CBSE Sample Question Paper Term 1

Class – XI (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 02

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. The physicist who unified electromagnetism and optics was: **[0.77]**

a) James Clerk Maxwell
b) Abdus Salam
c) Issac Newton
d) Albert Einstein

2. The dimension of torque is **[0.77]**

a) $[ML^{-1}T^{-1}]$
b) $[MLT^{-2}]$
c) $[ML^{2}T^{-2}]$
d) $[ML^{3}T^{-3}]$

3. Path length is defined as **[0.77]**

a) distance from origin to origin.
b) the total length of the path traversed by an object.
c) the distance from origin to maximum point.
d) the distance from origin to minimum point.

4. A ball is thrown upwards with an initial velocity of 10 m s^{-1}. Determine the maximum height reached above the thrower's hand. **[0.77]**

a) 5.25 m
b) 5.23 m
c) 5.43 m
d) 5.10 m

5. Which of the following pairs does not have same dimensions? **[0.77]**

a) Angular momentum and Planck's constant
b) Moment of inertia and moment of force
c) Impulse and momentum
d) Work and torque

6. A particle is orbiting in a vertical plane. Its linear momentum will be directed: **[0.77]**

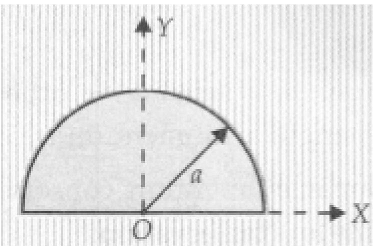
a) Vertically

b) Tangential to the orbit

c) At 45° to the vertical

d) Horizontally

7. What will be the position of centre of mass of a half disc of uniform mass density as shown? **[0.77]**



a) $\left(0, \frac{2a}{3\pi}\right)$

b) $\left(0, \frac{4a}{3\pi}\right)$

c) $\left(0, \frac{a}{\pi}\right)$

d) $\left(0, \frac{2a}{\pi}\right)$

8. Potential energy of a satellite having mass **m** and rotating at a height of 6.4×10^6 m from the earth centre is: **[0.77]**

a) -mgR_e

b) -0.5 mgR_e

c) -0.67 mgR_e

d) -0.33 mgR_e

9. A stone thrown from the top of a building is given an initial velocity of 20.0 m/s straight upward. Determine the maximum height it travels in meters. (Take g = 9.8 m/sec^2) **[0.77]**

a) 15.4

b) 25.4

c) 30.4

d) 20.4

10. 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.

11. A shell of mass 0.020 kg is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80 ms^{-1}, what is the recoil speed of the gun? **[0.77]**

a) 1.7 cm/s

b) 1.6 cm/s

c) 1.9 cm/s

d) 1.8 cm/s

12. A 6.0-kg box moving at 3.0 m/s on a horizontal, frictionless surface runs into a light spring of force constant 75 N/cm Use the work–energy theorem to find the maximum compression of the spring. **[0.77]**

a) 7.5 cm

b) 8.5 cm

c) 9.5 cm

d) 6.5 cm

13. The radius of gyration of a body about an axis at a distance of 6 cm from its centre of mass is 10 cm. Then, its radius of gyration about a parallel axis through its centre of mass will be **[0.77]**

a) 80 cm

b) 8 cm

c) 0.8 cm | d) 800 cm

14. A body of weight 72 N moves from the surface of earth at a height half of the radius of earth, then gravitational force exerted on it will be: **[0.77]**

a) 36 N
b) 144 N
c) 50 N
d) 32 N

15. The law of conservation of energy is valid: **[0.77]**

a) only for Newtonian mechanics.
b) only for applied mechanics.
c) only for relativistic mechanics.
d) across all domains of nature.

16. The significant digits in 0.000532 are **[0.77]**

a) 5, 3, 2
b) 2, 3
c) 0,5,3,2
d) 5, 3

17. For one-dimensional motion displacement is the change in position and is given by **[0.77]**

a) $\Delta \mathrm{x}=\mathrm{x}_2-\mathrm{x}_1$
b) $\Delta \mathrm{x}=\left(\mathrm{x}_2+\mathrm{x}_1\right)/2$
c) $\Delta \mathrm{x}=\mathrm{x}_2+\mathrm{x}_1$
d) $\Delta x=2(x_2+x_1)$

18. An arbitrary vector $\vec{v}$ can be expressed as a sum of three mutually perpendicular unit vectors each multiplied by a **[0.77]**

a) scalar constant equal to -1
b) some scalar constant
c) same scalar constant
d) scalar constant equal to 1

19. Which of the following statements is true? **[0.77]**

a) Laws of nature have identical form in all reference frames
b) Velocity of light in vacuum is maximum
c) Velocity of light is constant in all media
d) Velocity of light is same in all reference frames

20. The S.I unit of force is **[0.77]**

a) Joule
b) dyne
c) Newton
d) erg

21. A planet is revolving around the sun in an elliptical orbit. The maximum and the minimum distances of the planet from the sun are 3×10^{12} m and 2×10^{10} m respectively. The speed of the planet when it is nearest to sun is 2×10^{7} m/sec. What is the speed of the planet when it is farthest from the sun? **[0.77]**

a) 1.33×10^5 m/sec
b) 1.5×10^7 m/sec
c) 3×10^5 m/sec
d) 2.66×10^5 m/sec

22. At what height from the surface of the earth the gravitational potential and the value of g are $-5.4 \times 10^7 Jkg^{-2}$ and $6.0\ ms^{-2}$ respectively? Take the radius of earth as 6400 km. **[0.77]**

a) 1600 km
b) 2000 km
c) 1400 km
d) 2600 km

23. A car traveling at a constant speed of 45.0 m/s passes a trooper hidden behind a billboard. One second after the speeding car passes the billboard; the trooper sets out from the billboard to catch it, accelerating at a constant rate of 3 m/s^2. How long does it take her to overtake the car? **[0.77]**

a) 34.0 s
b) 36.0 s
c) 33.0 s
d) 31.0 s

24. Vectors can be added by: **[0.77]**

a) Vector addition
b) Adding the magnitudes of the vectors
c) Translating the two vectors
d) Adding the angles of the vectors

25. An army vehicle of mass 1000 kg is moving with a velocity of 10 m/s and is acted upon by a forward force of 1000 N due to the engine and a retarding force of 500 N due to friction. What will be its velocity after 10 s? **[0.77]**

a) 10 m/s
b) 15 m/s
c) 20 m/s
d) 5 m/s

Section B

Attempt any 20 questions

26. A rope is wound around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N? **[0.77]**

a) 25 m/s^2
b) 0.25 rad/s^2
c) 5 m/s^2
d) 25 rad/s^2

27. Two bodies have their moments of inertia I and 2 I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular velocity will be in the ratio **[0.77]**

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

28. A body is projected from earth's surface to become its satellite. Its time period of revolution will not depend upon: **[0.77]**

a) mass of earth
b) its own mass
c) gravitational constant
d) radius of earth

29. Two bodies of mass m and 4 m have equal kinetic energy. What is the ratio of their momentum? **[0.77]**

a) 2 : 1
b) 1 : 1
c) 1 : 4
d) 1 : 2

30. Displacement is a **[0.77]**

a) tensor
b) scalar
c) Hector
d) Vector

31. The position of a particle is given by $\vec{r} = 3.0t\hat{i} + 2.0t^2\hat{j} + 4.0\hat{k}$. Find the magnitude and direction of the velocity of the particle at t = 2.0 s. **[0.77]**

a) 8.84 m s^{-1}, $75°$ with x-axis
b) 6.54 m s^{-1}, $74°$ with x-axis
c) 7.54 m s^{-1}, $72°$ with x-axis
d) 8.54 m s^{-1}, $70°$ with x-axis

32. The mass of a ship is 2×10^7 kg. On applying a force of 25×10^5 N, it is displaced through 25 m. The speed of ship is **[0.77]**

a) 2.5 m/s
b) 5 m/s
c) 12.5 m/s
d) 3.7 m/s

33. Two bodies, A and B initially, at rest, move towards each other under mutual force of attraction. At the instant when the speed of A is v and that of B is 2v, the speed of the centre of mass of the bodies is **[0.77]**

a) 2v
b) 3v
c) zero
d) 1.5v

34. An inclined plane makes an angle 30° with horizontal. A solid sphere rolling down this inclined plane has a linear acceleration of **[0.77]**

a) $\frac{5g}{7}$
b) $\frac{2g}{3}$
c) $\frac{5g}{14}$
d) $\frac{g}{3}$

35. A drag racer starts her car from rest and accelerates at 10.0 $\mathrm{m/s^2}$ for the entire distance of 400 m . What is the speed of the race car in m/s at the end of the run? **[0.77]**

a) 89.4
b) 87.2
c) 86.0
d) 90.3

36. Null vector or a zero vector has a magnitude **[0.77]**

a) greater than zero
b) of complex nature
c) equal to zero
d) less than zero

37. According to the special theory of relativity, which of the following has same value in all inertial frames? **[0.77]**

a) Velocity of light
b) Mass of an object
c) Length of an object
d) Velocity of sound

38. The fundamental force with the shortest range is: **[0.77]**

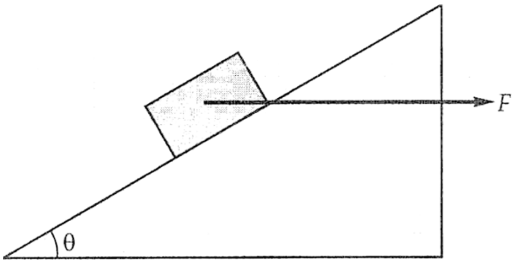
a) Weak Nuclear Force
b) Electromagnetic Force
c) Strong Nuclear Force
d) Gravitational Force

39. The ratio of the dimensions of Planck constant and that of the moment of inertia is the dimensions of **[0.77]**

a) time
b) velocity
c) frequency
d) angular momentum

40. The figure shows a horizontal force acting on a block of mass m on an inclined plane **[0.77]**

making an angle θ with the horizontal. What is the normal reaction N on the block?



a) mg cos θ - F sin θ

b) mg sin θ - F cos θ

c) mg sin θ + F cos θ

d) mg cos θ + F sin θ

41. The acceleration due to gravity at the North Pole of Neptune is approximately 10.7 m/s^2. Neptune has a mass 1.0×10^{26} kg and radius 2.5×10^4 km and rotates once around its axis in about 16 h. What is the gravitational force on a 5.0-kg object at the north pole of Neptune? **[0.77]**

a) 53.5 N

b) 55.8 N

c) 54.5 N

d) 56 N

42. Mass of moon is $\frac{1}{81}$ time that of earth and its radius is $\frac{1}{4}$ the earth's radius. If escape velocity at surface of earth is 11.2 km/s, then its value at surface of moon is: **[0.77]**

a) 0.5 km/s

b) 0.14 km/s

c) 2.5 km/s

d) 5 km/s

43. The acceleration due to gravity at a height h in terms of mass of earth $\mathrm{M_E}$, radius of the earth $\mathrm{R_E}$ and **gravitational** constant G is **[0.77]**

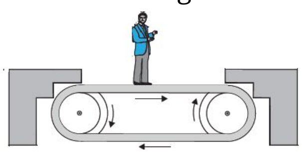
a) $g(h) = \frac{M_E}{(R_E+h)^2}$

b) $g(h) = \frac{GM_E}{(R_E+2h)^2}$

c) $g(h) = \frac{GmM_E}{(R_E+h)^2}$

d) $g(h) = \frac{GM_E}{(R_E+h)^2}$

44. The figure shows a man standing stationary with respect to a horizontal conveyor belt that is accelerating with 1 ms^{-2}. What is the net force on the man? Mass of the man = 65 kg **[0.77]**



a) 70 N

b) 55 N

c) 65 N

d) 60 N

45. **Assertion (A):** A particle thrown upward has zero velocity at its uppermost point. **[0.77]**
Reason (R): The zero-velocity of a particle at any instant implies that the acceleration of the particle is also zero at that instant.

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):** When a particle moves in a circle with a uniform speed, its velocity and acceleration both changes. **[0.77]**

Reason (R): The centripetal acceleration in circular motion is dependent on angular velocity of the body.

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 mechanics, we treat length, mass and time as the three basic or fundamental quantities. **[0.77]**

Reason (R): Length, mass and time cannot be obtained from one another.

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):** When a body accelerates down an incline rolling purely, static friction force acts on the body. **[0.77]**

Reason (R): Point of contact of the body with incline remains at rest.

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):** When an automobile while going too fast around a curve overturns, its inner wheels leave the ground first. **[0.77]**

Reason (R): For a safe turn the velocity of an automobile should be less than the value of safe limit velocity.

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 lift is coming from 8^{th} floor and is just about to reach 4^{th} floor. Taking ground floor as origin and positive direction upwards for all quantities, which one of the following is correct? **[0.77]**

a) $x > 0, v < 0, a < 0$
b) $x < 0, v < 0, a > 0$
c) $x > 0, v < 0, a > 0$
d) $x > 0, v > 0, a < 0$

51. A body of mass 0.40 kg moving initially with a constant speed of 10 ms^{-1} to the north is subject to a constant force of 8.0 N directed towards the south for 30 s. Take the instant the force is applied to be t = 0, the position of the body at that time to be x = 0, and predict its position at t = -100 s **[0.77]**

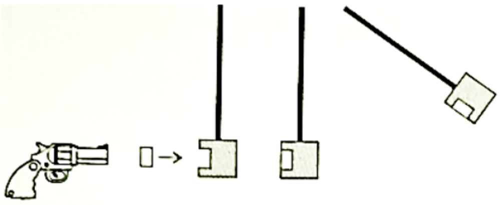
a) -67 km
b) -60 km
c) -50 km
d) -55 km

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

questions:

The ballistic pendulum was invented in 1742 by English mathematician Benjamin Robins.

A Ballistic Pendulum is a device for measuring a bullet's momentum and speed by employing perfectly inelastic collision.



A large wooden block suspended by two cords serves as the pendulum bob. When a bullet is fired into the bob, it gets embedded in the bob and its momentum is transferred to the bob.

The bullet's momentum and velocity can be determined from the amplitude of the pendulum swing.

The velocity of the bullet, in turn, can be derived from its calculated momentum.

After collision, if the pendulum reaches a height h, then from principle of conservation of mechanical energy

$\frac{1}{2}(m+M)v_p^2 = (m + M)gh$

where, m= mass of bullet, M = mass of the bob v_P = velocity of the bob-bullet combination

$\therefore v_p = \sqrt{2gh}$

Now, Momentum before collision = Momentum after collision

$mv_B = (m+M)v_p$

where, v_B = velocity of bullet

$v_B = \frac{m+M}{m}\sqrt{2gh}$

the ballistic pendulum used to be a common tool for the determination of the muzzle velocity of bullets as a measure of the performance of firearms and ammunition (Nowadays, the ballistics pendulum has been replaced by the ballistic chronograph, an electronic device).

52. In ballistic pendulum the collision is **[0.77]**

a) Perfectly inelastic
b) Partly elastic, partly inelastic
c) Elastic
d) Inelastic

53. Which two principles of Physics are applied to find the velocity of the bullet? **[0.77]**

a) conservation of mass and conservation of momentum
b) conservation of mechanical energy, conservation of momentum and conservation of mass
c) conservation of mechanical energy and conservation of momentum
d) conservation of mechanical energy and conservation of mass

54. The ballistic pendulum was invented by a **[0.77]**

a) Chemist
b) Warrior
c) Mathematician
d) Physicist

55. Ballistic pendulum has been replaced by **[0.77]**

a) Gyrograph
b) Seismograph

c) Tachograph d) Chronograph

Solution

SUBJECT - PHYSICS 042 - TEST - 02

Class 11 - Physics

Section A

1. **(a)** James Clerk Maxwell
   Explanation: The unification of light and electrical phenomena led to his prediction of the existence of radio waves. **Maxwell** is also regarded as a founder of the modern field of electrical engineering.

2. **(c)** $[ML^2T^{-2}]$
   Explanation: [Torque] = $[ML^2T^{-2}]$

3. **(b)** the total length of the path traversed by an object.
   Explanation: The path length is defined as the total length of the path traversed by an object. Unlike displacement, which is the shortest distance between two points, the path length is the total distance travelled, regardless of where it travelled.

4. **(d)** 5.10 m
   Explanation: Initial velocity is given by ,u = 10m/s
   As at the maximum height ball will stop, so final velocity is given by v = 0 m/s
   Only acceleration working on it is the acceleration due to gravity g = -9.8m/s^2
   Let height = h
   We know that, $v^2 - u^2 = 2as$
   $\Rightarrow (0)^2 - (10)^2 = 2 \times (-9.8)h$
   $\Rightarrow\ h = \frac{-100}{-19.6}$ = 5.10 m

5. **(b)** Moment of inertia and moment of force
   Explanation: Moment of inertia,
   [I] = Mass $\times$ distance^2 = $[ML^2]$
   Moment of force,
   $[\tau]$ = Force $\times$ distance
   = $MLT^{-2} \cdot L$ = $[ML^2T^{-2}]$
   $\therefore [I] \neq [\tau]$

6. **(b)** Tangential to the orbit
   Explanation: As the direction of velocity at any point moving in a circular orbit is tangent at that point, thus momentum would be tangential to the orbit.

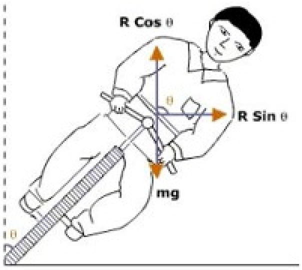
7. **(b)** $\left(0, \frac{4a}{3\pi}\right)$
   Explanation: x_{CM} = 0
   $y_{CM} = \frac{4a}{3\pi}$

8. **(b)** -0.5 mgR_e
   Explanation: Height h = 6.4 $\times$ 10^6 m is the radius R_e of the earth.
   $\therefore \quad U = -\frac{GMm}{R_e + R_e}$
   = $-\frac{gR_r^2 m}{2R_e}$ = -0.5 mgR_e

9. **(d)** 20.4
   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 sign show the opposite direction of motion)
   Let maximum height = s
   We know, $v^2 - u^2 = 2as$
   $\Rightarrow 0^2 - (20)^2 = 2 \times (-9.8)s$

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

10. **(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

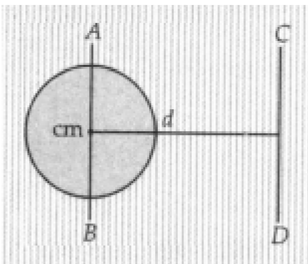


N cosθ = mg ....(1)
N sinθ = $\frac{mv^2}{r}$.....(2)
Dividing (2) by (1), we get
$\tan\theta = \frac{v^2}{rg}$
$\Rightarrow \theta = tan^{-1}(\frac{v^2}{rg})$
In actual practice, the value of θ is slightly less because the force of friction also contributes towards the centripetal force.

11. **(b)** 1.6 cm/s
Explanation: Mass of shell, m = 0.02kg
Mass of gun, M = 100kg
Speed of shell, v = 80ms^{-1}
Let V be the recoil speed of the gun. According to the law of conservation of momentum,
Initial momentum = Final momentum
0 = mv + MV
V = $-\frac{mv}{M} = -\frac{0.02\times80}{100}$
recoil speed of the gun is ,V = −0.016ms^{-1} = −1.6cms^{-1}
A negative sign indicates that the gun moves backward as the bullet moves forward.

12. **(b)** 8.5 cm
Explanation: For maximum compression of spring, kinetic energy will be converted into the potential energy of spring.
$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$
$x^2 = \frac{mv^2}{k} = \frac{6\times3\times3}{75\times10^2}$
$x = \sqrt{\frac{6\times3\times3}{75\times10^2}}$ = 0.085m = 8.5cm

13. **(b)** 8 cm
Explanation:
$I_{CD} = I_{AB} + M^2$



$Mk_{CD}^2 = Mk_{CM}^2 + Md^2$
$k_{CM}^2 = k_{CD}^2 - d^2 = (10)^2 - 6^2 = 64$
$\therefore k_{CM}$ = 8 Cm

14. **(d)** 32 N
Explanation: $F_{surface} = G\frac{Mm}{R_e^2}$
$F_{\frac{R_c}{2}} = G\frac{Mm}{\left(\frac{Re+Re}{2}\right)^2} = \frac{4}{9} \times F_{surface} = \frac{4}{9} \times 72 = 32$ N

15. **(d)** across all domains of nature.
Explanation: The law of conservation of energy is thought to be valid across all domains of nature, from the microscopic to the macroscopic. It is routinely applied in the analysis of atomic, nuclear, and elementary particle processes. At the other end. all kinds of violent phenomena occur in the universe all the time. Yet the total energy of the universe (the most ideal isolated system possible!) is believed to remain unchanged.

16. **(a)** 5, 3, 2
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.

Keeping these rules in mind, we can say that only 5,3,2 are significant digits.

17. **(a)** $\Delta x = x_2 - x_1$
Explanation: Displacement is defined to be the change in position of an object. It can be defined mathematically with the following equation:
$Displacement = \Delta x = x_2 - x_1$
where x_2 refers to the value of the final position, x_1 refers to the value of the initial position and Δx is the symbol used to represent displacement.

18. **(c)** same scalar constant
Explanation: Set of elements (vectors) in a vector space is called a basis, or a set of basis vectors, if the vectors are linearly independent and every vector in the vector space is a linear combination of this set.In more general terms, a basis is a linearly independent spanning set.
Given a basis of a vector space, every element of vector space can be expressed uniquely as a linear combination of basis vectors, whose coefficients are referred to as vector coordinates or components.
We can represent vector v as
$\vec{v} = x\hat{i} + y\hat{j} + z\hat{k}$

19. **(b)** Velocity of light in vacuum is maximum
Explanation: Velocity of light is maximum in vacuum.

20. **(c)** Newton
Explanation: In the International System of Units (SI) the newton is the unit for force. It is equal to the amount of net force required to accelerate a mass of one kilogram at a rate of 1 m/sec^2 in direction of the applied force. It is named after Isaac Newton in recognition of his work on classical mechanics, specifically Newton's second law of motion.

21. **(a)** 1.33×10^5 m/sec
Explanation: Perihelion is the nearest distance of planet from focus.
aphelion is the farthest distance of planet from focus.
$v_p = 2 \times 10^7$m/s
v_a = ?
$r_p = 2 \times 10^{10}$m
$r_a = 3 \times 10^{12}$m
$\frac{v_p}{v_a} = \frac{r_a}{r_p}$
$\frac{2\times10^7}{v_a} = \frac{3\times10^{12}}{2\times10^{10}}$
$v_a = 1.33 \times 10^5$m/s

22. **(d)** 2600 km

Explanation: V = $\frac{GM}{R+h}$ and $g_h = \frac{GM}{(R+h)^2}$

$\therefore \quad \frac{|V|}{g_h} = R + h$

$\Rightarrow$ R + h = $\frac{5.4 \times 10^7}{6.0} = 9 \times 10^6$ m = 9000 km

$\therefore$ h = (9000 - 6400)km

= 2600 km

23. **(d)** 31.0 s

Explanation: The initial speed of the car u = 45 m/s

Let t = 0 s when the car passes the trooper.

The trooper starts from rest 1 s after the car passes the billboard.

In this 1 s the car would have covered a distance of 45 m.

Let y be the time at which the trooper overtakes the car.

Distance covered by car at time y

S = 45 + uy = 45 + 45y......(1)

(The distance is measured from the billboard)

The same distance is covered by the trooper also.

S = 0 + $\frac{1}{2} \times 3 \times (y)^2$....(2)

(Initial speed of trooper = 0).

Equating (1) and (2)

45 + 45y = $\frac{3}{2}(y)^2$

$\Rightarrow 3y^2 - 90y - 90 = 0$

$\Rightarrow y^2 - 30y - 30 = 0$

Using quadratic formula, we get:

$\Rightarrow \frac{30 \pm \sqrt{900+120}}{2} = \frac{30 \pm 31.93}{2}$ = 30.97 s $\approx$ 31 s

neglected negative value of y.

24. **(a)** Vector addition

Explanation: Vector addition is the operation of adding two or more vectors together into a vector sum. The so-called parallelogram law gives the rule for vector addition of two or more vectors. For two vectors, the vector sum is obtained by placing them head to tail and drawing the vector from the free tail to the free head.

25. **(b)** 15 m/s

Explanation: Net forward force = 1000 - 500 = 500 N

$a = \frac{F}{m} = \frac{500}{1000} = \frac{1}{2}$ ms^{-2}

v = u + at $= 10 + \frac{1}{2} \times 10$ = 15 ms^{-1}

Section B

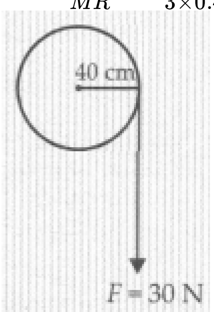
26. **(d)** 25 rad/s^2

Explanation:

$\tau = l\alpha$

$F \times R = MR^2\alpha$

$\alpha = \frac{F}{MR} = \frac{30}{3 \times 0.40} = 25 \text{rad/s}^2$



27. **(b)** $\sqrt{2} : 1$

Explanation: $\omega = \sqrt{\frac{2\times \text{ Rotational } K.\text{E}}{I}}$

For same rotational K.E.,

$\omega \propto \frac{1}{\sqrt{I}}$

$\frac{\omega_1}{\omega_2} = \sqrt{\frac{I_2}{I_1}} = \sqrt{\frac{2I}{I}} = \sqrt{2} : 1$

28. **(b)** its own mass

Explanation: T = $2\pi\sqrt{\frac{(R+h)^3}{GM}}$, Clearly, T does not depend on the mass m of the satellite.

29. **(d)** 1 : 2

Explanation: p = $\sqrt{2mK}$

For same K, p $\propto \sqrt{m}$

$\therefore \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{m}{4m}} = \frac{1}{2}$ = 1 : 2

30. **(d)** Vector

Explanation: Displacement vector is a vector which gives the position of a point with reference to a point other than the origin of the coordinate system.

31. **(d)** 8.54 m s^{-1}, 70° with x-axis

Explanation: Position vector is given by, $\vec{r} = 3.0t\hat{i} + 2.0t^2\hat{j} + 4.0\hat{k}$

We know velocity is given by:-

$\vec{v} = \frac{dr}{dt}$

So, $\vec{v} = 3.0\hat{i} + 4t\hat{j}$

Velocity after 2 seconds is:

$\vec{v} = 3\hat{i} + 8\hat{j}$

Magnitude of velocity = $\sqrt{(3)^2 + (8)^2}$ = $\sqrt{73}$= 8.54 ms^{-1}

Direction is given by

$\theta = tan^{-1}(\frac{8}{3}) = 69.5 \approx 70^\circ$ with x-axis

32. **(a)** 2.5 m/s

Explanation: $a = \frac{F}{m} = \frac{25\times10^5}{2\times10^7} = \frac{1}{8}$ ms^{-2}

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

$v^2 - 0^2 = 2 \times \frac{1}{8} \times 25 = \frac{25}{4}$

$v = \frac{5}{2}$ = 2.5 ms^{-1}

33. **(c)** zero

Explanation: As there is no external force and the two bodies move due to mutual force of attraction, so $v_{CM} = 0$.

34. **(c)** $\frac{5g}{14}$

Explanation: $a = \frac{5}{7}g\sin 30^\circ = \frac{5g}{14}$

35. **(a)** 89.4

Explanation: Initial velocity, u = 0

Acceleration, a = 10.0 m/s^2

Distance covered, s = 400 m

Final velocity, v = ?

We know that, $v^2 - u^2 = 2as$

$\Rightarrow v^2 - 0 = 2 \times 10 \times 400$

$\Rightarrow 8000 = v^2$

$\Rightarrow v = \sqrt{8000} = 89.4\ m/s$

36. **(c)** equal to zero

Explanation: A null vector is a vector having a magnitude equal to zero. It is represented by $\vec{0}$. A null vector has no direction or it may have any direction. Generally a null vector is either equal to resultant of two equal vectors acting in opposite directions or multiple vectors in different directions.

$\vec{0} = \vec{A} + (-\vec{A})$

37. **(a)** Velocity of light

Explanation: Velocity of light is same in all inertial frames.

38. **(a)** Weak Nuclear Force

Explanation: There are four fundamental forces in nature which are Gravitational force, Strong force, Weak force, and Electromagnetic force.

Gravitational Force: This force is the weakest but has an infinite range.

Strong Nuclear force: This force holds the nucleus of an atom together. It is the strongest of the forces. It acts over a range of about 10^{-15} m.

Weak Nuclear Force: This force is weak compared to the strong force as the name implies and has the shortest range of 10^{-18}m.

Electromagnetic Force: This is the second strongest force after the strong force and it acts on electrically charged particles. It has a strength of $\frac{1}{137}$ relative to the strong force but has an infinite range.

Hence, the weakest force is the weak nuclear force.

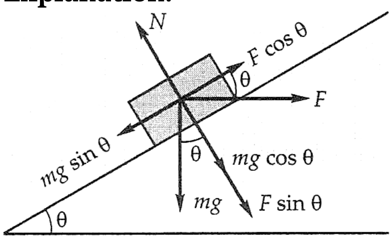
39. **(c)** frequency

Explanation: $\left[\frac{h}{I}\right] = \frac{E}{vI} = \frac{[\mathrm{ML^2\,T^{-2}}]}{[\mathrm{T^{-1}}][\mathrm{ML^2}]}$

= $[T^{-1}]$ = [Frequency]

40. **(d)** mg cos θ + F sin θ

Explanation:



Clearly, N = mg cos θ + F sin θ

41. **(a)** 53.5 N

Explanation: Gravitational Force

F = mg

$\Rightarrow$ F = 5 $\times$ 10.7 = 53.5 N

42. **(c)** 2.5 km/s

Explanation: v_e(earth) = $\sqrt{\frac{2GM}{R}}$ = 11.2 km s^{-1}

v_e(moon) = $\sqrt{\frac{2G(\frac{M}{81})}{\frac{R}{4}}}$

= $\frac{2}{9}\sqrt{\frac{2GM}{R}} = \frac{2}{9} \times 11.2\ \mathrm{ms}^{-1}$

= 2.45 km/s

43. **(d)** $g\,(h) = \frac{GM_E}{(R_E+h)^2}$

Explanation: We know by Newton's law of gravitation, the force on the body of mass m, situated at height h to the surface of the earth of mass M_E is given by:

$F = G\frac{M_e m}{(r+h)^2}$ ....(1)

We also know F = mass $\times$ acceleration(here acceleration is the acceleration due to gravity)

$\Rightarrow$ F = mg ....(2)

Equating (i) & (ii), we get
$g = G\frac{M_e}{(r+h)^2}$

44. **(c)** 65 N
Explanation: Net force on the man = ma = 65 $\times$ 1 = 65 N

45. **(c)** A is true but R is false.
Explanation: When the velocity of a particle thrown upward becomes zero then it cannot move further which means it has reached its uppermost point. So, the assertion is true.
But, then also acceleration due to gravity is acting on it in the downward direction. Hence the reason is false.

46. **(b)** Both A and R are true but R is not the correct explanation of A.
Explanation: Both A and R are true but R is not the correct explanation of A.
In uniform circular motion, the magnitude of velocity and acceleration remains same, but due to change in direction of motion, the direction of velocity and acceleration changes. Also the centripetal acceleration is given by $a = \omega^2 r$.

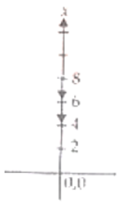
47. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: As length, mass and time represent our basic scientific quantities, therefore they are called fundamental quantities as they cannot be obtained from each other.

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

49. **(b)** Both A and R are true but R is not the correct explanation of A.
Explanation: If μ_s, is the coefficient of static friction between the tyres and the road, the magnitude of frictional force F cannot exceed μ_s mg, so that F $\leq \mu_s$ mgjjj
Thus for a safe turn: $\frac{mv^2}{r} \leq \mu_s mg$
or $\mu_s \geq \frac{v^2}{rg}$, or $v \leq \sqrt{\mu_s rg}$
Therefore when the speed of car exceeds the value $\sqrt{\mu_s rg}$ then the car overturns. Since the inner wheels are moving in a circle of smaller radius, the maximum permissible velocity for them is less. Hence the inner wheels leave the ground first and the car will overturn on the outside.

Section C

50. **(b)** x < 0, v < 0, a > 0
Explanation:
As the lift is coming from 8th to 4th then, the value of x becomes less (negative)
Let x < 0. Velocity is downwards(i.e., negative). So, v < 0. Before reaching 4th-floor lift is retarded i.e acceleration is upwards. Hence a > 0



From 8th floor to 4th floor

51. **(c)** -50 km
Explanation: a = $\frac{F}{m} = \frac{8}{0.4}$ = 20ms^{-2} towards the south
position at t = 30 sec
s = ut + $\frac{1}{2}at^2$
$s_1 = (10 \times 30) - \frac{1}{2} \times 20 \times 30 \times 30$ = -8700 m
velocity at t = 30 sec
v = u + at
v = 10 - (20 $\times$ 30) = −590m/sec
for motion between 30 sec to 100 sec (for 70 sec)
s_2 = (−590 $\times$ 70) + 0 = −41300m

total distance

$s = s_1 + s_2 = -(8700 + 41300) = -50000m = -50Km$

52. **(a)** Perfectly inelastic

Explanation: A large wooden block suspended by two cords serves as the pendulum bob.
When a bullet is fired into the bob, it gets embedded in the bob and its momentum is transferred to the bob. Hence the collision is perfectly inelastic.

53. **(c)** conservation of mechanical energy and conservation of momentum

Explanation: Principle of conservation of mechanical energy, an expression for the bob-bullet combination after collision is derived. Then the principle of conservation of momentum is applied to find the velocity of the bullet before collision.

54. **(c)** Mathematician

Explanation: The ballistic pendulum was invented in 1742 by English mathematician Benjamin Robins.

55. **(d)** Chronograph

Explanation: The ballistic pendulum. has now been replaced by the ballistic chronograph, an electronic device.