire B and tension in the wire A is double that in wire B. What is the ratio of velocities of waves of waves in wire A and B?

(1) $\sqrt{3}$: 2 (2) 2 : $\sqrt{3}$ (3) 3 : $\sqrt{2}$ (4) $\sqrt{2}$: 3 (5) 1 : $\sqrt{2}$

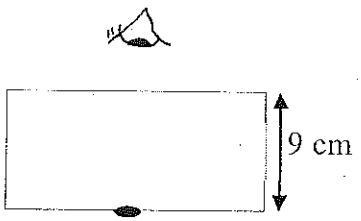
15. Four wires of identical lengths, diameters and material and stretched on a sonometer box. The ratio of their tension is 1 : 4 : 9 : 16. the ratio of their fundamental frequencies is

(1) 1 : 6 : 9 : 16 (2) 1:3: 5 :7 (3) 4 : 3 : 2 : 1 (4) 1 : 2 : 3 : 4 (5) 1 : 4 : 9 : 16

16. Linear magnification of an image formed by an object kept 20 cm from the lens is 0.25. What would be the image distance?

(1) 4 cm (2) 10 cm (3) 20 cm (4) 30 cm (5) 80 cm

17. A glass block with height 9 cm and refractive index n=3/2 is kept on an ink drop as shown in the following figure. What will be the **apparent displacement** of the ink drop when observed through the top surface?

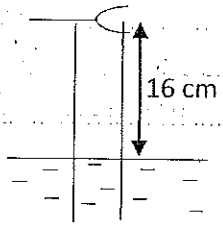


(1) 1.5 cm (2) 2 cm (3) 3 cm (4) 6 cm (5) 4 cm

18. A rocket works on the principle of conservation of

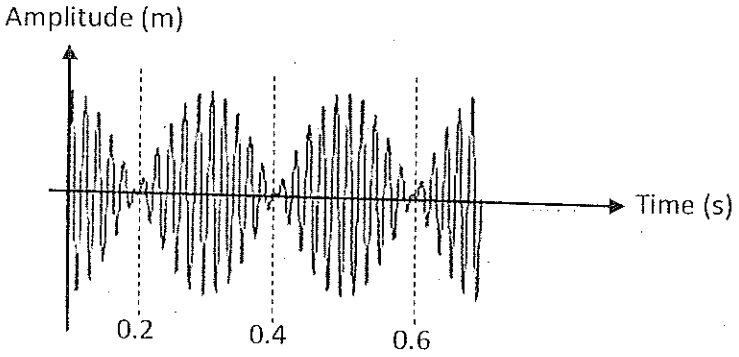
1. Mass 2. Linear momentum 3. Energy 4. Angular momentum 5. Charge

19. A tuning fork with frequency f is held above a tube immersed in water as shown in the following figure. The tube is resonating with the tuning fork with its fundamental mode of vibration and the length of the tube above the water level is 15 cm. what will be the value of the frequency (f) of the tuning fork? (Neglect the end correction and take the speed of sound as 330 ms^{-1})



(1) 110 Hz (2) 550 Hz (3) 640 Hz (4) 200 Hz (5) 500 Hz

20. Following diagram shows the variation of the amplitude with time for a system having two sound sources with slightly different frequencies. What will be the beat frequency?

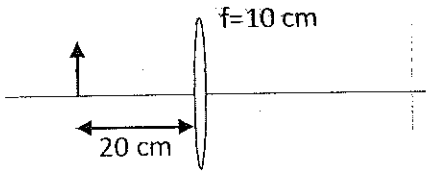


(1) 5 Hz (2) 10 Hz (3) 1 Hz (4) 0.1 Hz (5) 100 Hz

21. What would be the speed of transverse waves in a rope under tension 10 N and mass per unit length 0.1 kg m^{-1}?

(1) 20 m s^{-1} (2) 40 m s^{-1} (3) 10 m s^{-1} (4) 30 m s^{-1} (5) 50 m s^{-1}

22. An object is placed near a convex lens (f=10 cm) as shown in the following figure. What will be the distance to the image from the lens?



(1) 10 cm (2) 20 cm (3) 30 cm
(4) 50 cm (5) 80 cm

23. The weight of an object on the earth's surface is 600 N. What is the weight of the object when it is at a height equal to the radius of the earth?

(1) 150 N (2) 240 N (3) 300 N (4) 600 N (5) 2400 N

24 A satellite of mass m is revolving around the earth at a height R above the surface of the earth. If the g is the gravitational field strength at the surface of the earth and R is the radius of the earth, the Kinetic energy of the satellite will be

(1) mgR/4 (2) mgR/2 (3) mgR (4) 2mgR (5) 4mgR

25. Forces proportional to AB, BC and 2 CA act along the sides of a triangle ABC in order. Their resultant is represented in magnitude and direction by,

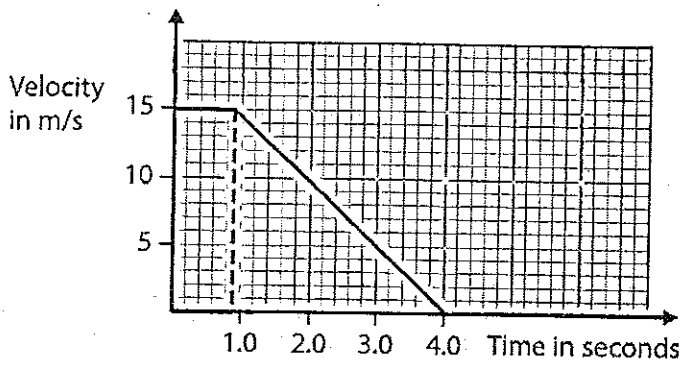
1. $\overrightarrow{CA}$ 2. $\overrightarrow{AC}$ 3. $\overrightarrow{BC}$ 4. $\overrightarrow{CB}$ 5. $\overrightarrow{2AC}$

(4× 25 = 100 Marks)

Part - B

- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earns twenty five (25) marks, amounting to total of 50% marks.**

1. A. A car diver sees a hazard on the road ahead. The graph shows the velocity of the car from when the driver sees the hazard.



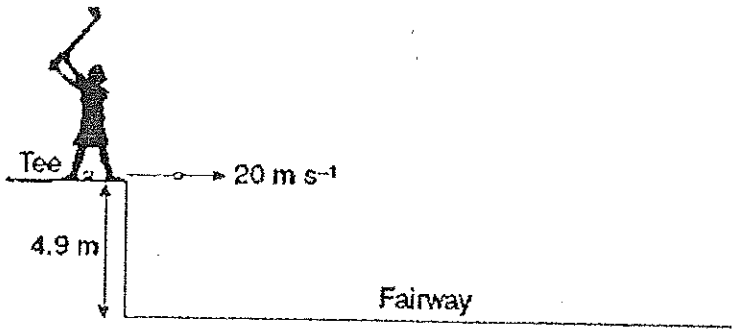
i. Use the graph to determine the reaction time of the driver. **(2 Marks)**

ii. Calculate the stopping distance of the car. **(3 Marks)**

iii. Calculate the acceleration of the car is braking. **(3 Marks)**

iv. The speed of the car affects the thinking distance and the braking distance. Discuss other factors that affect the thinking distance and the braking distance of the car. **(2 Marks)**

(B). A golfer practicing on a range with an elevated tee 4.9 m above the fairway is able to strike a ball so that it leaves the club with a horizontal velocity of 20 m s^{-1}. (Assume the acceleration due to gravity is 10 m s^{-2}, and the effects of air resistance may be ignored unless otherwise stated.)



i. How long after the ball leaves the club will it land on the fairway? **(3 Marks)**

ii. What horizontal distance will the ball travel before striking the fairway? **(3 Marks)**

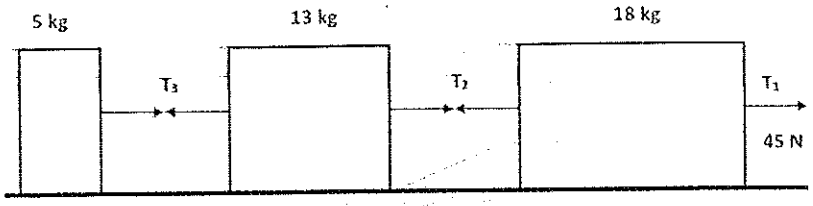
iii. What is the acceleration of the ball 0.5 s after being hit? **(3 Marks)**

iv. Calculate the speed of the ball 0.80 s after it leaves the club. **(3 Marks)**

v. With what speed will the ball strike the ground? **(3 Marks)**

2. A State the Newton's laws of motion. **(2 Marks)**

Three blocks are connected and placed on a frictionless horizontal table as shown in the Figure. If a force of 45 N is applied as T_1. Calculate,

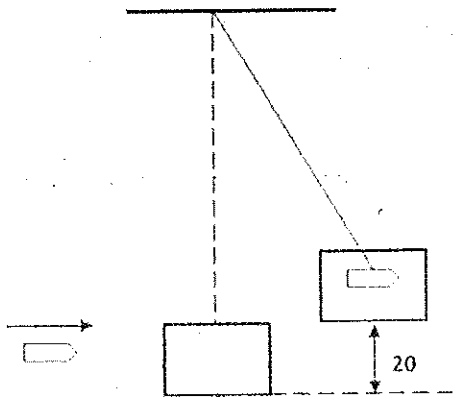


i. Acceleration of the system **(5 Marks)**

ii. T_2 and T_3 in the connecting cords. **(5 Marks)**

B. State the law of conservation of liner momentum and law of conservation of energy. **(3 Marks)**

In order to measure the speed of a bullet by using ballistic pendulum of mass 5 kg is set up as shown in the Figure. When the bullet of mass 20 g is fired as it gets embedded in the block and block rise a vertical distance of 20 cm.



(i) Find the speed of bullet after the collision. **(5 Marks)**

(ii) Find the speed of bullet before the collision **(5 Marks)**

3. (A). A wire of length 4.35 m and mass 137 g is under a tension of 125 N. A standing wave has formed which has seven nodes including the endpoints.

(i) What is the frequency of this wave? **(3 Marks)**

(ii) Which harmonic is it? **(3 Marks)**

(iii) What is the fundamental frequency? **(3 Marks)**

(B). A frequency generator with fixed frequency of 343 Hz is allowed to vibrate above a 1.0 m high closed tube. A pump is switched on to fill the water slowly in the tube. In order to get resonance, what must be the minimum height of the water? (Speed of sound in air is 343 $m\ s^{-1}$) **(8 Marks)**

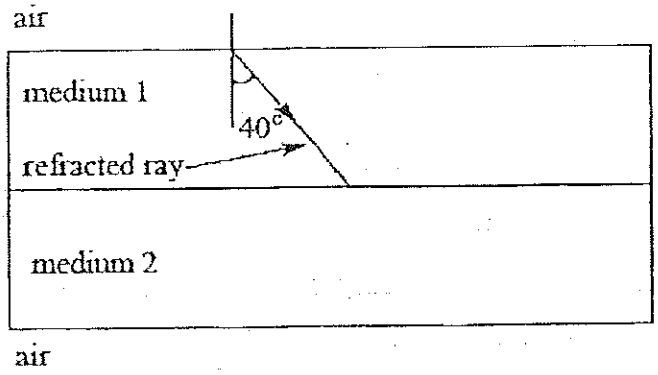
(C). Consider a tuning fork which is used to produce resonance in an air column. A resonance air column is a glass tube whose length can be adjusted by a variable piston. At room temperature, the two successive resonances observed are at 20 cm and 85 cm of the column length. If the frequency of the tuning fork is 256 Hz, compute the velocity of the sound in air at room temperature. **(8 Marks)**

4. Explain the Doppler effect of sound **(5 Marks)**

(i). A driver in a car is traveling on a road next to railway tracks. When the train approaches, it blows the horn which generates a sound with a single frequency of 420.0 Hz. The driver is driving at the speed of 18.0 m/s and the train's speed is 32.0 m/s. Further, the sound's speed is 340.0 m/s. Calculate the frequency of the sound which the driver of the car will hear. **(10 Marks)**

(ii). A bike rider approaching a vertical wall observes that the frequency of his bike horn changes from 440 Hz to 480 Hz when it gets reflected from the wall. Find the speed of the bike if the speed of sound is 330 m/s. **(10 Marks)**

5. (A). A glass plate surrounded by air is made up of two parallel sided sheets of glass in perfect contact as shown in the figure. Medium 1, the top sheet of glass, has a smaller refractive index than the medium 2.



A ray of light in air is incident on the top sheet of glass and is reflected at an angle of 40^0 as shown in the figure. At the boundary between medium 1 and medium 2 some light is transmitted and the remainder reflected.

By copping the given figure as it is, sketch the following without calculation,

(i) (a) The path followed by the transmitted ray showing it entering from the air at the top and emerging into the air at the bottom. **(3 Marks)**

(b) The path followed by the reflected ray showing it emerging from medium 1 into the air. **(3 Marks)**

(ii) The refractive index of the medium 1 is 1.35 and that of medium 2 is 1.65.

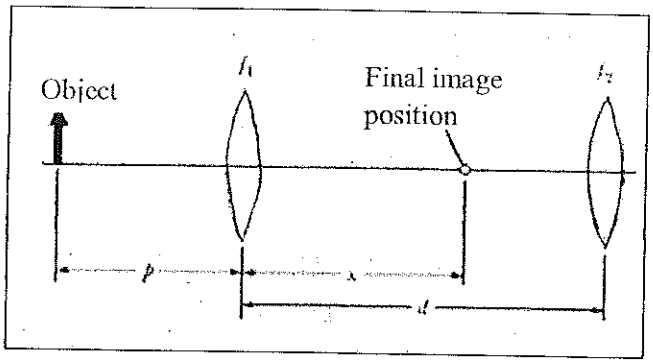
(a)Calculate the angle of incidence where the ray enters medium 1from the air. **(4 Marks)**

(b)Calculate the angle of refraction at the boundary between medium 1 and medium 2. **(4 Marks)**

(iii). Total internal reflection will not occur for any ray incident in medium 1 at the boundary with medium 2. Explain, without calculation, why this statement is true. **(4 Marks)**

(B). A diver working at a depth of 5 m has a bright point source of light. What is the diameter of the circle of light on the surface of the water seen by his colleagues in a boat? [Refractive index of the water =1.33] **(7 Marks)**

6. (A) Two converging lenses having focal lengths of f_1 = 10.0 cm and f_2 = 20.0 cm are placed a distance d = 50.0 cm apart as shown in Figure. The image due to light passing through both lenses is to be located between the lenses at the position x = 31.0 cm indicated.



(i) At what value of p should the object be positioned to the left of the first lens? **(3 Marks)**

(ii) What is the magnification of the final image? **(3 Marks)**

(iii) Is the final image upright or inverted? **(3 Marks)**

(iv) Is the final image real or virtual? **(3 Marks)**

(B). A concave lens has focal length of 15 cm. At what distance should the object from the lens be placed so that it forms an image at 10 cm from the lens? Also, find the magnification produced by the lens. **(6 Marks)**

(C). An object, 4.0 cm in size, is placed at 25.0 cm in front of a concave mirror of focal length 15.0 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image?
Find the nature and the size of the image. **(7 Marks)**

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