THE OPEN UNIVERSITY OF SRI LANKA
ADVANCED CERTIFICATE IN SCIENCE
PHF2523-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

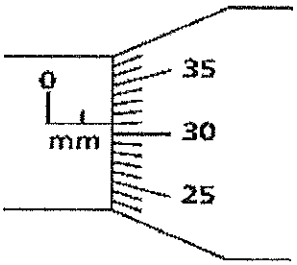
5. The distance travelled by a body falling from rest in the first, second and third second are in the ratio,

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

6. 5.0 ±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) $\overleftarrow{160\ \text{m s}^{-1}}$

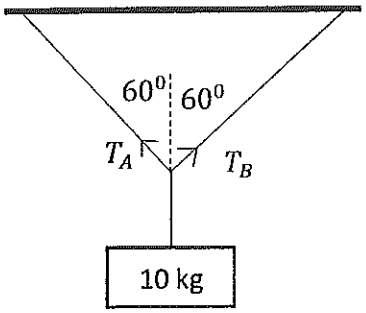
9. An elevator is moving upward with a constant speed of 10 m s^{-1}. A man standing in the elevator drops a coin from a height of 2.5 m. The coin reaches the floor of the elevator after a time

(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. .A mass of 10 kg is attached to a system of light stings as shown in the figure. What will be the tension T_A , T_B respectively?



(1) 100 N, 100 N (2) 50 N, 50 N (3) 20 N, 40 N (4) 40 N,60 N (5) 10 N,40 N

12. A body is gently dropped on a conveyor belt moving at 3 m s^{-1}. If μ= 0.5, how far will the body move relative to the belt before coming to rest?

(1). 0.3 m (2). 0.6 m (3). 0.9 m (4). 1.8 m (5). 1.2 m

13. A pump can take out 36,000 kg of water per hour from a 100 m deep well. If the efficiency of the pump is 50%, its power is,

(1). 5 kW (2). 10 kW (3). 15 kW (4): 20 kW (5). 25 kW

14. Young's modulus of a substance is defined as,

(1). Stress/Strain (2). Stress × Strain (3). Strain/Stress (4). 1/Stress (5). 1/Strain

15. A rocket works on the principle of conservation of

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

16. A small sphere is suspended by a thread of length L. The horizontal velocity that should be given to it so that it may just reach the same height as the point of suspension is,

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

17. A motor car of mass m travels with a uniform speed v on a circular bridge of radius r. When the car is at the highest point of the bridge, then the force exerted by the car on the bridge is

(1). mg (2). $mg + \frac{mv^2}{r}$ (3). $mg - \frac{mv^2}{r}$ (4). $\frac{mv^2}{r}$ (5). $2mg$

18. Young's modulus of steel is 2×10^{11} Nm^{-2}. A steel wire has a length of 1 m and area of cross section 1 mm^2. The work required to increase its length by 1 mm is,

(1). 0.1 J (2). 1 J (3). 10 J (4). 100 J (5). 200 J

19. A hollow sphere and a solid sphere, having the same mass, are released from rest simultaneously from the top of an inclined plane which of the two will reach the bottom first?

(1). Solid sphere

(2). Hallow sphere

(3). The one which has the greater density

(4). The one which has the greater volume

(5). Both will reach the bottom simultaneously

20. A wire of length L and radius r is fixed at one end and a force F is applied to the other end to produces an extension l. The extension produces in another wire of the same material, of length 2L and radius 2r, by a force 2F is,

(1). $l/2$ (2). l (3). $2l$ (4). $4l$ (5). $3l/2$

21. A solid object is floating in liquid A with half of its volume immersed and in liquid B with 2/3 of its volume immersed. The density of the liquid A and B are in the ratio,

(1). 4:3 (2). 3:2 (3). 3:4 (4). 1:3 (5). 1:2

22. A steel ball of radius 2 mm acquires a terminal velocity of 20 cm s^{-1} in a liquid. The terminal velocity of another steel ball of radius 1 mm in the same liquid will be,

(1). 5 cm s^{-1} (2). 10 cm s^{-1} (3). 40 cm s^{-1} (4). 80 cm s^{-1} (5). 100 cm s^{-1}

23. The rate of the steady volume flow of water through a capillary tube of length l and radius r, under a pressure difference p, is V. What is the rate of steady flow through a series combination of the tube with another tube of same length and half the radius if the same pressure difference p is maintained across the combination?

(1). V/16 (2). V/17 (3). 16V/ 17 (4). 17V/ 16

(5). None of the above

24. Rain drops are spherical because of

(1). Gravitational force (2). Surface tension (3). Viscosity of water

(4). Air resistance (5). None of the above

25. Water rise to a height of 2 cm in a capillary tube held vertically. When the tube is tilted 60^0 from vertical, the length of the water column in the tube will be

(1). 1.0 cm (2). 2.0 cm (3). 3.0 cm (4). 4.0 cm (5). 5.0 cm

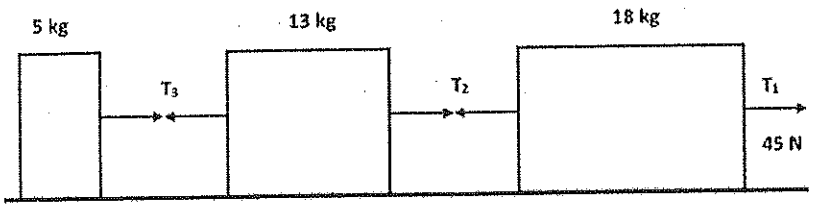
$(4\times 25 = 100$ Marks)

Part - B

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

1. A. State the Newton's laws of motion. (5 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,

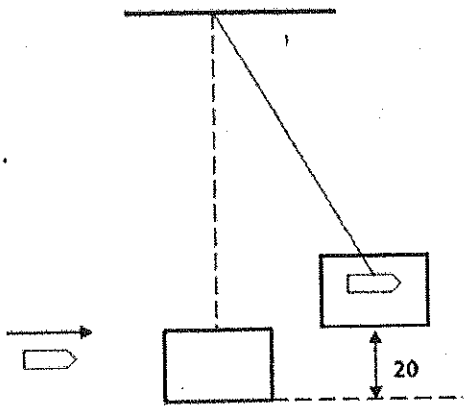


i. Acceleration of the system (5 Marks)

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. (5 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.



a. Find the speed of bullet after the collision. (5 Marks)
b. Find the speed of bullet before the collision (5 Marks)

2. A. State the principle of conservation of angular momentum. (5 Marks)

An ice skater spine with arms stretched at 2 rev s^{-1} and her momentum of inertia is 1.40 kg m^2. She pulls her arms in and her momentum of inertia is reducing to 0.56 kg m^2. What is the new rate of rotation?

(5 Marks)

B. Suppose a car is travelling round a circular bend (Radius of the bend is r) with uniform speed on a horizontal road.

i. Explain the how to travel car around the circular bend. (5 Marks)

ii. If coefficient of the static friction between the road and tire is μ and gravitational acceleration is g, obtain the expression of maximum velocity (V) of the car. (5Marks)

iii. Calculate the maximum speed of the car which can safety negotiate a horizontal circular bend of radius 60m, on a dry day. Assume that coefficient of static friction in dry weather to be 0.78. (5 Marks)

3. A. Write down equation for density and the hydrostatic pressure of a certain point of liquid column. (5 Marks)

i. In order to determine the internal radius of a capillary tube, a mercury column was drawn in and length measured as 9.732 cm. The mass of mercury is 1.012g. What is the internal radius of the capillary tube? (The density of mercury is 13,600 kg m^{-3})

(5 Marks)

ii. Calculate the hydrostatic difference in blood pressure between the brain and the foot in a person of height 1.92 m. (The density of blood is 1060 kg m^{-3})

(5 Marks)

B. State Archimedes' principle and principle of flotation. (5 Marks)

The density of ice is 920 kg m^{-3}. The average density of sea water in which an iceberg floats is 1025 kg m^{-3}. What fraction of the iceberg is beneath the surface of water?

(10 Marks)

4. Define surface tension and state its units. (5 Marks)

(i). Let the surface tension coefficient of the liquid be T and the angle of contact is θ. White done expression for the vertical component of the upward force supporting the weight of the liquid. (5 Marks)

(ii) Show that $h = \frac{2T\,Cos\theta}{rpg}$

(10 Marks)

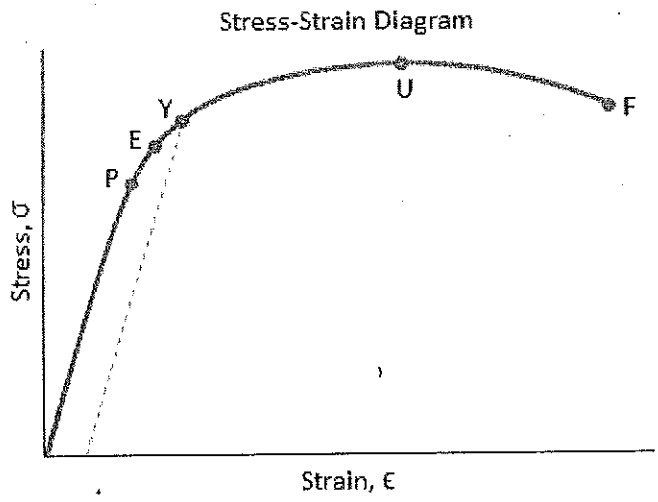
(ii) A capillary tube with of internal diameter 1.0 mm is placed vertically dipped in water. Assuming the angle of contact to be zero, find the height of the water rise in the capillary tube.

The density of the water = 1000 kg m^{-3} surface tension of water $=7.25 \times 10^{-2}$ N m^{-1}.

(5 Marks)

5. (A)(i) Explain the terms tensile stress and tensile strain (5 marks)

(ii)A stress- stain graph for a certain metal wire is shown in Figure.



(iii)Referring to the structure and behavior of the metal under a tensile force, explain about the each point P, E, Y, U, and F. (5 Marks)

B. A mass of 20 kg was gradually applied to the lower end of a vertical steel wire of length 1.6 m and radius 1.0 mm. Assuming that the proportional limit is not exceeded, calculate,

(i). The extension of the steel wire (5 Marks)

(ii). The energy stored in the wire (5 Marks)

(iii). The loss in gravitational potential energy of the wire during loading and explain the reason for the difference between the answer (i) and (ii). (5 Marks)

6. State Newton's formula for viscosity force exerted by the liquid when the object is moving on the liquid and show that it is dimensionally correct.

(4 Marks)

(i) A flat plate of area 0.4 m^2 is placed on a horizontal surface separated by a layer of oil with 10 μm thickness. If the coefficient of oil is 2.25 N s m^{-2}, find the force required to cause the plane to slide on the surface at a constant velocity of 1.2 mm s^{-1}.

(8 Marks)

(ii). When solid sphere moves in a fluid, it is reasonable to assume that the viscous force F acting on the sphere depends on, the coefficient of viscosity of the fluid η, the velocity of the sphere **v**, and the radius of the sphere

(a). Obtain the expression for viscous force acting on sphere by using the dimensional analysis. (Constant k= 6π)

(5 Marks)

(iii) What is the limitations on the use of above equation? (3 Marks)

(iv) Explain what is meant by terminal velocity. (5 Marks)