CBSE Sample Question Paper Term 1

Class – XI (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 05

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. For motion under an external conservative force: **[0.77]**

   a) P.E of a body is a constant
   b) Total kinetic energy of a body is a constant
   c) None of these
   d) Total mechanical energy is a constant

2. If C and R denote capacitance and resistance, the dimensional formula of CR is **[0.77]**

   a) not expressible in terms of MLT
   b) $[M^0L^0T^{-1}]$
   c) $[M^0L^0T^1]$
   d) $[M^0L^0T^0]$

3. Average speed is **[0.77]**

   a) never positive
   b) always zero
   c) always negative
   d) always positive

4. Passengers on a carnival ride move at constant speed in a horizontal circle of radius 5.0 m, making a complete circle in 4.0 s. What is their acceleration? **[0.77]**

   a) 14 m s^{-2}
   b) 16 m s^{-2}
   c) 12 m s^{-2}
   d) 15 m s^{-2}

5. The units of surface tension are: **[0.77]**

   a) Nm^2
   b) N-s
   c) Nm
   d) Nm^{-1}

6. A uniform rod of Length L and mass 1.8 kg is made to rest on two measuring scales at its **[0.77]**

two ends. A uniform block of mass 2.7 kg is placed on the rod at a distance of L/4 from the left end. The force experienced by the measuring scale on the right end is

a) 29 N
b) 16 N
c) 45 N
d) 27 N

7. In the pure translational motion of a rigid body: **[0.77]**

a) at any instant of time, every particle of the body has the same velocity.
b) at any instant of time different particles of the body have different velocities.
c) at any instant of time velocity is dependent on the position vector of a point on the body.
d) at different instants of time, every particle of the body has the same velocity.

8. The velocity with which a projectile must be fired so that it escapes earth's gravitational field (escape velocity) doesn't depend on: **[0.77]**

a) mass of the earth
b) mass of the projectile
c) universal gravitational constant G
d) radius of orbit

9. A particle moves along the x-axis. Its position is given by the equation x = 2.00 + 3.00t − $4.00t^2$ with x in meters and t in seconds. Determine its position in m at the instant it changes direction **[0.77]**

a) 3.21 m
b) 1.97 m
c) 2.22 m
d) 2.56 m

10. To find the sum of vectors $\vec{A}$ and $\vec{B}$, we place vector $\vec{B}$ so that its **[0.77]**

a) tail is at the tail of the vector $\vec{A}$
b) direction is the same as that of vector $\vec{A}$
c) tail is at the head of the vector $\vec{A}$
d) head is at the head of the vector $\vec{A}$

11. If a cycle wheel of radius 4 m completes one revolution in two seconds, then acceleration of the cycle is **[0.77]**

a) π m/s^2
b) $2\pi^2$ m/s^2
c) 4π m/s^2
d) $4\pi^2$ m/s^2

12. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm, the potential energy stored in it is **[0.77]**

a) $\frac{U}{4}$
b) 16U
c) 8U
d) 4U

13. The front wheel on an ancient bicycle has radius 0.5 m. It moves with angular velocity given by the function $\omega(t) = 2 + 4t^2$, where t is in seconds. About how far does the bicycle move between t = 2 and t = 3 seconds? **[0.77]**

a) 27 m
b) 14 m

c) 36 m d) 21 m

14. A uniform, solid, 1000.0-kg sphere has a radius of 5.00 m. Find the gravitational force this sphere exerts on a 2.00-kg point mass placed at a distance of 2.50 m from the center of the sphere? **[0.77]**

a) 2.67×10^{-9} N b) 2.47×10^{-9} N

c) 2.07×10^{-9} N d) 2.27×10^{-9} N

15. Newtonian mechanics could not explain **[0.77]**

a) flight of rockets. b) fall of bodies on earth.

c) some of the most basic features of atomic phenomena. d) movement of planets.

16. Dimensions $[ML^{-1}T^{-1}]$ are related to **[0.77]**

a) torque b) coefficient of viscosity

c) work d) energy

17. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km/ hr, and train B moves south with a speed of 90 km/ hr. What is the velocity of a monkey running on the roof of the train A against its motion (with a velocity of 18 km/hr with respect to the train A) as observed by a man standing on the ground? Choose the positive direction of x-axis to be from the south to north. **[0.77]**

a) 14 ms^{-1} b) 8 ms^{-1}

c) 12 ms^{-1} d) 10.0ms^{-1}

18. Which of the following physical quantities is a scalar? **[0.77]**

a) average velocity b) linear momentum

c) current d) relative velocity

19. For a car not to turn safely on a curved road **[0.77]**

a) speed is slow b) distance between tyres is large

c) centre of gravity for car is low d) low friction force

20. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking g = 10 $\frac{m}{s^2}$, the work done against friction is **[0.77]**

a) 200 J b) 100 J

c) 1000 J d) zero

21. A wheel is rotating about an axis through its centre at 720 r.p.m. When acted upon by a constant torque opposing its motion for 8 seconds it stops rotating. The value of this torque in Nm is (given I = $\frac{24}{\pi}$ kg m^2) **[0.77]**

a) 72 b) 48

c) 96 d) 120

22. Satellite is revolving around earth. If its height is increased to four times the height of **[0.77]**

geostationary satellite, what will become its time period?

a) 4 days
b) 2 days
c) 8 days
d) 16 days

23. A truck covers 40.0 m in 8.50 s while smoothly slowing down to a final speed of 2.80 m/s. Find its original speed in m/s: **[0.77]**

a) 6.61
b) 8.61
c) 5.61
d) 7.61

24. The vector addition is **[0.77]**

a) associative
b) non-commutative
c) asymmetric
d) intransitive

25. An iron block of sides 5 cm $\times$ 8 cm $\times$ 15 cm has to be pushed along the floor. The force required will be minimum when the surface in contact with ground is **[0.77]**

a) 8 cm $\times$ 5 cm surface
b) force is the same for all surfaces
c) 5 cm $\times$ 15 cm surface
d) 8 cm $\times$ 15 cm surface

Section B

Attempt any 20 questions

26. A thin uniform rod of length 2l and mass M is acted upon a constant torque. The angular velocity changes from zero to ω in time t. The value of torque is: **[0.77]**

a) $\frac{Ml^2\omega}{3t}$
b) $\frac{2Ml^2\omega}{3t}$
c) $\frac{Ml^2\omega}{12t}$
d) $\frac{Ml^2\omega}{t}$

27. Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and 2v at any instant, then the speed of centre of mass of the system will be **[0.77]**

a) v
b) 1.5v
c) 2v
d) zero

28. The earth (mass = 6×10^{24} kg) revolves around the sun with an angular velocity of 2×10^{-7} rad/s in a circular orbit of radius 1.5×10^{8} km. The force exerted by the sun on the earth, in newton, is: **[0.77]**

a) 18×10^{25}
b) Zero
c) 36×10^{21}
d) 27×10^{39}

29. The bob of a pendulum is released from a horizontal position. If the length of the pendulum is 1.5 m, what is the speed with which the bob arrives at the lowermost point, given that it dissipated 5% of its initial energy against air resistance? **[0.77]**

a) 5.5 m/s
b) 4.7 m/s
c) 5.3 m/s
d) 4.9 m/s

30. A jet lands on an aircraft carrier at 60 m/s. It stops in 2.0 s. What is the displacement of the **[0.77]**

plane when it stops?

a) 60.0 b) 50

c) 45 d) 35

31. It is found that $|A + B| = |A|$.This necessarily implies, **[0.77]**

a) B = 0 b) A.B $\leq$ 0

c) A, B are perpendicular d) A, B are antiparallel

32. Force is required: **[0.77]**

a) only to keep an object moving b) only to stop a moving object

c) to start a stationary object and to stop a moving object d) only to start a stationary object moving

33. A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on the inclined plane, then **[0.77]**

a) solid sphere reaches the bottom first b) disc will reach the bottom first

c) solid sphere reaches the bottom last d) all reach the bottom at the same time

34. The vector product of two vectors a and b is a vector c such that the magnitude of c is given by: **[0.77]**

a) $|\mathbf{a}||\mathbf{b}|\cos\theta$ b) $|\mathbf{a}||\mathbf{b}|\tan\theta$

c) $|\mathbf{a}||\mathbf{b}|\cot\theta$ d) $|\mathbf{a}||\mathbf{b}|\sin\theta$

35. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km/ hr, and train B moves south with a speed of 90 km/ hr. What is the velocity of B with respect to A in m/sec? Choose the positive direction of x-axis to be from south to north. **[0.77]**

a) -40.0 b) -55.0

c) -30.0 d) -45.0

36. Two vectors are equal if **[0.77]**

a) the magnitude and direction are the same for both. b) the direction is the same for both.

c) the magnitude is the same for both. d) the two vectors have opposite directions.

37. The velocity of a body of rest mass m_0 is $\frac{\sqrt{3}}{2}c$ (where c is the velocity of light in vacuum). Then mass of this body is **[0.77]**

a) $(\frac{1}{2})m_0$ b) $(\frac{2}{\sqrt{3}})m_0$

c) $(\frac{\sqrt{3}}{2})m_0$ d) $2m_0$

38. The difference between nuclear forces and electromagnetic forces is that: **[0.77]**

a) Nuclear forces do not depend on the charge b) Nuclear forces are mediated by photons compared to gluons for

electromagnetic forces

c) Nuclear forces are weaker compared to electromagnetic forces

d) Nuclear forces have longer range compared to electromagnetic forces

39. The number of significant digits in 3,000,000 is **[0.77]**

a) 3

b) 5

c) 4

d) 1

40. Two iron blocks of equal masses but with different surface areas slide down an inclined plane with friction coefficient μ. If the first block with the surface area. A experiences a friction force f, then the second block with surface area 2 A will experience a frictional force **[0.77]**

a) $\frac{f}{2}$

b) 4 f

c) f

d) 2 f

41. For a planet having a mass equal to the mass of the earth, the radius is one-fourth of the radius of the earth. Then escape velocity for this planet will be: **[0.77]**

a) 5.6 km/sec

b) 11.2 km/sec

c) 22.4 km/sec

d) 44.8 km/sec

42. The orbital speed of Jupiter is: **[0.77]**

a) equal to the orbital speed of earth

b) greater than the orbital speed of earth

c) proportional to distance from the earth

d) less than the orbital speed of earth

43. A body of mass **m** is taken from the earth's surface to a height equal to twice the radius (R) of the earth. The change in potential energy of body will be: **[0.77]**

a) $\frac{1}{3}$mgR

b) $\frac{2}{3}$mgR

c) 3 mgR

d) mg^2R

44. A block is lying static on the floor. The maximum value of static frictional force on the block is 10 N. If a horizontal force of 8 N is applied to the block, what will be the frictional force on the block? **[0.77]**

a) 2 N

b) 18 N

c) 8 N

d) 10 N

45. **Assertion (A):** A body may have constant speed by variable velocity. **[0.77]**
Reason (R): Speed is a scalar quantity but velocity is a vector quantity.

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):** If $\vec{A}$ is parallel to $\vec{B}$ then $\vec{A} \times \vec{B}$ is a null vector. **[0.77]**
Reason (R): The magnitude cross product of two vectors is given by, $|\vec{A} \times \vec{B}|$ = AB sin θ.

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):** In the expression F = 6 πrvη, the dimensions of η are $ML^{-1} T^{-1}$. **[0.77]**
Reason (R): The coefficient of viscosity and linear momentum have same dimensions.

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):** Inertia and moment of inertia are same quantities. **[0.77]**
Reason (R): Inertia represents the capacity of a body to oppose its state of motion.

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):** If $\vec{A} \times \vec{B} = 0$ and $\vec{A} \cdot \vec{B} = 0$, then either $\vec{A}$ or $\vec{B}$ is a null vector. **[0.77]**
Reason (R): Magnitude of null vector is 0.

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 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

51. A rocket with a lift-off mass 3.5×10^4 kg is blast upward with an initial acceleration of 10 m/s^2. Then, the initial thrust of the blast is **[0.77]**

a) 1.75×10^5 N

b) 3.5×10^5 N

c) 7.0×10^5 N

d) 14.0×10^5 N

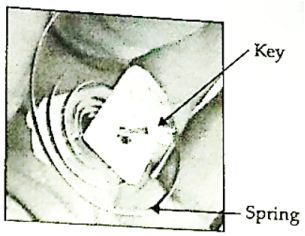
Question No. 52 to 55 are based on the given text. Read the text carefully and answer the questions:

Clockwork refers to the inner workings of mechanical clock or watch (where it is known as "movement") and different types of toys which work using a series of gears driven by a spring. Clockwork device is completely mechanical and its essential parts are:

- A key (or crown) which you wind to add energy
- A spiral spring in which the energy is stored

- A set of gears through which the spring's energy is released. The gears control how quickly (or slowly) a clockwork machine can do things. Such as in mechanical clock/watch the mechanism is the set of hands that sweep around the dial to tell the time. In a clockwork car toy, the gears drive the wheels.

Winding the clockwork with the key means tightening a sturdy metal spring, called the mainspring. It is the process of storing potential energy. Clockwork springs are usually twists of thick steel, so tightening them (forcing the spring to occupy a much smaller space) is actually quite hard work. With each turn of the key, fingers do work and potential energy is stored in the spring. The amount of energy stored depends on the size and tension of the spring. Harder a spring is to turn and longer it is wound, the more energy it stores.



While the spring uncoils, the potential energy is converted into kinetic energy through gears, cams, cranks and shafts which allow wheels to move faster or slower. In an ancient clock, gears transform the speed of a rotating shaft so that it drives the second hand at one speed, the minute hand at $\frac{1}{60}$ of that speed, and the hour hand at $\frac{1}{3600}$ of that speed. Clockwork toy cars often use gears to make themselves race along at surprising speed.

52. What is the meaning of **movement** of old age mechanical clocks? **[0.77]**

a) The pendulum of the clock
b) The gears which move the hands of the clock
c) A spring and combination of gears which move the hands of the clock
d) The hands of the clock

53. What type of energy is stored in the spring while winding it? **[0.77]**

a) Potential
b) Heat
c) Both kinetic and potential
d) Kinetic

54. When the spring of a clockwork uncoils **[0.77]**

a) Kinetic energy is converted into potential energy
b) Potential energy is converted into kinetic
c) Potential energy is converted into heat, light and sound energy
d) Kinetic energy is converted into heat, light and sound energy

55. In clockwork devices, _____ transform the speed of a rotating _____ to drive wheels slower or faster. **[0.77]**

a) Shaft, spring
b) shaft, gear
c) Gear, Shaft
d) Spring, gear

Solution

SUBJECT - PHYSICS 042 - TEST - 05

Class 11 - Physics

Section A

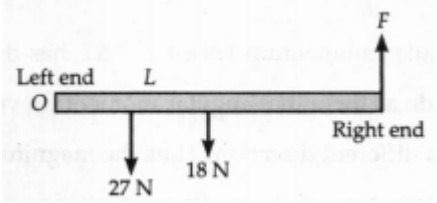
1. **(d)** Total mechanical energy is a constant
   Explanation: Mechanical energy is the sum of the potential and kinetic energies in a system. The principle of the conservation of mechanical energy states that the total mechanical energy in a system (i.e., the sum of the potential and kinetic energies) remains constant as long as the only forces acting are conservative forces.

2. **(c)** $[M^0L^0T^1]$
   Explanation: $[CR] = \frac{q}{V} \cdot \frac{V}{I} = \frac{q}{I}$
   = $\frac{[IT]}{[I]}$ = $[M^0L^0T^1]$

3. **(d)** always positive
   Explanation: Average speed is the total distance traveled divided by the elapsed time. Average speed is the absolute value of the average velocity or the magnitude of the velocity. Therefore, average Speed is always positive.

4. **(c)** 12 m s^{-2}
   Explanation: The speed is constant, so this is uniform circular motion. We are given the radius R = 5.0 m and the period T = 4.0 s, so we can calculate the acceleration directly using equation
   $a_{rad} = \frac{4(\pi)^2 R}{T^2}$ = $\frac{4\times22\times22\times5.0}{7\times7\times4.0\times4.0}$ = 12m/s^2

5. **(d)** Nm^{-1}
   Explanation: Surface tension = $\frac{Force}{Length}$
   ∴ SI unit of surface tension = Nm^{-1}

6. **(b)** 16 N
   Explanation:
   As the rod is at rest, the net torque about the left end should be zero.
   

   Net torque about O,
   $\tau = 27 \times \frac{L}{4} + 18 \times \frac{L}{2} - F \times L = 0$
   or $F = \frac{27}{4} + \frac{18}{2} = \frac{63}{4} \simeq 16$ N

7. **(a)** at any instant of time, every particle of the body has the same velocity.
   Explanation: In translational motion when the body moves along a straight line or more exactly when every point of the body travels on parallel lines, thus at any instant of time every particle of the body has the same velocity.

8. **(b)** mass of the projectile
   Explanation: Escape velocity does not depend on the mass of the projectile.

9. **(d)** 2.56 m
   Explanation: it will change direction When the speed is zero.
   Velocity v = $\frac{dx}{dt}$ = 3 - 8t
   Put v = 0, we get
   $\Rightarrow$ 3 − 8t = 0
   $\Rightarrow$ t = $\frac{3}{8}$

It ll change direction at $t = \frac{3}{8}$

Position at this time.

$x(\frac{3}{8}) = 2 + 3(\frac{3}{8}) - 4(\frac{3}{8})^2$

= $2 + \frac{9}{8} - \frac{9}{16}$

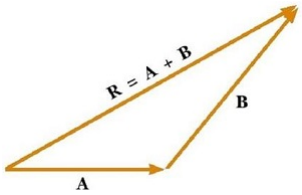
= $\frac{32 + 18 - 9}{16}$

= $\frac{41}{16}$

= 2.56 m

10. **(c)** tail is at the head of the vector $\vec{A}$

Explanation: Triangle law of vector addition states that when two vectors are represented as two sides of the triangle with the order of magnitude and direction, then the third side of the triangle represents the magnitude and direction of the resultant vector. Thus resultant vector is R= a+ b



Taken in same order mean tail of Vector B should be placed at the head of vector A as shown in image.

11. **(d)** $4\pi^2$ m/s^2

Explanation: $\omega = \frac{2\pi}{T} = \frac{2\pi}{2\text{ s}} = \pi$ rad s^{-1}

a = $r\omega^2$ = 4m (π rads^{-1})^2

= $4\pi^2$ m/s^2

12. **(b)** 16U

Explanation: U = $\frac{1}{2}$ kx^2

$\therefore \frac{U_2}{U_1} = \left(\frac{x_2}{x_1}\right)^2 = \left(\frac{8}{2}\right)^2$ = 16

$U_2 = 16U_1 = 16U$

13. **(b)** 14 m

Explanation: $\omega t = \frac{d\theta}{dt} = 2 + 4t^2$

$\int d\theta = \int_2^3 \left(2 + 4t^2\right) dt$

$\theta = \left[2t + \frac{4}{3}t^3\right]_2^3 = (6 + 36) - \left(4 + \frac{32}{3}\right)$

$= \frac{82}{3}\text{rad}$

$s = \theta r = \frac{82}{3} \times 0.5 = 13.7 \simeq 14\text{ m}$

14. **(a)** 2.67×10^{-9} N

Explanation: In this case, at r = 2.50 m, only a fraction of mass M is located,

so first, we calculate a mass for the position r = 2.50

since density is uniform, So

$\sigma = \sigma$'

$\frac{M}{\frac{4}{3}\pi R^3} = \frac{M'}{\frac{4}{3}\pi r^3}$

Here R = 5 m, r = 2.50 m

$\Rightarrow \frac{1000}{(5)^3} = \frac{M'}{(2.50)^3}$

$\Rightarrow M' = \frac{1000 \times 2.5 \times 2.5 \times 2.5}{125}$

$\Rightarrow$ M' = 125 kg

We know the gravitational force

F = $\frac{GM'm}{r^2}$

Here G = 6.67×10^{-11}Nm^{2}kg^{-2}

M' = 125 kg m = 2.0 kg

r = 2.5 m

$\Rightarrow F = \frac{6.67\times10^{-11}\times125\times2}{(2.5)^2}$

$\Rightarrow F = \frac{1667.5\times10^{-11}\times10^2}{625}$

$\Rightarrow$ F = 2.668 $\times$ 10^{-9} = 2.67 $\times$ 10^{-9}N

15. **(c)** some of the most basic features of atomic phenomena.
Explanation: When science progressed into the realm of the microscopic (of dimensions the size of an atom) world i.e. less than a nanometer, it was observed that Newtonian mechanics and classical electrodynamics were in contradiction with experiments.

16. **(b)** coefficient of viscosity
Explanation: [Coefficient of viscosity] = [$ML^{-1}T^{-1}$]

17. **(d)** 10.0ms^{-1}
Explanation: Let the velocity of the monkey with respect to the ground be v_M. The relative velocity of the monkey with respect to A,
$v_{MA} = v_M - v_A = -18kmh^{-1} = -5ms^{-1}$
Therefore velocity of monkey will be given by , $v_M = (15-5)ms^{-1} = 10ms^{-1}$ [
$\because v_A = +54kmh^{-1} = 15ms^{-1}$]

18. **(c)** current
Explanation: Electric current is a scalar quantity. It represents the direction of flow of positive charge but it is treated as a scalar quantity because current follows the laws of scalar addition and not the laws of vector addition, because the angle between the wires carrying current does not affect the total current in the circuit.

19. **(d)** low friction force
Explanation: If friction is low, the car will skid off the road.

20. **(b)** 100 J
Explanation: Total work done = Work done against friction + Increase in P.E.
300 J = W + 2 $\times$ 10 $\times$ 10
W = 300 - 200 = 100 J

21. **(a)** 72
Explanation: $n = \frac{720}{60} = 12$ rev/s
angular velocity $\omega = 2\pi n$ = $2\pi \times 12 = 24\pi$ rad/s
moment of inertia
I = $\frac{24}{\pi}$ kg m^2
torque
$T = I\alpha$
T = $I\frac{\Delta\omega}{\Delta t} = \frac{24}{\pi} \times \left(\frac{24\pi-0}{8}\right)$ = $\frac{24}{\pi} \times \frac{24\pi}{8}$ = 72.0Nm

22. **(c)** 8 days
Explanation: According to Kepler's law of periods,
$\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{\frac{3}{2}} = \left(\frac{4}{1}\right)^{\frac{3}{2}} = 8$
$\therefore$ $T_2 = 8T_1 = 8 \times 1$ day = 8 day

23. **(a)** 6.61
Explanation: Let initial velocity is given by = u
Final velocity is given by v = 2.80 m/s
Distance covered is ,s = 40.0 m
Time taken is, t = 8.50 s
We know,
v = u + at
$\Rightarrow$ v-u = at .....(1)

Also

$s = ut + \frac{1}{2}at^2$

From (1) put value of at, we get

$\Rightarrow$ s = ut + $\frac{1}{2}t(v - u)$

$\Rightarrow$ s = ut + $\frac{1}{2}tv - \frac{1}{2}ut$

$\Rightarrow$ s = $\frac{1}{2}ut + \frac{1}{2}tv$

Put all the given values, we get

$\Rightarrow 40 = \frac{1}{2} \times u \times 8.5 + \frac{1}{2} \times 2.8 \times 8.5$

$\Rightarrow$ 80 - 23.8 = 8.5u

$\Rightarrow$ 8.5u = 56.2

$\Rightarrow$ u = 6.61 m/s

24. **(a)** associative

Explanation: Vector addition is the operation of **adding** two or more **vectors** together into **a vector sum.** Associative law of vector addition. The law states that the sum of vectors remains the same irrespective of their order or grouping in which they are arranged.

$\vec{A} + (\vec{B} + \vec{C}) = (\vec{A} + \vec{B}) + \vec{C}$

This is known as the associative law of vector addition.

25. **(b)** force is the same for all surfaces

Explanation: The force of friction does not depend on the area of contact between two surfaces.

Section B

26. **(a)** $\frac{Ml^2\omega}{3t}$

Explanation:

As Torque(τ) is equal to the product of Moment of Inertia (I) and Angular acceleration (α)

$\tau = I\alpha$

$\tau = I\frac{\Delta\omega}{\Delta t}$

$\tau = \left[\frac{M(2l)^2}{12}\right]\left[\frac{\omega}{t}\right]$

$\tau = \frac{Ml^2\omega}{3t}$

27. **(d)** zero

Explanation: No external force is acting on the centre of mass of system. It remains at rest. The speed of the CM is zero.

28. **(c)** 36×10^{21}

Explanation: Force exerted by the sun = Centripetal force

F = $Mr\omega^2$

= $6 \times 10^{24} \times 1.5 \times 10^{11} \times (2 \times 10^{-7})^2 = 36 \times 10^{21}$ N

29. **(c)** 5.3 m/s

Explanation: 95% of potential energy is converted into kinetic energy.

applying conservation of mechanical energy between horizontal and lowermost points

$mgl \times \frac{95}{100} = \frac{1}{2}mv^2$

$gl \times \frac{95}{100} = \frac{1}{2}v^2$

v = $\sqrt{\frac{2 \times gl \times 95}{100}} = \sqrt{\frac{2 \times 9.8 \times 1.5 \times 95}{100}}$ = 5.3m/s

30. **(a)** 60.0

Explanation: Initial velocity, u = 60 m/s

As it stops so final velocity, v = 0 m/s

Time taken t = 2 seconds

We know, v - u = at

$\Rightarrow a = \frac{v-u}{t}$ $\ldots..(1)$

Also, $s = ut + \frac{1}{2}at^2$

From (1), we have
$s = ut + \frac{1}{2}(\frac{v-u}{t})t^2$
$\Rightarrow s = ut + \frac{1}{2}(v-u)t$
After putting given values, we have
$\Rightarrow s = (60 \times 2) + \frac{1}{2}(0-60) \times 2$
$\Rightarrow$ s = 120-60 = 60 m

31. **(a)** B = 0
Explanation: We have to identity statements which are always true. It is given that $|\vec{A} + \vec{B}| = |\vec{A}|$, it could be true in two conditions that is either $\vec{B}$ = 0 or $\vec{B}$= -2 $\vec{A}$.
For forming a single condition we will multiply them, as either one of them is true it will uphold the necessary condition
We know $\vec{B} = 0, \vec{B} - 2\vec{A}$ = 0 (from previous equations)
Therefore their magnitude's product will also be zero.
$|\vec{B}|(|\vec{B}| - 2|\vec{A}|) = 0$ (This will always be true)
$|\vec{B}|^2 - 2|\vec{A}||\vec{B}|$ = 0
Therefore,
$|\vec{A}||\vec{B}| \leq 0$ (Equality is true for B = 0)
Above condition is always true

32. **(c)** to start a stationary object and to stop a moving object
Explanation: Force is required to start a stationary object and to stop a moving object due to inertia.

33. **(a)** solid sphere reaches the bottom first
Explanation: $a = \frac{g\sin\theta}{1+\frac{I}{MR^2}}$
For a solid sphere, $I = \frac{2}{5}MR^2$
$\therefore a = \frac{5}{7}g\sin\theta$
For a disc, $I = \frac{1}{2}MR^2$
$\therefore a = \frac{2}{3}g\sin\theta$
For a solid cylinder,$I = \frac{1}{2}MR^2$
$\therefore a = \frac{2}{3}g\sin\theta$
As solid sphere has maximum acceleration, it reaches the bottom first. Both disc and cylinder reach together later.

34. **(d)** $|\mathbf{a}|\,|\mathbf{b}|\sin\theta$
Explanation: As per the definition of vector product:-
$\vec{c} = \vec{a} \times \vec{b} = |\vec{a}|\left|\vec{b}\right|\sin\theta\hat{n}$
$|\vec{c}| = |\vec{a}|\left|\vec{b}\right|\sin\theta$

35. **(a)** -40.0
Explanation: Velocity of A is given by , $v_A = +54\ kmh^{-1} = +15\ ms^{-1}$
Velocity of B is given by , $v_B = -90\ kmh^{-1} = -25\ ms^{-1}$
Relative velocity of B with respect to A, $v_{BA} = v_B - v_A = -25 - 15 = -40\ ms^{-1}$
i.e. the train B appears to A to move with a speed of 40 ms^{-1} from north to south.

36. **(a)** the magnitude and direction are the same for both.
Explanation: Equal vectors are vectors that have the same magnitude and the same direction. Equal vectors may start at different positions.

37. **(d)** $2m_0$
Explanation: $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m_0}{\sqrt{1-\frac{3}{4}c^2 \cdot \frac{1}{c^2}}} = 2m_0$

38. **(a)** Nuclear forces do not depend on the charge
Explanation: The nuclear force does not depend upon the charge of nucleons. Nuclear forces usually depend upon the velocity of the nucleons.

39. **(d)** 1
Explanation: There are three rules on determining how many significant figures are in a number:
- Non-zero digits are always significant.
- Any zeros between two significant digits are significant.
- A final zero or trailing zeros in the decimal portion ONLY are significant.

So keeping these rules in mind, there is only one significant digit.

40. **(c)** f
Explanation: Force of friction does not depend on the area of contact.

41. **(c)** 22.4 km/sec
Explanation: $v_e = \sqrt{2gR} = \sqrt{\frac{2GM}{R}}$
if R is $\frac{1}{4}$th then $v_e = 2v_{e-earth} = 2 \times 11.2 = 22.4$ km/sec

42. **(d)** less than the orbital speed of earth
Explanation: $v_0 = \sqrt{\frac{GM_{sun}}{r}}$
or $v_0 \propto \frac{1}{\sqrt{r}}$
As Jupiter is at a larger distance from the sun than the earth, so the orbital speed of Jupiter is less than that of the earth.

43. **(b)** $\frac{2}{3}$mgR
Explanation: Cgange in potential energy,
$\Delta U = -\left(\frac{GMm}{R+2R}\right) - \left(-\frac{GMm}{R}\right)$
$= -\frac{GMm}{3R} + \frac{GMm}{R}$
$= \frac{2GMm}{3R}$ [$\because g = \frac{GM}{R^2}$]
$= \frac{2}{3}$mgR

44. **(c)** 8 N
Explanation: In the stationary state,
Force of friction = Applied force
= 8 N

45. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: Speed is scalar quantity and velocity is a vector quantity. If the magnitude of speed remains constant, the speed is said to be constant. But, keeping the magnitude of velocity constant, even if the direction changes, the velocity is said to be variable.
Thus assertion and reason both are true and the reason explains the assertion.

46. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: As, $\vec{A} \| \vec{B}, \therefore \theta = 0 \Rightarrow \vec{A} \times \vec{B} = AB \sin 0 = \vec{0}$
ie. $\vec{A} \times \vec{B}$ is a null vector. Where null vector is a vector whose magnitude is zero but has a direction.

47. **(c)** A is true but R is false.
Explanation: Substituting the dimensions of all the terms R.H.S.
$\eta = \frac{[ML T^{-2}]}{[L][LT^{-1}]} = [ML^{-1}T^{-1}] \because 6\pi$ is a unitless constant.
Dimensions of momentum = mass $\times$ velocity = $[ML1^{-1}T^{-1}]$ i.e. dimensions of η is not equal to dimensions of momentum.

48. **(c)** A is true but R is false.
Explanation: There is a difference between inertia and the moment of inertia of a body. The inertia of a body depends only upon the mass of the body but the moment of inertia of a body about an axis not only depends upon the mass of the body but also upon the distribution of mass about the axis of rotation.

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

Explanation: $\vec{A} \times \vec{B}$ = AB sinθ = 0

If neither $\vec{A}$ nor $\vec{B}$ is a null vector, then sinθ = 0

$\vec{A} \cdot \vec{B}$ = AB cosθ = 0

If neither $\vec{A}$ nor $\vec{B}$ is a null vector, then cosθ = 0

But simultaneously cosθ = 0 and sin 0 = 0, this is not possible.

Hence either $\vec{A}$ or $\vec{B}$ should be a null vector.

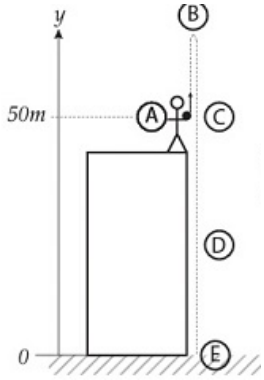
So, the assertion is true.

Magnitude of null vector is 0. So, the reason is also true. But it does not explain the assertion.

Section C

50. **(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.

51. **(c)** 7.0×10^5 N

Explanation: Initial thrust = m(a + g)

$= 3.5 \times 10^4(10 + 10)$N

$= 7.0 \times 10^5$ N

52. **(c)** A spring and combination of gears which move the hands of the clock

Explanation: Movement refers to the inner workings of mechanical clock using a series of gears driven by a spring.

53. **(a)** Potential

Explanation: Winding the spring means tightening a sturdy metal spring. It is the process of storing potential energy (forcing the spring to occupy a much smaller space) is actually quite hard work. With each turn of the key, fingers do work and potential energy is stored in the spring.

54. **(b)** Potential energy is converted into kinetic

Explanation: When the spring uncoils, the potential energy is converted into kinetic energy through gears, cams, cranks and shafts which allow wheels to move faster or slower.

55. **(c)** Gear, Shaft

Explanation: In an ancient clock, gears transform the speed of a rotating shaft so that it drives the second

hand at one speed, the minute hand at $\frac{1}{60}$ of that speed, and the hour hand at $\frac{1}{3600}$ of that speed. Clockwork toy cars often use gears to make themselves race along at surprising speed.