CBSE Sample Question Paper Term 1

Class – XI (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 03

Class 11 - Physics

Time Allowed: 1 hour and 30 minutes **Maximum Marks: 35**

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 any20 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

Attempt any 20 questions

1. Reductionism is: **[0.77]**

a) reducing all phenomena to logical consequences of Newton's laws

b) deriving the properties of a bigger, more complex, system from the properties and interactions of its constituent simpler parts.

c) reducing all phenomena to logical consequences of Einstein's laws.

d) deriving the properties of a bigger, more complex, system from first principles.

2. The force F is given in terms of time t and displacement x by the equation F = A cos Bx + C sin Dt. The dimensional formula of $\frac{D}{B}$ is: **[0.77]**

a) $[M^0L^0T^0]$

b) $[M^0LT^{-1}]$

c) $[M^0L^{-1}T^0]$

d) $[M^0L^0T^{-1}]$

3. A truck on a straight road starts from rest, accelerating at 2.00 m/s^2 until it reaches a speed of 20.0 m/s. Then the truck travels for 20.0 s at a constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5.00 s. How long in seconds is the truck in motion? **[0.77]**

a) 23.0

b) 37.3

c) 35.0

d) 32.0

4. A ball is dropped from a height. If it takes 0.2 s to cross the last 6.0 m before hitting the ground, find the height from which it was dropped. (Take g = $10m/s^2$) **[0.77]**

a) 57.05 m
b) 30.48 m
c) 32.35 m
d) 48.05 m

5. Light year is the unit of **[0.77]**

a) intensity of light
b) time
c) velocity
d) distance

6. Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the mass centre of particles through a distance d, by what distance would the particle of mass m_2, move so as to keep the mass centre of particles at the original position? **[0.77]**

a) d
b) $\frac{m_1}{m_1+m_2}d$
c) $\frac{m_1}{m_2}d$
d) $\frac{m_2}{m_1}d$

7. Angular acceleration α of a body is given by the relation α = $4at^3 - 3bt^2$. If initial angular velocity of the body is ω_n, then its velocity at time t will be **[0.77]**

a) $\omega_0 - at^4 + bt^3$
b) $\omega_0 + 12at^2 - 6bt$
c) $\omega_0 + 4at^4 - 4bt^3$
d) $\omega_0 + at^4 - bt^3$

8. What is not conserved in the case of celestial bodies revolving around sun? **[0.77]**

a) linear momentum
b) kinetic energy
c) angular momentum
d) mass

9. The displacement of a particle is given by $x = (t - 2)^2$ where x is in metres and t in seconds. The distance covered by the particle in first 4 seconds is **[0.77]**

a) 12 m
b) 4 m
c) 16 m
d) 8 m

10. The addition of vectors and the multiplication of a vector by a scalar together gives rise to **[0.77]**

a) distributive laws
b) commutative law
c) asymmetric laws
d) intransitive law

11. A body of mass 2kg travels according to the law $x(t) = pt + qt^2 + rt^3$ where $p = 3ms^{-1}$, $q = 4ms^{-2}$ and $r = 5ms^{-3}$. The force acting on the body at t = 2 seconds is **[0.77]**

a) 68 N
b) 134 N
c) 136 N
d) 158 N

12. The kinetic energy of body of mass 2 kg and momentum of 2 Ns is **[0.77]**

a) 4 J
b) 3 J
c) 1 J
d) 2 J

13. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass the same. Which of the following physical quantities would remain constant for the sphere? **[0.77]**

a) Angular velocity

b) Angular momentum

c) Rotational kinetic energy

d) Moment of inertia

14. A satellite moves in elliptical orbit about a planet. The maximum and minimum velocities of satellites are 3×10^4 m/s and 1×10^3 m/s respectively. What is the minimum distance of satellite from planet if maximum distance is 4×10^4 km? **[0.77]**

a) $\frac{4}{3} \times 10^3$ km

b) 1×10^3 km

c) 3×10^3 km

d) 4×10^3 km

15. Wave picture of light failed to explain________________. **[0.77]**

a) diffraction of light

b) the photoelectric effect

c) interference of light

d) polarization of light

16. Which of the following physical quantity has the dimension of $[ML^2T^{-3}]$? **[0.77]**

a) Pressure

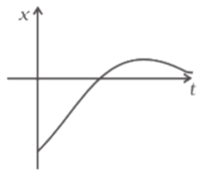
b) Work

c) Impulse

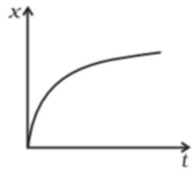
d) Power

17. Among the four graphs, there is only one graph for which average velocity over the time interval (0, T) can vanish for a suitably chosen T. Which one is it? **[0.77]**

a)

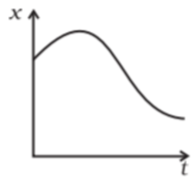


b)



c)

d)



18. The magnitude of displacement of a particle is **[0.77]**

a) is equal to the path length of the particle between two points.

b) is less than the path length of the particle between two points.

c) is more than the path length of the particle between two points.

d) is either less or equal to the path length of the particle between two points.

19. According to Newton's second law of motion: **[0.77]**

a) The momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts

b) The integration of the momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts

c) The momentum of a body is directly proportional to the applied force and takes place in the direction opposite to the force

d) The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts

20. If the kinetic energy of a body becomes four times of its initial value, then new momentum will **[0.77]**

a) become thrice its initial value
b) become twice its initial value
c) remain constant
d) become four times its initial value

21. A rigid body is a body which: **[0.77]**

a) becomes longer or shorter if force is applied.
b) does not deform on the application of force.
c) does not maintain the same distance between any two points on it if force is applied.
d) deforms on the application of force.

22. The effective value of acceleration due to gravity is $\frac{g}{4}$ at the depth(in respect of R = radius of earth): **[0.77]**

a) $\frac{3R}{4}$
b) R
c) $\frac{R}{4}$
d) $\frac{R}{2}$

23. A drag racer starts her car from rest and accelerates at 10.0 $\mathrm{m/s^2}$ for the entire distance of 400 m.How long did it take the race car to travel this distance in seconds? **[0.77]**

a) 9.01
b) 8.33
c) 10.2
d) 8.94

24. A motorcycle stunt rider rides off the edge of a cliff. Just at the edge his velocity is horizontal, with magnitude 9.0 m/s. Find the magnitude of the motorcycle's position vector after 0.50s it leaves the edge of the cliff. **[0.77]**

a) 4.7 m
b) 3.5 m
c) 5.2 m
d) 4.3 m

25. An object of mass 3 kg is at rest. Now a force of $\vec{F} = 6t^2\hat{i} + 4t\hat{j}$ is applied on the object. Then velocity of object at t = 3 is **[0.77]**

a) $18\hat{i} + 6\hat{j}$
b) $18\hat{i} + 4\hat{j}$
c) $18\hat{i} + 3\hat{j}$
d) $3\hat{i} + 18\hat{j}$

Section B

Attempt any 20 questions

26. What is the torque of the force $\vec{F} = 2\hat{i} - 3\hat{j} + 4\hat{k}N$ acting at the point $\vec{r} = 3\hat{i} + 2\hat{j} + 3\hat{k}$ m about origin? **[0.77]**

a) $-17\hat{i} + 6\hat{j} + 13\hat{k}$
b) $6\hat{i} - 6\hat{j} + 12\hat{k}$
c) $17\hat{i} - 6\hat{j} - 13\hat{k}$
d) $-6\hat{i} + 6\hat{j} - 12\hat{k}$

27. The motion of planets in the solar system is an example of the conservation of **[0.77]**

a) energy
b) mass
c) angular momentum
d) linear momentum

28. A central force is always directed **[0.77]**

a) perpendicular to the position vector of the point of application of the force with respect to the fixed point

b) at a fixed angle to the position vector of the point of application of the force with respect to the fixed point

c) at a varying angle to the position vector of the point of application of the force with respect to the fixed point

d) along the position vector of the point of application of the force with respect to the fixed point

29. A man squatting on the ground gets straight up and stand. The force of reaction of ground on the man during the process is **[0.77]**

a) variable but always greater than mg.

b) constant and equal to mg in magnitude.

c) at first, greater than mg, and later becomes equal to mg.

d) constant and greater than mg in magnitude.

30. A stone thrown from the top of a building is given an initial velocity of 20.0 m/s straight upward. Determine the time in seconds at which the stone returns to the height from which it was thrown. g = 9.8 m/sec^2. **[0.77]**

a) 4.08

b) 3.45

c) 4.44

d) 5.32

31. The reason why cyclists bank when taking a sharp turn is: **[0.77]**

a) to supply the acceleration required to move fast.

b) cyclists enjoy turning to one side and so bank.

c) to decelerate at the turns as turns are dangerous.

d) to supply the sidewise (centripetal) acceleration required to make the direction change.

32. A bullet of mass 10 g is fired from a gun of mass 1 kg. If the recoil velocity is 5 m/s, the velocity of the muzzle is **[0.77]**

a) 5 m/s

b) 500 m/s

c) 50 m/s

d) 0.05 m/s

33. In rotation of a rigid body about a fixed axis is that in which: **[0.77]**

a) every particle of the body moves in a circle, which lies in a plane perpendicular to the axis and has its centre on the axis.

b) every particle of the body moves in an ellipse, which lies in a plane perpendicular to the axis and has its focii on the axis.

c) particles close to the axis have larger velocities.

d) every particle of the body moves at the same speed.

34. If a solid sphere of mass 1 kg and radius 0.1 m rolls without slipping at a uniform velocity of 1 m/s along a straight line on a horizontal floor, the kinetic energy is **[0.77]**

a) $\frac{7}{10}J$ b) 1J

c) $\frac{2}{5}J$ d) $\frac{7}{5}$ J

35. A stone thrown from the top of a 50 m tall building is given an initial velocity of 20.0 m/s straight upward. Determine the velocity in m/sec when the stone returns to the height from which it was thrown. g = 9.8 m/sec^2. **[0.77]**

a) -20.0 b) -15.0

c) -30.0 d) -25.0

36. Which of the following physical quantities is a vector? **[0.77]**

a) temperature b) impulse

c) charge d) gravitational potential

37. If the normal force is doubled, then the coefficient of friction is **[0.77]**

a) not changed b) doubled

c) tripled d) halved

38. Which of these is not a fundamental force? **[0.77]**

a) Strong Nuclear Force b) Spring force

c) Weak Nuclear Force d) Electromagnetic Force

39. [ML^2T^{-2}] are dimensions of: **[0.77]**

a) moment of force b) force

c) momentum d) power

40. A boy of mass m stands on one end of a wooden plank of length L and mass M. The plank is floating on water. If the boy walks from one end of the plank to the other end at a constant speed, the resulting displacement of the plank is given by **[0.77]**

a) $\frac{mL}{(M-m)}$ b) $\frac{mL}{M}$

c) $\frac{mL}{(M+m)}$ d) $\frac{ML}{m}$

41. A satellite A of mass m is at a distance of r from the surface of the earth. Another satellite B of mass 2m is at a distance of 2r from the earth's surface. Their time periods are in the ratio of: **[0.77]**

a) 1 : 2 b) $1 : 2\sqrt{2}$

c) 1 : 16 d) 1 : 32

42. The acceleration due to gravity at a depth d in terms of g(acceleration due to gravity) at radius of the earth R_E is **[0.77]**

a) $g(d) = g(1 - \frac{2d}{R_E})$ b) $g(d) = g(1 - \frac{d}{R_E})$

c) $g(d) = g(1 + \frac{d}{R_E})$ d) $g(d) = g(1 + \frac{d}{2R_E})$

43. Moon has a mass of 7.36×10^{22} kg and a radius of 1.74×10^6 m. Calculate the acceleration due to gravity on the moon. **[0.77]**

a) $1.22\ m/s^2$

b) $1.62\ m/s^2$

c) $1.82\ m/s^2$

d) $1.42\ m/s^2$

44. You may have seen in a circus a motorcyclist driving in vertical loops inside a death well' (a hollow spherical chamber with holes, so the spectators can watch from outside). What is the minimum speed required at the uppermost position to perform a vertical loop if the radius of the chamber is 25 m? **[0.77]**

a) 18 m/s

b) 15.65 m/s

c) 14.5 m/s

d) 26 m/s

45. **Assertion (A):** A body may be accelerated even when it is moving at a uniform speed. **[0.77]**
Reason (R): When the direction of motion of the body is changing then the body may have acceleration.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

46. **Assertion (A):** Two objects of mass m_1 and m_2 ($m_1 > m_2$) is projected with same initial velocity at the same angle. Maximum height attained by both the objects will be same. **[0.77]**
Reason (R): Maximum height of a projectile is independent of mass.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

47. **Assertion (A):** The graph between P and Q is straight line, when $\frac{P}{Q}$ is constant. **[0.77]**
Reason (R): P straight line graph means that P proportional to Q or P is equal to constant multiplied by Q.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

48. **Assertion (A):** Moment of inertia of a particle is same, whatever be the axis of rotation. **[0.77]**
Reason (R): Moment of inertia depends on mass and distance of the particle from the axis of rotation.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

49. **Assertion (A):** Vector may change if frame of reference is rotated. **[0.77]**
Reason (R): A scalar quantity is independent of the orientation of frame of reference.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

Section C

Attempt any 5 questions

50. A jet lands on an aircraft carrier at 30 m/s. It stops in 2.0 s. What is the displacement of the plane when it stops? **[0.77]**

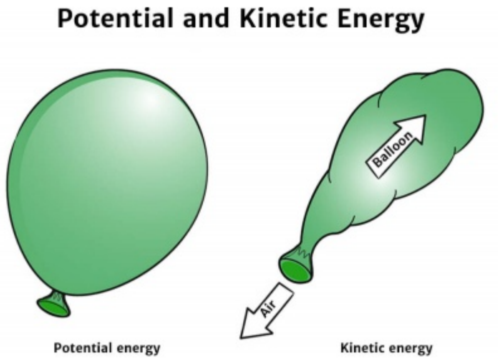
a) 45
b) 30
c) 35
d) 40

51. A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope? (g = 10 m/s^2) **[0.77]**

a) 25 m/s^2
b) 5 m/s^2
c) 2.5 m/s^2
d) 10 m/s^2

Question No. 52 to 55 are based on the given text. Read the text carefully and answer the questions:

Potential energy is the energy stored within an object, due to the object's position, arrangement or state. Potential energy is one of the two main forms of energy, along with kinetic energy. Potential energy depends on the force acting on the two objects.



52. A body is falling freely under the action of gravity alone in a vacuum. Which of the following quantities remain constant during the fall? **[0.77]**

a) mechanical energy
b) none of these
c) potential energy
d) kinetic energy

53. Work done by a conservative force is positive, if **[0.77]**

a) potential energy decreases
b) kinetic energy increases
c) potential energy increases
d) kinetic energy decreases

54. When does the potential energy of a spring increase? **[0.77]**

a) only when spring is compressed
b) none of these
c) both only when spring is stretched and compressed
d) only when spring is stretched

55. Dimension of k/m is, here k is the force constant **[0.77]**

a) T^2
b) T^{-2}

c) T^{-1} d) T^{1}

Solution

SUBJECT - PHYSICS 042 - TEST - 03

Class 11 - Physics

Section A

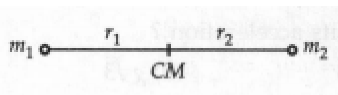
1. **(b)** deriving the properties of a bigger, more complex, system from the properties and interactions of its constituent simpler parts.
   Explanation: Reductionism is breaking down of a complex system into simple constituent systems so that laws of physics can be applied to these systems and we can understand the working of the complex system.

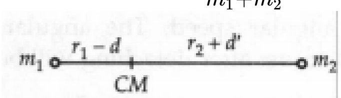
2. **(b)** [M^0LT^{-1}]
   Explanation: [D/B] = $\frac{[t^{-1}]}{[x^{-1}]} = \frac{T^{-1}}{L^{-1}}$ = [M^0LT^{-1}]

3. **(c)** 35.0
   Explanation: As start from rest,
   So Initial velocity u = 0 m/s
   Final velocity v = 20 m/s
   Acceleration a = 2 m/s^2
   Let Time during this period = t_1
   We know,
   v-u = at
   So, 20 − 0 = $2t_1$
   $t_1 = \frac{20}{2}$ = 10 s
   Now travel with a constant speed of 20 m/s for time t_2 = 20 s
   Time is taken to stop t_3 = 5s
   Total time of motion t = 10 + 20 + 5 = 35 s

4. **(d)** 48.05 m
   Explanation: Let the initial velocity of the ball before the last 6m be = u
   a = 10 m/s^2, s = 6.0m, t = 0.2 sec
   $\Rightarrow s = ut + \frac{1}{2}at^2$
   $\Rightarrow 6 = 0.2u + \frac{1}{2} \times 10 \times 0.04$
   ⇒ u = 29 m/s
   Now consider the journey from rest to this height.
   v = 29 m/s, u = 0 m/s,a = 10 m/s^2
   $v^2 - u^2$ = 2as
   ⇒ 841 − 0 = 2 × 10 × s
   ⇒ s = 42.05 m
   Therefore the total height = 42.05 + 6 = 48.05 m

5. **(d)** distance
   Explanation: One light-year is the distance traveled by light in one year.

6. **(c)** $\frac{m_1}{m_2}d$
   Explanation: 

   Initial $r_{\text{CM}} = \frac{m_1r_1+m_2r_2}{m_1+m_2}$
   

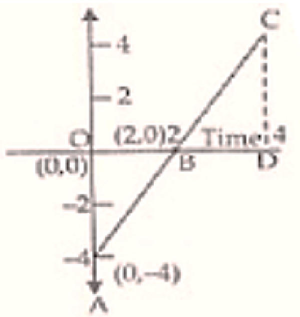
   Final $r_{CM} = \frac{m_1(r_1-d)+m_2(r_2+d')}{m_1+m_2}$
   Initial r_{CM} = Final r_{CM}

$\therefore m_1r_1 + m_2r_2 = m_1(r_1 - d) + m_2(r_2 + d)$
$0 = -m_1d + m_2 d'$
$\Rightarrow d' = \frac{m_1}{m_2}d$

7. **(d)** $\omega_0 + at^4 - bt^3$
Explanation: $\omega = \int \alpha dt = \int \left(4at^3 - 3bt^2\right) dt$
$= at^4 - bt^3 + c$
At $t = 0, \omega_0 = c$
$\therefore \omega = \omega_0 + at^4 - bt^3$

8. **(b)** kinetic energy
Explanation: K.E. changes due to the change in the speed of celestial body around the sun.

9. **(d)** 8 m
Explanation:
$x = (t - 2)^2$
$v = \frac{dx}{dt} = 2(t - 2)$m/s
$a = \frac{d^2}{dt^2} = 2(1 - 0) = 2\ ms^{-2}$
at t = 0, $v_0 = 2(0 - 2) = -4$ m/s
at t = 2, $v_2 = 2(2 - 2) = 0$ m/s
at t = 3, $v_4 = 2(4 - 2) = 4$ m/s



Distance = Area between time axis and(v - t) graph
= area ΔOAB + area ΔBCD
$= \frac{1}{2} \times OB \times OA + \frac{1}{2} \times BD \times CD$
$= \frac{1}{2} \times 2 \times 4 + \frac{1}{2} \times 2 \times 4$
Distance = 8 m

10. **(a)** distributive laws
Explanation: If a vector is multiplied by a scalar as in $p\vec{A}$, then the magnitude of the resulting vector is equal to the product of p and the magnitude of $\vec{A}$, and its direction is the same as $\vec{A}$ if p is positive and opposite to $\vec{A}$ if p is negative.
Distributive law for scalar multiplication:
$p(\vec{A} + \vec{B}) = p\vec{A} + p\vec{B}$

11. **(c)** 136 N
Explanation: We have given in question $x(t) = pt + qt^2 + rt^3$ so to find the force we will differentiate above position equation two times i.e. $\vec{F} = m\vec{a} = m\frac{d^2x}{dt^2}$
We have $x(t) = pt + qt^2 + rt^3$ where $p = 3\ ms^{-1}$, $q = 4\ ms^{-2}$, $r = 5\ ms^{-3}$
So $x(t) = 3t + 4t^2 + 5t^3$
Now first derivative of above equation
$\frac{dx(t)}{dt} = 3(1) + 4(2t) + 5(3t^2) = 3 + 8t + 15t^2$
$\frac{d^2x(t)}{dt^2} = 0 + 8 + 30t$

$\left[\frac{d^2x(t)}{dt^2}\right]$ t = 2 = 8 + 30 × 2 = 68 ms^{-2}

Hence $\vec{F} = m\frac{d^2x}{dt^2}$ = 2 × 68 = 136 N

12. **(c)** 1 J

Explanation: K = $\frac{p^2}{2m} = \frac{2^2}{2\times2}$ = 1 J

13. **(b)** Angular momentum

Explanation: $I = \frac{2}{5}MR^2$

$\tau_{\text{ext}} = \frac{dL}{dt} = 0 \Rightarrow$ L = constant

∴ Angular momentum remains constant.

14. **(a)** $\frac{4}{3} \times 10^3$ km

Explanation: By conservation of angular momentum,

$I_1 = I_2$ or $mv_1d_1 = mv_2d_2$

$\therefore v_2 = \frac{v_1d_1}{d_2}$

15. **(b)** the photoelectric effect

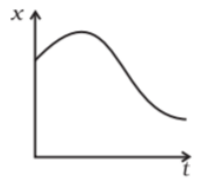
Explanation: The photoelectric effect cannot be explained according to wave theory because of the following reasons:

1. According to wave theory, after the light falls on a substance electrons are emitted after a small instant of time. However, in the photoelectric effect, the electron emissions are immediate without a time delay.
2. The energy of a wave increases with an increase in intensity. However, in the photoelectric effect, an increase in intensity has no effect on the energy of electrons emitted. All that happens is the number of electrons emitted, increases.

16. **(d)** Power

Explanation: [Power] $= \frac{\text{work}}{\text{time}} = \frac{[\text{ML}^2\,\text{T}^{-2}]}{[\text{T}]}$ = [ML^{2}T^{-3}]

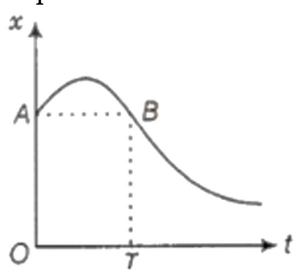
17. **(d)**



Explanation:

Main concept used: Average velocity of the body will be zero here is one displacement for different timings in any time interval-T in the x-t graph.

We need to identify the graph in which there is one displacement for different timings. It means that these displacements would be in opposite directions and when we add these opposite displacements, net displacement would be zero or average velocity would be zero. This thing is only possible in graph(b).



If we draw a line parallel to the time axis from point (A) on the graph at t = 0 sec. This line Can intersect the graph again at B. At this point, The change in displacement (O-T) time is zero i.e. displacement at A and B are equal so as the change in displacement is zero so the average velocity of the body vanishes to zero.

18. **(d)** is either less or equal to the path length of the particle between two points.

Explanation: The maximum possible value for displacement is the distance travelled, so it cannot be of a greater value than distance (path length). The magnitude of the displacement is always less than or equal to the distance traveled. If two displacements in the same direction are added, then the magnitude of their sum will be equal to the distance traveled.

19. **(d)** The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts
Explanation: If the mass does not change then the acceleration of a particle is dependent on the forces acting upon the particle and the particle's mass. For a given particle, if the net force is increased, the acceleration is increased. For a given net force, the more mass a particle has, the less acceleration it has.
$\mathbf{F} = m\mathbf{a} = m\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t} = \frac{\mathrm{d}(m\mathbf{v})}{\mathrm{d}t} = \frac{\mathrm{d}\mathbf{p}}{\mathrm{d}t}.$
hence the rate of change of momentum of a body is directly proportional to the applied force.

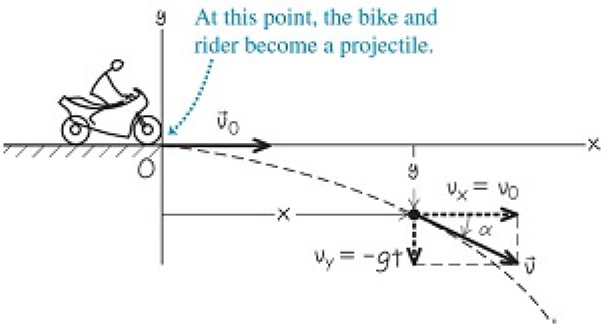
20. **(b)** become twice its initial value
Explanation: p = $\sqrt{2mK}$
$p' = \sqrt{2m \times 4K} = 2\sqrt{2mK}$ = 2p

21. **(b)** does not deform on the application of force.
Explanation: A rigid body is an idealization of a solid body in which deformation or change in shape is neglected on the application of deforming force.

22. **(a)** $\frac{3R}{4}$
Explanation: we know :
g' = $g\left(1 - \frac{d}{R}\right)$
$\Rightarrow \frac{g}{4} = g\left(1 - \frac{d}{R}\right)$
$\Rightarrow d = \frac{3R}{4}$

23. **(d)** 8.94
Explanation: Initial velocity u = 0
Acceleration a = 10.0 m/s^2
Distance covered s = 400 m
Time is taken, t = ?
We know
$s = ut + \frac{1}{2}at^2$
$\Rightarrow 400 = 0 \times t + \frac{1}{2} \times 10 \times t^2$
$\Rightarrow$ 400 = $5t^2$
$\Rightarrow$ t^2 = 80
$\Rightarrow$ t = $\sqrt{80}$ = 8.94 s

24. **(a)** 4.7 m
Explanation: The motorcycle's x- and y-coordinates at t=0.50 s are given by ;



x = v_{ox} t = 9.0×0.50 = 4.5 m
y = $-\frac{1}{2}gt^2$ = $-\frac{1}{2} \times 9.8 \times (0.50)^2$ = -1.2m
The negative value of y shows that the motorcycle is below its starting point.
The motorcycle's distance from the origin is given by , r = $\sqrt{x^2 + y^2} = \sqrt{(4.5)^2 + (-1.2)^2}$ = 4.7 m

25. **(a)** $18\hat{\imath}+6\hat{\jmath}$

Explanation: $\vec{a}=\frac{\vec{F}}{m}=\frac{1}{3}\left(6t^2\hat{\imath}+4t\hat{\jmath}\right)=\frac{d\vec{v}}{dt}$

$d\vec{v}=\frac{1}{3}\left(6t^2\hat{\imath}+4tj\right)dt$

Velocity at t = 3s will be

$\vec{v}=\int d\vec{v}=\frac{1}{3}\int_0^3\left(6t^2\hat{\imath}+4t\hat{\jmath}\right)dt$

$=\frac{1}{3}\left|2t^3\hat{\imath}+2t^2\hat{\jmath}\right|_0^3=\frac{2}{3}\left(3^3\hat{\imath}+3^2\hat{\jmath}\right)$

$=(18\hat{\imath}+6\hat{\jmath})\text{ms}^{-1}$

Section B

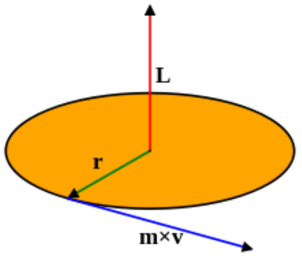
26. **(c)** $17\hat{\imath}-6\hat{\jmath}-13\hat{k}$

Explanation: $\vec{\tau}=\vec{r}\times\vec{F}=\begin{vmatrix}\hat{\imath} & \hat{\jmath} & k\\ 3 & 2 & 3\\ 2 & -3 & 4\end{vmatrix}=17\hat{\imath}-6\hat{\jmath}-13\hat{k}$

27. **(c)** angular momentum

Explanation: The motion of planets around the sun is an example of the conservation of angular momentum.

28. **(d)** along the position vector of the point of application of the force with respect to the fixed point

Explanation: 

The motion of a particle under a central force **F** always remains in the plane defined by its initial position and velocity. This may be seen by symmetry. Since the position **r**, velocity **v** and force **F** all lie in the same plane, there is never an acceleration perpendicular to that plane, because that would break the symmetry between "above" the plane and "below" the plane.

To demonstrate this mathematically, it suffices to show that the angular momentum of the particle is constant. This angular momentum **L** is defined by the equation

$\mathbf{L}=\mathbf{r}\times\mathbf{p}=\mathbf{r}\times m\mathbf{v}$

29. **(c)** at first, greater than mg, and later becomes equal to mg.

Explanation: In the process of squatting on the ground, he gets straight up and stands. Then he is tilted somewhat, the man exerts a variable force on the ground to balance his weight, hence he also has to balance frictional force besides his weight in this case.

N = Normal reaction force = friction + mg ⇒ N > mg

Once the man gets straight up that variable force = 0

⇒ Normal reaction force = mg

30. **(a)** 4.08

Explanation: Initial velocity u = 20.0 m/s

At maximum height stone will be stopped,

So final velocity v = 0 m/s

Acceleration due to gravity a = g = -9.8 m/s^2 (-ve Because it is in opposite direction of motion)

Let maximum height = s

We know,

$v^2 - u^2 = 2as$

$\Rightarrow 0^2 - (20)^2 = 2\times(-9.8)s$

$\Rightarrow -400 = -19.6s$

$\Rightarrow s=\frac{-400}{-19.6}$ = 20.4 m

Time to cover this distance upward is given by

$\Rightarrow$ v - u = at

$\Rightarrow$ 0-20 = (-9.8)t

$\Rightarrow$ t = $\frac{-20}{-9.8}$ = 2.04 sec

Again to reach the same level from where it has been thrown it has to cover the same distance downward.

For this initial velocity u = 0

s = 20.4 m

a = 9.8 m/s^2 (+ve because motion is in same direction).

So,

$\Rightarrow$ 20.4 = 0 $\times$ t + $\frac{1}{2}$ $\times$ 9.8t^2

$\Rightarrow t^2 = \frac{20.4}{4.9} = 4.16$

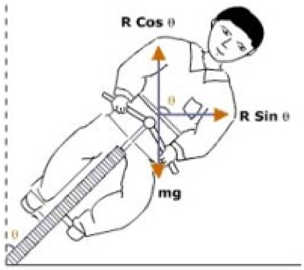
$\Rightarrow t = \sqrt{4.16}$ = 2.04

Total time = 2.04 + 2.04 = 4.08 s

31. **(d)** to supply the sidewise (centripetal) acceleration required to make the direction change.

Explanation: In order to make a safe turn, the cyclist has to bend a little from his vertical position. In this case, a component of the reaction provides the required centripetal force.

If θ is an angle made by the cyclist with the vertical then



N cosθ = mg ....(1)

N sinθ = $\frac{mv^2}{r}$.....(2)

Dividing (2) by (1), we get

$\tan\theta = \frac{v^2}{rg}$

$\Rightarrow \theta = tan^{-1}(\frac{v^2}{rg})$

In actual practice, the value of θ is slightly less because the force of friction also contributes towards the centripetal force.

32. **(b)** 500 m/s

Explanation: mv = MV

$v = \frac{MV}{m} = \frac{1\times5}{0.01}$ = 500 ms^{-1}

33. **(a)** every particle of the body moves in a circle, which lies in a plane perpendicular to the axis and has its centre on the axis.

Explanation: When a rigid body rotates about a fixed axis, all particles of the body except those which lies on the axis of rotation, move along circular paths in a plane perpendicular to the axis.

34. **(c)** $\frac{2}{5}J$

Explanation: K.E. of rolling

= $E_{\text{tran}} + E_{\text{rot}}$

$= \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

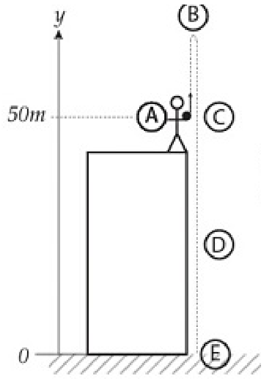
$= \frac{1}{2}mv^2 + \frac{1}{2}\cdot\frac{2}{5}mr^2\cdot\frac{v^2}{r^2}$

$= \frac{7}{10}mv^2 = \frac{7}{10}\times 1\times(1)^2$

$= \frac{7}{10}J$

35. **(a)** -20.0

Explanation:



$t_A = 0$

$y_A = 50m$

$v_A = 20 \frac{m}{s}$

$a = -g = -9.80 \frac{m}{s^2}$

$(v_C)^2 - (vA)^2 = 2a(y_C - y_A)$

With $y_C = y_A$ we get

$(VC)^2 = (v_A)^2$

$\Rightarrow v_C = \pm v_A$

As the motion of the stone is downward, and the"+"sign was assigned for the upward motion, we get for $v_C = -v_A = -20$ m/s.

36. **(b)** impulse
Explanation: Since force is a vector quantity, impulse is also a vector in the same direction. Impulse applied to an object produces an equivalent vector change in its linear momentum, also in the same direction. The SI unit of impulse is the newton second (Ns)

37. **(b)** doubled
Explanation: The coefficient of friction is independent of the normal force.

38. **(b)** Spring force
Explanation: The fundamental forces (or fundamental interactions) of physics are the ways that individual particles interact with each other. The four fundamental types of interactions are:
i. Gravity
ii. Electromagnetic
iii. Weak Interaction (or Weak Nuclear Force)
iv. Strong Interaction (or Strong Nuclear Force)

39. **(a)** moment of force
Explanation: [Moment of force] = [Torque] = $[ML^2T^{-2}]$

40. **(c)** $\frac{mL}{(M+m)}$
Explanation: If the boy walks with speed v on the plank and the plank moves in opposite direction with speed V, then by conservation of momentum,
$mv - (M + m)V = 0 \Rightarrow \frac{V}{v} = \frac{m}{M+m}$
As distance covered $\propto$ speed, so
$\frac{L'}{L} = \frac{V}{v} = \frac{m}{(M+m)}$
$\Rightarrow L' = \frac{mL}{(M+m)}$

41. **(b)** $1 : 2\sqrt{2}$
Explanation: Time period does not depend on mass of satellite.
$\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}} = \left(\frac{r}{2r}\right)^{\frac{3}{2}}$
$= \frac{1}{2\sqrt{2}} = 1 : 2\sqrt{2}$

42. **(b)** $g(d) = g(1 - \frac{d}{R_E})$

Explanation: Acceleration due to gravity at the surface of the earth of radius R_E

$g = G\frac{M}{R_E^2} = \frac{4}{3}\pi\rho G R_E$ ....(1)

Acceleration due to gravity at depth d from the surface of the earth

$g(d) = \frac{4}{3}\pi\rho G(R - d)$ ....(2)

From (1) & (2), we get

$g(d) = g(1 - \frac{d}{R_E})$

43. **(b)** 1.62 m/s^2

Explanation: We know

g = $\frac{GM}{r^2}$

G = 6.67×10^{-11} Nm^2kg^{-2}

M = $7.36 \times$ 1022kgr = 1.74×10^6 m

$\Rightarrow$ g $= \frac{6.67\times10^{-11}\times7.36\times10^{22}}{(1.74\times10^6)^2}$

$\Rightarrow$ g = $\frac{6.67\times7.36\times10^{11}}{1.74\times1.74\times10^{12}}$

$\Rightarrow$ g = 1.62 m/sec^2.

44. **(b)** 15.65 m/s

Explanation: As the centripetal force is equal to weight (mg) and normal reaction (R), we have

$\frac{mv^2}{r}$ = R + mg

At a minimum speed, R= 0, Therefore, we have

$\frac{mv^2}{r}$ = mg

v = $\sqrt{rg} = \sqrt{25 \times 9.8}$ = $15.65ms^{-1}$

45. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: The uniform motion of a body means that the body is moving with constant speed but if the direction of the motion is changing (such as in uniform circular motion), its velocity changes, and thus acceleration is producing in uniform motion.

46. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: Maximum height of a projectile

= $\frac{(u\sin\theta_0)^2}{2g}$

is independent of mass. So, both the objects will attain the same maximum height irrespective of their mass.

So, the assertion and reason both are true and reason explains the assertion.

47. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation: According to statement of reason, as the graph is a straight line, P $\propto$ Q, or, P = constant $\times$ Q

$\therefore \frac{P}{Q}$ = constant.

Equation of a straight line is y = mx + c

48. **(d)** A is false but R is true.

Explanation: The moment of inertia of a particle about an axis of rotation is given by the product of the mass of the particle and the square of the distance of the particle from the axis of rotation. For different axis, distance would be different, therefore moment of inertia of a particle changes with the change in axis of rotation.

49. **(d)** A is false but R is true.

Explanation: If the frame of reference is rotated or translated, the vector does not change but its components may change.

Section C

50. **(b)** 30

Explanation: Initial velocity u, = 30 m/s

As it stop so final velocity, v = 0 m/s
Time t = 2 s
Distance covered = s
we know that ,v= u +at
0= 30 + a(2)
a= - 15m/s^2
We know, s = $ut + \frac{1}{2}at^2$
$\Rightarrow s = 30 \times 2 + \frac{1}{2}(-15) \times 2^2$
$\Rightarrow$ s = 30 m

51. **(c)** 2.5 m/s^2
Explanation: When the monkey climbs the rope with acceleration a,
T = m(g + a)
or Mg = mg + ma
25 $\times$ 10 = 20 $\times$ 10 + 20a
or $a = \frac{50}{20}$ = 2.5 m/s^2

52. **(a)** mechanical energy
Explanation: mechanical energy

53. **(a)** potential energy decreases
Explanation: potential energy decreases

54. **(c)** both only when spring is stretched and compressed
Explanation: both only when spring is stretched and compressed

55. **(b)** T^{-2}
Explanation: T^{-2}