CBSE Sample Question Paper Term 1

Class – XI (Session : 2021 - 22)

SUBJECT - PHYSICS 042 - TEST - 01

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. 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.

2. Light year is used to measure: **[0.77]**

a) distance between atoms
b) distance between stars
c) stationary charge
d) none of these.

3. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of -5.00 m/s^2 as it comes to rest. From the instant the plane touches the runway, what is the minimum time in seconds before it can come to rest? **[0.77]**

a) 20.0
b) 10.0
c) 25.0
d) 30.0

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

a) 11.3 m/s
b) 8.98 m/s
c) 10.2 m/s
d) 9.65 m/s

5. If the unit of force is 1 kilonewton, the length is 1 km and time 100 s, what will be the unit of mass? **[0.77]**

a) 1,000 kg
b) 10,000 kg

c) 100 kg

d) 1 kg

6. A sphere rolls down an inclined plane of inclination θ. What is the acceleration as the sphere reaches bottom? **[0.77]**

a) $\frac{2}{5}g\sin\theta$

b) $\frac{5}{7}g\sin\theta$

c) $\frac{3}{5}g\sin\theta$

d) $\frac{2}{7}g\sin\theta$

7. If a solid sphere and solid cylinder of same mass and radius rotate about their own axis the moment of inertia will be greater for **[0.77]**

a) solid cylinder and solid sphere

b) solid sphere

c) solid cylinder

d) both solid cylinder and solid sphere are equal

8. A man weighs 60 kg at earth's surface. At what height above the earth' surface weight becomes 30 kg? Given radius of earth is 6400 km. **[0.77]**

a) 2020 km

b) 3000 km

c) None of these

d) 2624 km

9. At a metro station, a girl walks up a stationary escalator in time t_1. If she remains stationary on the escalator, then the escalator take her up in time t_2. The time taken by her to walk up on the moving escalator will be **[0.77]**

a) $\frac{t_1 t_2}{(t_2 - t_1)}$

b) $\frac{t_1 t_2}{(t_2 + t_1)}$

c) $t_1 - t_2$

d) $\frac{(t_1 + t_2)}{2}$

10. An elevator is descending with uniform acceleration. A person in the elevator drops a marble at the moment the elevator starts to measure the acceleration of the elevator. The marble is 2 m above the floor when it is dropped. It takes 1.2 s to reach the floor of the elevator. What is the acceleration of the floor? Take g = 10 ms^{-2}. **[0.77]**

a) 8.18 ms^{-2}

b) 6.58 ms^{-2}

c) 7.2 ms^{-2}

d) 6.08 ms^{-2}

11. A particle of mass 4 kg is acted upon by steady force of 4 N. Distance travelled by the particle in 4 sec is **[0.77]**

a) 4 m

b) 2 m

c) 16 m

d) 8 m

12. The work done by an applied variable force $F = x + x^3$ from x = 0 m to x = 2 m, where x is displacement, is **[0.77]**

a) 8 J

b) 10 J

c) 6 J

d) 12 J

13. The centre of mass of a system of particles does not depend on **[0.77]**

a) relative distance between the particles

b) masses of the particles

c) forces acting on the particles

d) position of the particles

14. Two heavy spheres each of mass 100 kg and radius 0.10 m are placed 1.0 m apart on a horizontal table. What is the gravitational force and potential at the midpoint of the line joining the centers of the spheres? Is an object placed at that point in equilibrium? If so, is the equilibrium stable or unstable? **[0.77]**

a) 0, 1.9 $\times$ 10^{-8} J/kg, unstable

b) 0, 1.9 $\times$ 10^{-8} J/kg stable

c) 0, 2.7 $\times$ 10^{-8} J/kg, unstable

d) 0, 2.7 $\times$ 10^{-8} J/kg, stable

15. Strong Nuclear Force **[0.77]**

a) is responsible for holding the nucleus of an atom together

b) is responsible for holding the electrons of an atom together

c) is a long range force

d) is responsible for holding the nucleus of an atom and the electrons

16. The specific resistivity ρ of a circular wire of radius r, resistance R and length l is given by $\rho = \frac{\pi r^2 R}{l}$. Given, r = (0.24 $\pm$ 0.02) cm, R = (30 $\pm$ 1)Ω and l = (4.80 $\pm$ 0.01)cm. The percentage error in ρ is nearly: **[0.77]**

a) none of these

b) 20%

c) 18%

d) 7%

17. Two parallel rail tracks run north-south. Train A moves north with a speed of 27 km/ hr, and train B moves south with a speed of 45 km/ hr. What is the velocity of B with respect to A in m/s? Choose the positive direction of the x-axis to be from the south to north: **[0.77]**

a) -18

b) -28

c) -20

d) -15

18. 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

19. A body of mass 5 kg starts from the origin with an initial velocity $\vec{u} = (30\hat{i} + 40\hat{j})$ m/s. If a constant force $(-6\hat{i} - 5\hat{j})$N acts on the body, the time in which the y-component of the velocity becomes zero is **[0.77]**

a) 20 s

b) 5 s

c) 80 s

d) 40 s

20. A block of mass M is attached to the lower end of a vertical spring. The spring is hung from the ceiling and has force constant value k. The mass is released from rest with the spring initially unstretched. The maximum extension produced in the length of the spring will be **[0.77]**

a) $\frac{Mg}{k}$

b) 4 $\frac{Mg}{k}$

c) 2 $\frac{Mg}{k}$

d) $\frac{Mg}{2k}$

21. 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) $\frac{Ml^2\omega}{12t}$

b) $\frac{Ml^2\omega}{t}$

c) $\frac{2Ml^2\omega}{3t}$

d) $\frac{Ml^2\omega}{3t}$

22. For a satellite to be in a circular orbit 780 km above the surface of the earth, what is the period of the orbit (in hours)? **[0.77]**

a) 1.98 hr

b) 1.65 hr

c) 1.78 hr

d) 1.88 hr

23. A body moving with uniform acceleration has a velocity of 12.0 cm/s in the positive x-direction when its x coordinate is 3.00 cm. If its x coordinate 2.00 seconds later is -5.00 cm, what is the magnitude of its acceleration in $\mathrm{cm/s^2}$? **[0.77]**

a) -14.0

b) -12.0

c) -16.0

d) -18.0

24. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then which of the following are necessarily true: **[0.77]**

a) The acceleration of the particle is bounded.

b) The acceleration of the particle is necessarily in the plane of motion.

c) The acceleration of the particle is zero.

d) The particle must be undergoing a uniform circular motion

25. A body of mass 0.25 kg is projected with muzzle velocity 100 m/s from a tank of mass 100 kg. What is the recoil velocity of the tank? **[0.77]**

a) 0.25 m/s

b) 0.5 m/s

c) 5 m/s

d) 25 m/s

Section B

Attempt any 20 questions

26. A horizontal platform is rotating with a uniform angular velocity ω around the vertical axis passing through its centre. At some instant of time, a viscous liquid of mass m is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period **[0.77]**

a) remains unaltered

b) decreases initially and increases again

c) increases continuously

d) decreases continuously

27. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water, the centre of mass of the system shifts by **[0.77]**

a) zero

b) 2.3 m

c) 0.75 m

d) 3.0 m

28. 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

29. A force $\vec{F} = 2\hat{i} + 3\hat{j} + \hat{k}$ acts on a body. The work done by the force for a displacement of $-2\hat{i} + \hat{j} - \hat{k}$ is **[0.77]**

a) 2 units

b) -2 units

c) -4 units

d) 4 units

30. A truck accelerates at 1 m / sec^2 from rest. What is its velocity in m/s at a time of 2 sec? **[0.77]**

a) 2

b) 4

c) 1

d) 3

31. A batter hits a baseball so that it leaves the bat at speed v_0 = 37.0 m/s at an angle a = 53.1^o. Find the time when the ball reaches the highest point of its flight, and its height h at this time? **[0.77]**

a) 3.02 s, 44.7 m

b) 3.32 s, 41.7 m

c) 3.12 s, 43.7 m

d) 3.22 s, 42.7 m

32. A stone is dropped from a height h. It hits the ground with a certain momentum p. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by **[0.77]**

a) 68%

b) 41%

c) 200%

d) 100%

33. In precession such as that of a top: **[0.77]**

a) the axis of rotation oscillates vertically

b) the axis of rotation is fixed

c) the axis of rotation oscillates horizontally

d) the axis of rotation moves

34. Joule second is the unit of **[0.77]**

a) angular momentum

b) pressure

c) work

d) momentum

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 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 in m/s ? Choose the positive direction of x-axis to be from south to north **[0.77]**

a) 10.0

b) 3

c) 8

d) 11

36. A projectile is fired a velocity of 150 meters per second at an angle of 30 degrees with the horizontal. What is the magnitude of the vertical component of the velocity at the time the projectile is fired? **[0.77]**

a) 225 m/s
b) 75 m/s
c) 150 m/s
d) 130 m/s

37. A body of mass 8 kg is moved by a force F = 3x N, where x is the distance covered. Initial position is x = 2 m and the final position is x = 10 m. The initial speed is zero. The final speed is **[0.77]**

a) 14 m/s
b) 18 m/s
c) 6 m/s
d) 12 m/s

38. Classical Physics deals mainly with________________. **[0.77]**

a) transport phenomena
b) macroscopic phenomena
c) microscopic phenomena
d) surface phenomena

39. Which of the following is a dimensionless quantity? **[0.77]**

a) Specific heat
b) Strain
c) Stress
d) Quantity of heat

40. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string, a horizontal force F = 600 N is applied to the 10 kg mass so as to pull it. What is the tension in the string? **[0.77]**

a) 450 N
b) 300 N
c) 400 N
d) 370 N

41. Calculate the escape speed from the Earth for a 5000-kg spacecraft. mass of the earth = 6.0×10^{24} kg; radius of the earth = 6.4×10^{6} m; G = 6.67×10^{-11} N m^2 kg^{-2}. **[0.77]**

a) 1.52×10^4 m/s
b) 1.32×10^4 m/s
c) 1.12×10^4 m/s
d) 1.72×10^4 m/s

42. Different points in the earth are at slightly different distances from the sun and hence experience different forces due to gravitation. For a rigid body, we know that if various forces act at various points in it, the resultant motion is as if a net force acts on the c.m. (centre of mass) causing translation and net torque at the c.m. causing rotation around an axis through the c.m. For the earth-sun system (approximating the earth as a uniform density sphere) **[0.77]**

a) the torque is zero
b) the torque causes the earth to spin
c) the rigid body result is not applicable since the earth is not even approximately a rigid body
d) the torque causes the earth to move around the sun

43. The asteroid Toro has a radius of about 5.0 km. assuming that the density of Toro is the same as that of the earth (5.5 g/cm^3) Suppose an object is to be placed in a circular orbit around Toro, with a radius just slightly larger than the asteroid's radius. What is the speed of the object?. Mass of the earth = 6.0×10^{24} kg; radius of the earth = 6.4×10^{6} m; G = 6.67×10^{-11} Nm^2 kg^{-2}. **[0.77]**

a) 6.8 m/s
b) 6.6 m/s
c) 6.4 m/s
d) 6.2 m/s

44. A 30 g bullet travelling initially at 500 m/s penetrates 12 cm into wooden block. The average force exerted will be **[0.77]**

a) 31750 N
b) 3040 N
c) 31250 N
d) 41250 N

45. **Assertion (A):** A body falling freely may do so with constant velocity. **[0.77]**
Reason (R): The body falls freely when the acceleration of a body is equal to the acceleration due to gravity.

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):** A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 seconds. The centripetal acceleration produced is π^2 ms^{-2}. **[0.77]**
Reason (R): Centripetal acceleration = $\omega^2 R$

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 result of every measurement by any measuring instrument contains some uncertainty. **[0.77]**
Reason (R): This uncertainty in measurement is accuracy.

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 plays the same role in rotational motion, as mass plays in linear motion. **[0.77]**
Reason (R): Moment of inertia depends only on the mass 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.

49. **Assertion (A):** A safe turn by a cyclist should neither be fast nor sharp. **[0.77]**
Reason (R): The bending angle from the vertical would decrease with an increase in 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 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) -0.368
c) -0.3878
d) 4.756

51. If μ_s is coefficient of static friction and μ_k is coefficient of kinetic friction, then **[0.77]**

a) generally, $\mu_s = \mu_k$
b) there is no relation between μ_s and μ_k
c) generally $\mu_s < \mu_k$
d) generally $\mu_s > \mu_k$

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

In everyday life, the term work is used to refer to any form of activity that requires the exertion of mental or muscular efforts. In physics, work is said to be done by a force or against the direction of the force, when the point of application of the force moves towards or against the direction of the force. If no displacement takes place, no work is said to be done.

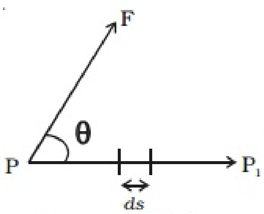


Fig. Work done by a force

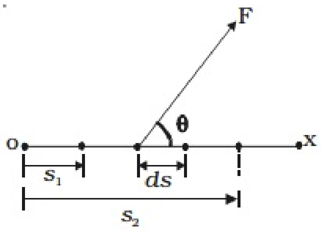


Fig. Work done by a constant force

52. A box is pushed through 4.0 m across a floor offering 100 N resistance. How much work is done by the applied force? **[0.77]**

a) 100 J
b) 300 J
c) 400 J
d) 200 J

53. What is work done in holding a 15 kg suitcase while waiting for 15 minutes? **[0.77]**

a) 22.5 J
b) zero
c) 225 J
d) 150 J

54. Frictional forces are: **[0.77]**

a) conservative forces
b) non-conservative forces
c) buoyant force
d) none of these

55. When the body moves in a circular motion, net 'work' done is: **[0.77]**

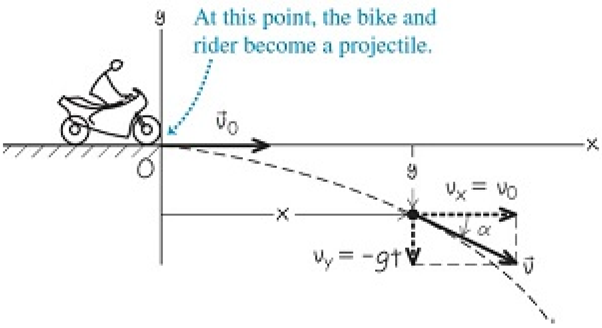
a) none of these
b) positive
c) negative
d) zero

Solution

SUBJECT - PHYSICS 042 - TEST - 01

Class 11 - Physics

Section A

1. **(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.
2. **(b)** distance between stars
   Explanation: Light year is the distance traveled by light in one year.
3. **(a)** 20.0
   Explanation: Initial velocity, u = 100 m/s
   As it stops so final velocity, v = 0
   Acceleration a = - 5 m/s^2
   We know, v - u = at
   $\Rightarrow t = \frac{v-u}{a}$
   $\Rightarrow t = \frac{0-100}{-5} = \frac{-100}{-5}$
   $\Rightarrow$ t = 20.0 s
4. **(c)** 10.2 m/s
   Explanation: 

   the velocity components at t = 0.50 s are
   $v_x = v_{ox}$ = 9.0m/s
   v_y = −gt = −9.8 × 0.50 = −4.9m/s
   The motorcycle has the same horizontal velocity v_x as when it left the cliff at t = 0, but in addition there is a downward (negative) vertical velocity v_y.
   The velocity vector at t = 0.50 s is given by ,
   $\vec{v} = v_x\hat{i} + v_y\hat{j} = 9.0\hat{i} + (-4.9)\hat{j}$
   at t = 0.50 s the velocity has magnitude v is given by,
   v = $\sqrt{(v_x)^2 + (v_y)^2} = \sqrt{(9.0)^2 + (-4.9)^2}$
   Hence, velocity is v = 10.2 m/s
5. **(b)** 10,000 kg
   Explanation: Let x kg be the unit of mass.
   As [F] = [MLT^{-2}]
   $\therefore$ 1000 = [xkg]^1[1000m]^1[100s]$^{-2}$
   or x = 10,000 kg
6. **(b)** $\frac{5}{7}g\sin\theta$
   Explanation: $a = \frac{g\sin\theta}{1+\frac{I}{MR^2}}$
   For a sphere, $I = \frac{2}{5}MR^2 \therefore a = \frac{5}{7}g\sin\theta$

7. **(c)** solid cylinder
Explanation: M.I. of solid sphere = $\frac{2}{5}MR^2$
M.I. of solid cylinder $= \frac{1}{2}MR^2$
Clearly, $I_{\text{cylinder}} > I_{\text{sphere}}$

8. **(c)** None of these
Explanation: $mg' = mg\frac{R^2}{(R+h)^2}$
$\Rightarrow \quad 30 = 60 \times \frac{(6400)^2}{(6400+h)^2}$
$\Rightarrow$ 6400 + h = $6400\sqrt{2}$
$\Rightarrow$ h = 6400(1.414 - 1)
= 2651 km

9. **(b)** $\frac{t_1t_2}{(t_2+t_1)}$
Explanation: Let L be the length of the escalator.
Velocity of girl w.r.t. ground $v_g = \frac{L}{t_1}$
Velocity of escalator w.r.t. ground $v_e = \frac{L}{t_2}$
Effective Velocity of girl on moving escalator with respect to ground = $v_g + v_e = \frac{L}{t_1} + \frac{L}{t_2} = L\left[\frac{1}{t_1} + \frac{1}{t_2}\right]$
$v_{ge} = L\left[\frac{t_1+t_2}{t_1t_2}\right]$
Time t taken by girl on moving escalator in going up the distance Lis
t = $\frac{distance}{speed} = \frac{L}{L\left(\frac{t_1+t_2}{t_1t_2}\right)} = \frac{t_1t_2}{t_1+t_2}$

10. **(c)** 7.2 ms^{-2}
Explanation: Let the acceleration of the elevator be ‘a’ downwards. As the elevator is going downwards the marble has to travel a distance more than 2 m in order to strike the floor.
Initial velocity, u = 0 for both the marble and the elevator.
Distance travelled by elevator in 1.2 s = $\frac{1}{2}a \times (1.2)^2$
Distance travelled by marble in 1.2 s = $\frac{1}{2}g \times (1.2)^2 = \frac{1}{2} \times 10 \times (1.2)^2$
This distance should be equal to height of marble + distance covered by elevator.
So, $\frac{1}{2} \times 10 \times (1.2)^2 = 2 + \frac{1}{2} \times a \times (1.2)^2$
On solving, we get, a = 7.2 ms^{-2} downwards.

11. **(d)** 8 m
Explanation: $a = \frac{F}{m} = \frac{4}{4}$ = 1 ms^{-2}
$s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 1 \times 4^2$ = 8 m

12. **(c)** 6 J
Explanation: W = $\int$ F dx = $\int_0^2 (x + x^3)\,dx = \left[\frac{x^2}{2} + \frac{x^4}{4}\right]_0^2$
= 6 J

13. **(c)** forces acting on the particles
Explanation: The centre of mass of a system of particles does not depend on the forces acting on the particles.

14. **(c)** 0, 2.7 $\times 10^{-8}$ J/kg, unstable
Explanation: Here, G = 6.67 $\times 10^{-11}$ N m^2 kg^{-2}
M = 100 kg
R = 0.1 m
Distance between the two spheres d = 1.0 m
Suppose that the distance of either sphere from the midpoint of the line joining their centre is r. Then
r = $\frac{d}{2}$ = 0.5 m

The gravitational field at the midpoint due to two spheres will be equal and opposite.
Hence, the resultant gravitational field at the midpoint = 0
The gravitational potential at the midpoint.
$= \left(\frac{-GM}{r}\right) \times 2$
$= -\frac{6.67 \times 10^{-11} \times 100 \times 2}{0.5}$
= -2.7×10^{-8} Jkg^{-1}
As the effective force on the body placed at the midpoint is zero, so the body is in equilibrium, if the body is displaced a little towards either mass body from its equilibrium position, it will not return to its initial position of equilibrium. Hence, the body is in unstable equilibrium.

15. **(a)** is responsible for holding the nucleus of an atom together
Explanation: The strong nuclear force is the nuclear binding force, the force that provides the attraction.it might also be responsible for holding particles together within the nucleus of atoms.

16. **(b)** 20%
Explanation: $\frac{\Delta\rho}{\rho} \times 100$ = $\frac{2\Delta r}{r} \times 100 + \frac{\Delta R}{R} \times 100 + \frac{\Delta l}{l} \times 100$
= $2 \times \frac{0.02}{0.24} \times 100 + \frac{1}{30} \times 100 + \frac{0.01}{4.80} \times 100$
= 16.7 + 3.3 + 0.2 = 20.2% $\simeq$ 20%

17. **(c)** -20
Explanation: The velocity of A is given by, v_A = +27 kmh^{-1} = +7.5 ms^{-1}
The velocity of B is given by , v_B = -45 kmh^{-1} = -12.5 ms^{-1}
The relative velocity of B with respect to A is given by, $v_{BA} = v_B - v_A$ = −7.5−12.5 = –20 ms^{-1}
i.e. the train B appears to A to move with a speed of 20 ms^{-1} from north to south.

18. **(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

19. **(d)** 40 s
Explanation: $\vec{u} = (30\hat{i} + 40\hat{j})\text{m/s}$
$\therefore$ u_y = 40 m/s
$\vec{F} = (-6\hat{i} - 5\hat{j})\text{N}$
$\therefore$ F_y = -5N
$a_y = \frac{F_y}{m} = \frac{-5}{5}$ = -1 m/s^2
v_y = 0
But $v_y = u_y + a_y t$
$\therefore$ 0 = 40 - 1 $\times$ or t = 40 s

20. **(c)** 2 $\frac{Mg}{k}$
Explanation: Loss of gravitational P.E. = Gain of spring P.E.

Mg x = $\frac{1}{2}$ kx^2

$\therefore$ x = $\frac{2Mg}{k}$

21. **(d)** $\frac{Ml^2\omega}{3t}$

Explanation:

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

$\tau = I\alpha$

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

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

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

22. **(b)** 1.65 hr

Explanation: Mass of the Earth, M_e = 6.0 $\times$ 10^{24} kg

The radius of the Earth, Re = $6.4 \times 10^6 m$

Universal gravitational constant, G = 6.67 $\times$ 10^{-11}Nm^2 kg^{-2}

Height of the satellite, h = 780 km = 780 $\times$ 10^3m = 0.78 $\times$ 10^6 m

Time Period of the satellite, T = $2\pi\sqrt{\frac{(R_e+h)^3}{GM_e}}$

$= 2 \times \frac{22}{7} \times \sqrt{\frac{(6.4\times10^6+0.78\times10^6)^3}{6.67\times10^{-11}\times6.0\times10^{24}}}$

$= 2 \times \frac{22}{7} \times \sqrt{\frac{(7.18\times10^6)^3}{40\times10^{13}}}$

$= 2 \times \frac{22}{7} \times \sqrt{9 \times 10^5}$

$= 2 \times \frac{22}{7} \times 948$

= 2 $\times$ 22 $\times$ 135.42

= 5958.85 sec = 1.65 hr

23. **(c)** -16.0

Explanation: Distance covered s = Final position - initial position = -5 - 3 = -8 cm

Initial velocity u = 12.0 cm/s

Time taken t = 2.0 s

We know

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

$\Rightarrow$ - 8 = 2 $\times$ 12.0 + $\frac{1}{2}a \times 4$

$\Rightarrow$ -8 = 24 + 2a

$\Rightarrow$ a = $\frac{-8-24}{2}$ = -16.0 cm/s^2 hence this is required result

24. **(b)** The acceleration of the particle is necessarily in the plane of motion.

Explanation: We know that change in acceleration and velocity is in the direction of Force (F) by $\vec{F}$ = m $\vec{a}$ and change in velocity is zero so acceleration will also be zero and will be in the same planes as that of velocity.

25. **(a)** 0.25 m/s

Explanation: By conservation of momentum,

100 $\times$ v = 0.25 $\times$ 100

v = 0.25 m/s

Section B

26. **(b)** decreases initially and increases again

Explanation: By conservation of angular momentum,

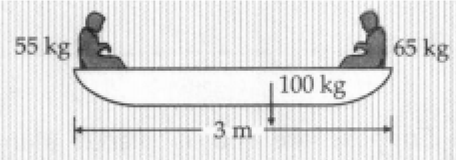
L = Iω = constant

As the liquid is dropped, it starts spreading out. The moment of inertia increases and angular velocity decreases. As the liquid starts falling, the moment of inertia again decreases and angular velocity increases.

27. **(a)** zero

Explanation:

As there is no external force, the centre of mass of the system does not shift.



28. **(b)** $\frac{2}{3}$mgR

Explanation: Cgange in potential energy,

$\Delta U=-\left(\frac{GMm}{R+2R}\right)-\left(-\frac{GMm}{R}\right)$

$=-\frac{\text{GMm}}{3\text{R}}+\frac{\text{GMm}}{\text{R}}$

$=\frac{2\text{GMm}}{3\text{R}}\ [\because g=\frac{GM}{R^2}]$

= $\frac{2}{3}$mgR

29. **(a)** 2 units

Explanation: $\vec{F}$ = $2\hat{i} + 3\hat{j} + \hat{k}$

$\vec{s}$ = $-2\hat{i} + \hat{j} - \hat{k}$

W = $\vec{F}\cdot\vec{s}$ = -4 + 3 - 1 = -2 units

30. **(a)** 2

Explanation: Initial velocity, u = 0 m/s

final velocity = v

Time t = 2 s

Acceleration, a = 1 m/s^2

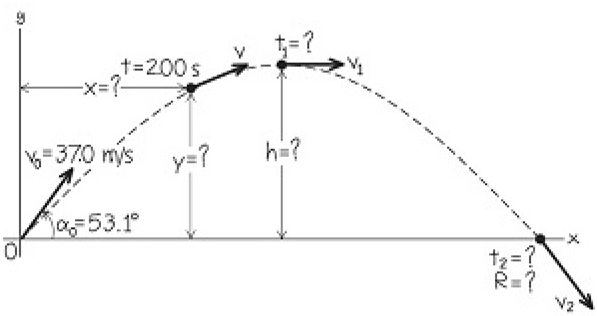
We know, v = u + at

$\Rightarrow v=0+1\times 2$

$\Rightarrow$ v = 2 m/s

31. **(a)** 3.02 s, 44.7 m

Explanation:



The initial velocity of the ball has components

v_{ox} = v_o cos α_o= 37.0 $\times$ cos53.1^o

= 22.2 m/s

v_{oy} = v_o sin α_o= 37.0 $\times$ sin 53.1^o

= 29.6 m/s

At the highest point, the vertical velocity v_y is zero. Call the time when this happens t_1; then

v_y = v_{oy} - gt_1 = 0

$\Rightarrow$ t_1 = $\frac{v_{oy}}{g}$ = $\frac{29.6}{9.8}$ = 3.02 s

The height at the highest point is the value of y at time t_1:

$h=v_{oy}t_1-\frac{1}{2}g(t_1)^2$

$= 29.6 \times 3.02 - \frac{1}{2} \times 9.8 \times (3.02)^2$
= 44.7 m

32. **(b)** 41%
Explanation: p = mv $= m\sqrt{2gh}$
$p' = m\sqrt{2g \times 2h} = \sqrt{2}p$ = 1.414 p
% change $= \frac{p-p}{p} = \frac{1.414p-p}{p} \times 100$ = 41.4%

33. **(d)** the axis of rotation moves
Explanation: Precession is a change in the orientation of the rotational axis of a rotating body, so the orientation of the axis of rotation of Top change.

34. **(a)** angular momentum
Explanation: [Angular momentum] = [Work] [Time]
∴ Js is the unit of angular momentum.

35. **(a)** 10.0
Explanation: Choose the positive direction of the x-axis to be from the south to the north.
Then, v_A = +54 km h^{-1} = +15 ms^{-1}
v_B = -90 km h^{-1} = - 25 ms^{-1}
The relative velocity of B with respect to A
= 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.
The relative velocity of ground with respect to B = 0 - v_B = 0 - (-25) = 25ms^{-1}
Now, 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 = 18 -54 kmh^{-1} = - 10ms^{-1}.

36. **(b)** 75 m/s
Explanation: Initial velocity, u = 150 m/s
Angle $\theta = 30^\circ$
Vertical component is given by
$v_y = usin\theta = 150sin30^\circ = 150 \times \frac{1}{2}$
= 75 m/s

37. **(c)** 6 m/s
Explanation: F = ma $= m\frac{dv}{dt} = m\frac{dv}{dx} \cdot \frac{dx}{dt}$
Fdx = mv dv $\left[\frac{dx}{dt} = v\right]$
3x dx = 8v dv
$3\int_2^{10} xdx = 8\int_0^v vdv$
$\frac{3}{2}\left[x^2\right]_2^{10} = \frac{8}{2}\left[v^2\right]_0^v$
$\frac{3}{2}[100 - 4]$ = 4[v^2 - 0]
or $\frac{3}{2} \times \frac{96}{4} = v^2$ or v = 6 m/s.

38. **(b)** macroscopic phenomena
Explanation: Classical physics is the study of motion, projectiles, pulleys, and the planets. It mainly deals with the movement of large objects (macroscopic) through space at relatively low slow speeds.

39. **(b)** Strain
Explanation: Strain is a dimensionless quantity.

40. **(c)** 400 N
Explanation: Let, T= tension on the string
a = acceleration, Given that , m_1 = mass of light body is = 10 kg and m_2 = mass of heavy body is = 20 kg

$a = \frac{F}{m_1+m_2} = \frac{600}{30}$ = 20ms^{-2}
Now the tension in the string will be,
T = m_2a = 20 $\times$ 20 = 400N

41. **(c)** 1.12 $\times$ 10^4 m/s
Explanation: We know, V_{esc} = $\sqrt{\frac{2GM}{R}}$
Here G = 6.67 $\times$ 10^{-11}Nm^{2}kg^{-2}
M = 6 $\times$ 10^{24} kg
R = 6.4 $\times$ 10^6 m
$\Rightarrow V_{esc} = \sqrt{\frac{2GM}{R}}$
$= \sqrt{\frac{2\times6.67\times10^{-11}\times6\times10^{24}}{6.4\times10^6}}$
$= \sqrt{\frac{12\times6.67\times10^7}{6.4}}$
= 1.12 $\times$ 10^4 m/sec

42. **(a)** the torque is zero
Explanation: As the earth is revolving around the sun in a circular motion (approximately in actual the path of the earth around the sun is elliptical) due to gravitational attraction. When we consider the earth-sun as a single system and we are taking earth as a sphere of uniform density. Then the gravitational force (F) will be of radial nature, i.e. the angle between position vector r and force F is zero. So, torque
$|\vec{\tau}| = |\vec{r} \times \vec{F}| = rF\sin 0^\circ$ = 0

43. **(d)** 6.2 m/s
Explanation: We know Orbital velocity:
$V_{orbital}$ = $= \sqrt{\frac{GM_{toro}}{r}}$ .....(1)
We can calculate the mass of Toro by mass density relationship:
Mass = Volume $\times$ Density
$\Rightarrow M_{\text{toro}} = \frac{4}{3}\pi R_{\text{toro}}^3 \times \rho_{\text{toro}}$
Here R_{toro} = 5.0 km = 5000 m
$\rho_{\text{toro}} = 5.5\text{g/cm}^3 = 55 \times 10^2\text{kg/m}^3$
$\Rightarrow$ M_{toro} = (4/3)π(5000)^3 $\times$ 55 $\times$ 10^2
$\Rightarrow$ M_{toro} = (4/3) $\times$ (22/7) $\times$ 125 $\times$ 10^9 $\times$ 55 $\times$ 10^2 $\Rightarrow$ M_{toro} = 2.9 $\times$ 10^{15}kg
Putting Value Of M_{toro},G = 6.67 $\times$ $10^{-11}$and r $\approx$ R_{toro} = 5000 in Eqn (1)
$V_{orbital} = \sqrt{\frac{6.67\times10^{-11}\times2.9\times10^{15}}{5000}}$
$\Rightarrow V_{\text{orbital}} = \sqrt{\frac{19.34\times10^4}{5\times10^3}}$
$\Rightarrow V_{\text{orbital}} = \sqrt{3.886 \times 10}$
$\Rightarrow V_{\text{orbital}} = \sqrt{38.86}$ = 6.2m/sec

44. **(c)** 31250 N
Explanation: v^2 - u^2 = 2a
0^2 - $(500)^2$ = 2a $\times$ 0.12
$a = -\frac{500\times500}{2\times0.12}$
Average force = ma $= \frac{30}{1000} \times \frac{500\times500}{2\times0.12}$ = 31250

45. **(d)** A is false but R is true.
Explanation: When a body is falling freely, only a gravitational force acts on it in a vertically downward direction. Due to this downward acceleration, the velocity of a body increases and will be maximum when the body touches the ground. If downward accelerating force is balanced by the upward retarding force, the body falls with constant velocity. This constant velocity is called the terminal velocity of the body.

46. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation: R = 1 m, f = $\frac{22}{44}$ = 0.5 Hz, ω = 2πf
= $2\pi \times 0.5 = \pi$ radian
Centripetal acceleration = $\omega^2 \mathrm{R}$ = π^2ms^{-2}
So, the assertion and reason both are true and the reason explains the assertion.

47. **(c)** A is true but R is false.
Explanation: The result of every measurement by any measuring instrument contains some uncertainty. This is known as an error. So, the A is true but R is false.

48. **(c)** A is true but R is false.
Explanation: The mass or inertia is the property of bodies by virtue of which the bodies have a tendency to remain at rest or in a state of uniform linear motion unless an external force is exerted on them. Greater is the mass of the body, greater is the external force required to brings it in the position of rest or uniform motion. Similarly, in order to rotate a body about an axis, a torque has to be applied to the body. This is described by saying that the body has a moment of inertia about the axis of rotation. The greater is the moment of inertia of a body about an axis, the greater is the torque required to rotate or to stop the body about that axis. Thus, the moment of inertia plays the same role in the rotational motion as mass or inertia plays in translational motion.

49. **(c)** A is true but R is false.
Explanation: During a turn tan $\theta = \frac{v^2}{rg}$, where θ is angle of bending with vertical, when v is large and r is small, tan θ increases. Therefore, as θ increases, so chances of skidding increase. Thus for a safe turn, θ should be small, for which v should be small and r should be large i.e. turning should be at a slow speed and along a track of larger radius.

Section C

50. **(a)** 6.61
Explanation: We know that, for a particle moves in a straight line with a constant acceleration a_x, its motion is described by the kinematic equation given by:
$\Delta x = \frac{1}{2}(v_{xi} + v_{xf})\Delta t$
Rearranging it, we have
$v_i = \frac{2\Delta x}{\Delta t} - v_f$
Substituting the values of $\Delta x, \Delta t\ and\ v_f$ into this equation, we get
$v_i = \frac{2(40.0\mathrm{m})}{8.50\mathrm{s}} - (2.80\mathrm{m/s}) = 6.61\mathrm{m/s}$

51. **(d)** generally $\mu_s > \mu_k$
Explanation: generally $\mu_s > \mu_k$

52. **(c)** 400 J
Explanation: 400 J

53. **(b)** zero
Explanation: zero

54. **(b)** non-conservative forces
Explanation: non-conservative forces

55. **(d)** zero
Explanation: zero