

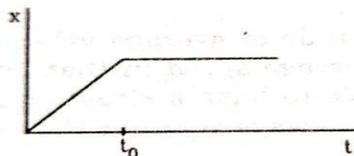
General Instructions:

1. The Question Paper contains three sections.
2. Section A has 25 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 6 questions. Attempt any 5 questions.
5. All questions carry equal marks.
6. There is no negative marking.

SECTION A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable numbers of questions are attempted, ONLY first 20 will be considered for evaluation.

- 1 Which fundamental force mainly governs the large scale motion in the universe?
 - A. Gravitational force
 - B. Electromagnetic force
 - C. Strong Nuclear force
 - D. Weak Nuclear force
- 2 Figure shows the displacement – time graph of a particle moving on the X-axis.



- A. the particle is continuously going in positive x direction.
 - B. the particle is at rest.
 - C. the velocity increases up to a time t_0 and then becomes constant.
 - D. the particle moves at a constant velocity up to a time t_0 , and then stops.
- 3 What is the displacement of a cyclist who rides from a position of -500 m to a position of -300 m?
 - A. -300 m
 - B. +300 m
 - C. -200 m
 - D. +200 m
- 4 When Neils Bohr shook hand with Werner Heisenberg, what kind of force they exerted?
 - A. Gravitational
 - B. Electromagnetic
 - C. Nuclear
 - D. Weak
- 5 Three students are asked to find the mass of a piece of metal whose mass is known to be 0.520 g. They obtain the data given in the table.

Student	Measurement 1	Measurement 2	Measurement 3	Average mass
A	0.52 g	0.51 g	0.50 g	0.51 g
B	0.516 g	0.515 g	0.514 g	0.515 g
C	0.521 g	0.520 g	0.520 g	0.520 g

Out of these three students whose readings are more accurate and precise as well?

- A. A
 - B. B
 - C. C
 - D. None of them
- 6 A player throws a ball upwards with an initial speed of 29.4 m/s. Choose the $x = 0$ m and $t = 0$ s to be the location and time of the ball at its highest point, vertically downward direction to be the positive direction of x-axis, and give the signs of position, velocity and acceleration of the ball

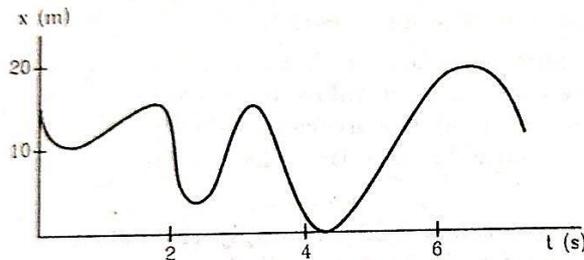
during its upward motion.

- A. Negative, Negative, Negative
- B. Positive, Positive, Positive
- C. Positive, Negative, Positive
- D. Negative, Positive, Negative

7 Vector \vec{A} , \vec{B} and \vec{C} satisfy the vector equation $\vec{A} + \vec{B} = \vec{C}$, and their magnitudes are related by the scalar equation $A + B = C$. How is vector \vec{A} oriented with respect to vector \vec{B} ?

- A. opposite direction
- B. incline at an angle of 90 degrees
- C. same direction
- D. incline at an angle of 30 degrees

8 Figure shows the position of a particle moving on the X-axis as a function of time.



- A. The particle has come to rest 6 times.
- B. The maximum speed is at $t = 6$ s.
- C. The velocity remains positive for $t = 0$ to $t = 6$ s.
- D. The average velocity for the total period shown is negative.

9 When a large star becomes a supernova, its core may be compressed so tightly that it becomes a neutron star, with a radius of about 20 km. If a neutron star rotates once every second, what is the estimated speed of a particle on the star's equator?

- A. 1.3×10^5 m/s
- B. 1.3×10^2 m/s
- C. 3.14×10^{-4} m/s
- D. 3.14×10^4 m/s

10 In which of the following situations could an object be in equilibrium?

- A. Three forces act on the object. The forces all point along the same line but may have different directions.
- B. Two perpendicular forces act on the object.
- C. A single force acts on the object.
- D. None of these.

11 Using a screw gauge, the diameter of a metal rod was measured. The observations are given as follows: 0.39 mm, 0.38 mm, 0.37 mm, 0.41 mm, 0.38 mm, 0.37 mm, 0.40 mm, 0.39 mm. Which among the following is the most accurate value of the diameter?

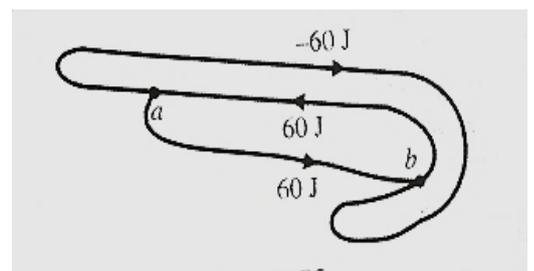
- A. 0.386 mm
- B. 0.38 mm
- C. 0.39 mm
- D. 0.3862 mm

12 The figure shows three paths connecting points a and b.

A single force \vec{F} does the indicated work on a particle moving along each path in the indicated direction.

On the basis of this information, the force \vec{F} is

- A. conservative
- B. non-conservative
- C. can't be determined
- D. data insufficient



13 When a horse pulls a cart, the force helps the horse to move forward is the force exerted by

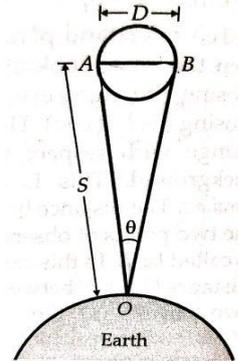
- A. the cart on the horse
- B. the ground on the cart

- C. the horse on the ground
 D. the ground on the horse
- 14 A block lies on a floor. If a horizontal force of 5 N is applied to the block, but the block does not move, what is the magnitude of the frictional force on it?
 A. 0 N
 B. equals to 5 N
 C. less than 5 N
 D. greater than 5 N

- 15 According to the diagram, which formula best describes the way to find the diameter of the moon?

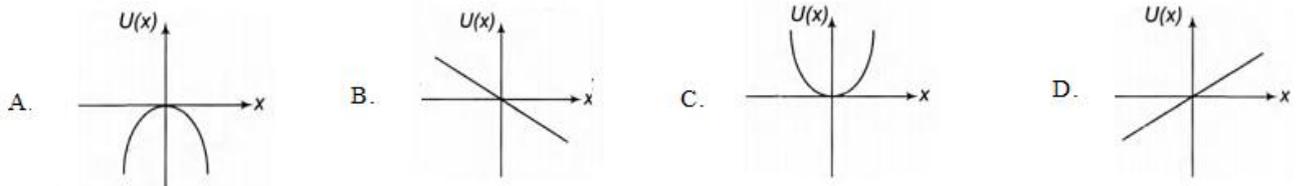
Here, linear diameter = D , Distance = S and angular diameter = θ .

- A. Linear diameter = Distance \times angular diameter
 B. Linear diameter = $\frac{\text{Distance}}{\text{angular diameter}}$
 C. Linear diameter = $\frac{\text{angular diameter}}{\text{Distance}}$
 D. Linear diameter = $\frac{1}{\text{Distance} \times \text{angular diameter}}$



- 16 A lift is moving upward with increasing speed with acceleration a . The apparent weight will be
 A. less than the actual weight
 B. more than the actual weight and have a fixed value
 C. more than the actual weight which increases as long as velocity increases
 D. zero

- 17 A particle is acted by a force $F = -kx$, where k is a constant. Its potential energy at $x = 0$ is zero. Which curve correctly represents the variation of potential energy of the block with respect to x ?



- 18 What are the dimensions of angular speed ?

- A. $[LT^{-1}]$
 B. $[T^{-1}]$
 C. $[T]$
 D. $[LT]$

- 19 You lift a suitcase from the floor and keep it on a table. The work done by you depends on

- A. the path taken by the suitcase
 B. the time taken by you in doing so
 C. the weight of the suitcase
 D. your weight

- 20 The center of mass of a system of particles does not depend on

- A. position of the particles
 B. relative distance between the particles
 C. masses of the particles
 D. force acting on the particles

- 21 The following equations give the position $x(t)$ of a particle in four situations (in each equation, x is in meters, t is in seconds, and $t > 0$)

Situation 1: $x = 3t - 2$

Situation 2: $x = -4t^2 - 2$

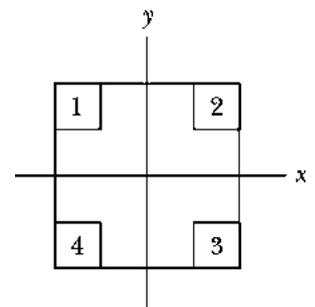
Situation 3: $x = 2/t^2$

Situation 4: $x = -2$

In which situation is the velocity v of the particle constant?

- A. Situation 1
 B. Situation 2

- C. Situation 3
D. Situation 4
- 22 A 30g squash ball hits a wall horizontally at a speed of 15 m/s and bounces back in the opposite direction at a speed of 12 m/s. What is the impulse on the squash ball?
A. +0.09 kgm/s
B. -0.09 kgm/s
C. +0.81 kgm/s
D. -0.81 kgm/s
- 23 A block of mass m is placed on a smooth inclined plane of inclination θ with the horizontal. The force exerted by the plane on the block has a magnitude
A. mg
B. $mg/\cos\theta$
C. $mg \cos\theta$
D. $mg \tan\theta$
- 24 The negative of the work done by the conservative internal forces on a system equals the change in
A. total energy
B. potential energy
C. kinetic energy
D. none of these
- 25 The figure shows a uniform square plate from which four identical squares in shape and mass distribution at the corners will be removed. Where is the center of mass of the plate after removal of square 1 and 2 ?
A. At the origin (0, 0)
B. On y-axis above origin
C. On y-axis below origin
D. In third or fourth quadrant



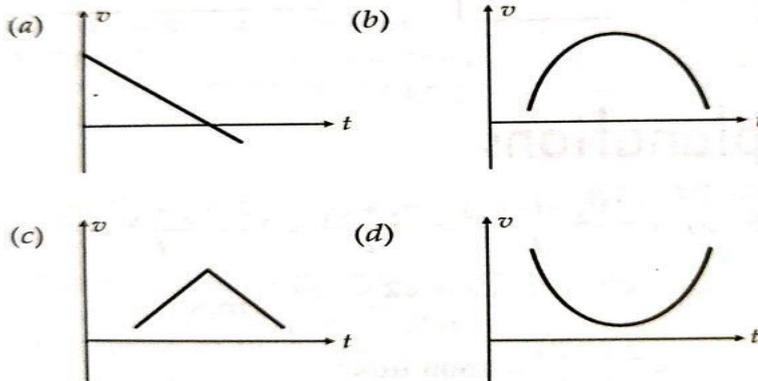
SECTION B

This section consists of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions is attempted, ONLY first 20 will be considered for evaluation.

- 26 Velocity of a body on reaching the point from which it was projected upwards, is
A. $v = 0$
B. $v = 0.5 u$
C. $v = 2 u$
D. $v = u$
- 27 The maximum speed with which a car can be driven round a curve of radius 18 m without skidding (when the coefficient of friction between the rubber tyres and the roadway is 0.2 and $g = 10 \text{ m/s}^2$ is
A. 10 m/s
B. 5 m/s
C. 6 m/s
D. 4 m/s
- 28 A heavy box of mass 20 kg is pulled on a horizontal surface by applying a horizontal force. If the coefficient of kinetic friction between the box and the horizontal surface is 0.25, what will be the force of friction exerted by the horizontal surface on the box?
A. 49 N
B. 50 N
C. 20 N
D. 0 N
- 29 Parsec is the unit of
A. time
B. distance
C. frequency
D. angular momentum

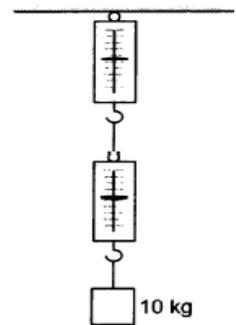
- 30 A body falling from rest describes distances s_1 , s_2 and s_3 in the first, second and third seconds of its fall, then the ratio $s_1 : s_2 : s_3$ is
- 1 : 1 : 1
 - 1 : 3 : 5
 - 1 : 2 : 3
 - 1 : 4 : 9

- 31 A particle is thrown above, then correct v-t graph will be-



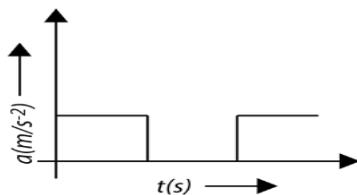
- Graph (a)
 - Graph (b)
 - Graph (c)
 - Graph (d)
- 32 Which of the following statements is false for a particle moving in a circle with a constant angular speed?
- The velocity vector is tangent to the circle
 - The acceleration vector is tangent to the circle
 - The acceleration vector points to the center of the circle
 - The velocity and acceleration vectors are perpendicular to each other

- 33 A block of mass 10 kg is suspended through two light spring balances as shown in figure.

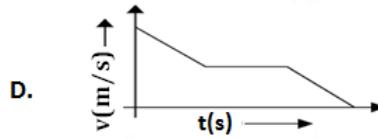
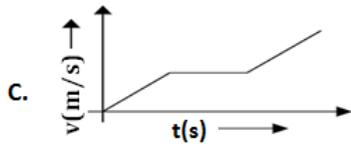
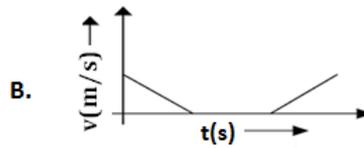
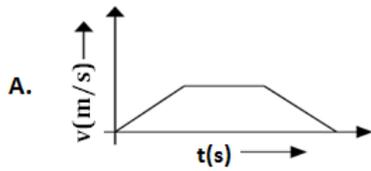


Which statement is true?

- Both the scales will read 5 kg
 - Both the scales will read 10 kg
 - The upper scale will read 10 kg and the lower zero
 - The readings may be anything but their sum will be 10 kg
- 34 If the dimensions of a physical quantity are given by $M^a L^b T^c$, then the physical quantity will be
- Velocity if $a=1, b=0, c=-1$
 - Acceleration if $a=1, b=1, c=-2$
 - Force if $a=0, b=-1, c=-2$
 - Pressure if $a=1, b=-1, c=-2$
- 35 Acceleration-time graph of a body is shown.



The corresponding velocity-time graph of the same body is:



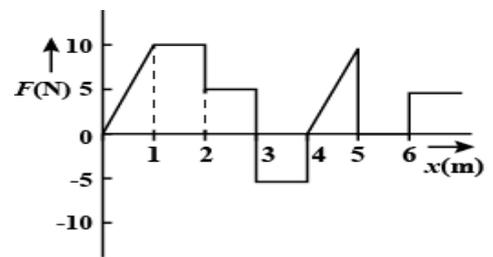
36 A train of 150 metre length is going towards north direction at a speed of 10m/s. A parrot flies at the speed of 5m/s towards south direction parallel to the railway track. The time taken by the parrot to cross the train is

- A. 12 sec
- B. 8 sec
- C. 15 sec
- D. 10 sec

37 The relationship between the force F and position x of a body is as shown in figure

The work done in displacing the body from $x = 1$ m to $x = 5$ m will be

- A. 15 J
- B. 30 J
- C. 25 J
- D. 20 J



38 The density of a cube is measured by measuring its mass and length of its sides. If the maximum errors in the measurement of mass and lengths are 3% and 2% respectively, the maximum error in the measurement of density would be –

- A. 12 %
- B. 14 %
- C. 7 %
- D. 9 %

39 Three identical blocks of masses $m = 2$ kg are drawn by a force of 10.2 N on a frictionless surface.



What is the tension (in N) in the string between the blocks B and C?

- A. 9.2
- B. 3.4
- C. 8
- D. 9.8

40 The angle between the two vectors $\vec{A} = 5\hat{i} + 5\hat{j}$ and $\vec{B} = 5\hat{i} - 5\hat{j}$ will be

- A. 30°
- B. 90°
- C. 45°
- D. 0°

41 Which of the following is true for solid angle?

- A. $d\Omega = \frac{dA}{r}$ radian
- B. $d\Omega = \frac{dA}{r}$ steradian
- C. $d\Omega = \frac{dA}{r^2}$ radian
- D. $d\Omega = \frac{dA}{r^2}$ steradian

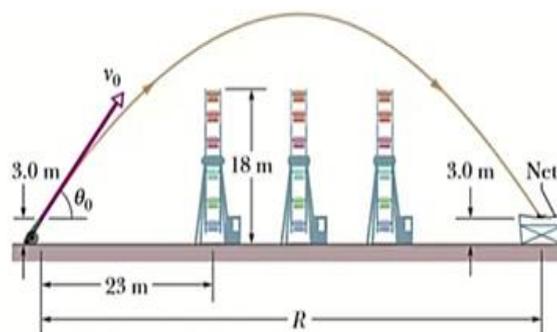
- 42 A 70 kg physics teacher, starting from rest, glides gracefully down a slide. The net force on her during the slide is a constant 350 N. How fast will she be travelling at the bottom of the 8.0 m slide?
- 9.3 m/s
 - 5.4 m/s
 - 8.9 m/s
 - 89 m/s
- 43 In an inelastic collision
- the initial kinetic energy is equal to the final kinetic energy
 - the final kinetic energy is less than the initial kinetic energy
 - the kinetic energy remains the constant
 - the kinetic energy first increases then decreases
- 44 A swimmer can swim in still water at a rate 4.0 km/h. If he swims in a river flowing at 3.0 km/h and keeps his direction (with respect to water) perpendicular to the current, find his velocity with respect to ground.
- 5.0 km/h
 - 7.0 km/h
 - 9.0 km/h
 - 11.0 km/h
- 45 **Assertion:** If a body of mass m is projected upwards with a speed u , making an angle θ with the vertical, then the change in momentum of the body along the x-axis is zero.
Reason: Mass of the body remains constant along the x-axis.
- Both assertion and reason are true and reason is correct explanation of assertion
 - Both assertion and reason are true and reason is not correct explanation of assertion
 - Assertion is true but reason is false
 - Both assertion and reason are false
- 46 **Assertion:** On a rainy day, it is difficult to drive a car or bus at high speed.
Reason: The value of coefficient of friction is lowered due to wetting of the surface.
- Both assertion and reason are true and reason is correct explanation of assertion
 - Both assertion and reason are true and reason is not correct explanation of assertion
 - Assertion is true but reason is false
 - Both assertion and reason are false
- 47 **Assertion:** Use of ball bearings between two moving parts of a machine is a common practice.
Reason: Ball bearings reduce vibrations and provide good stability
- Both assertion and reason are true and reason is correct explanation of assertion
 - Both assertion and reason are true and reason is not correct explanation of assertion
 - Assertion is true but reason is false
 - Both assertion and reason are false
- 48 **Assertion:** When a body moves along a circular path, no work is done by the centripetal force
Reason: The centripetal force is used in moving the body along the circular path and hence no work is done.
- Both assertion and reason are true and reason is correct explanation of assertion
 - Both assertion and reason are true and reason is not correct explanation of assertion
 - Assertion is true but reason is false
 - Both assertion and reason are false
- 49 **Assertion:** A spring has potential energy, both when it is compressed or stretched.
Reason: In compressing or stretching, work is done on the spring against the restoring force.
- Both assertion and reason are true and reason is correct explanation of assertion
 - Both assertion and reason are true and reason is not correct explanation of assertion
 - Assertion is true but reason is false
 - Both assertion and reason are false

SECTION C

This section consists of 6 multiple choice questions with an overall choice to attempt any 5. In case more than desirable number of questions is attempted, ONLY first 5 will be considered for evaluation.

- 50 Two springs of spring constant 1500 N/m and 3000 N/m respectively are stretched with a same force. Their potential energies will be in the ratio of
 A. 2 : 1
 B. 1 : 2
 C. 4 : 1
 D. 1 : 4
- 51 Three identical metal balls each of radius r are placed touching each other on a horizontal surface such that an equilateral triangle is formed, when centres of three balls are joined the centre of mass of system is located at
 A. line joining center of any two balls
 B. center of one of the balls
 C. horizontal surface
 D. point of intersection of the medians

Case In 1939 or 1940, Emanuel Zacchini took his human-cannonball act to an extreme. After being shot from a cannon, he soared over three Ferris wheels and into a net as shown in the figure. Assume that he is launched with a speed of 26.5 m/s and at an angle of 53.0° . Given the value of $\sin 106^\circ = 0.96$ and $\sin 53^\circ = 0.79$



- 52 Which of the following is constant in projectile motion?
 A. Velocity of projection
 B. Horizontal component of the velocity
 C. Vertical component of the velocity
 D. All of these
- 53 At the uppermost point of a projectile, its velocity and acceleration are at an angle of
 A. 0°
 B. 45°
 C. 90°
 D. 180°
- 54 What is the correct expression for horizontal range in a projectile motion?
 A. $\frac{2u \sin \theta}{g}$
 B. $\frac{u^2 \sin^2 \theta}{2g}$
 C. $\frac{u^2 \sin 2 \theta}{g}$
 D. $\frac{u^2 \sin \theta}{g}$
- 55 How far from the cannon should the nets center have been positioned?
 A. 56.6 m
 B. 4.2 m
 C. 1.68 m
 D. 68.7 m