NORTH-EX PUBLIC SCHOOL
(Senior Secondary, Affiliated To CBSE)
School Block, Jain Nagar, Sector-38, Rohini, Delhi – 81
HALF YEARLY EXAMINATION, 2023-24
SUBJECT – PHYSICS
CLASS - XI

TIME: 3 hrs. **MM: 70**

General Instructions

i. The question paper has five sections and 33 questions.
ii. All questions are compulsory.
iii. Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section–C has 7 questions of 3 marks each; Section–D has 2 questions of 4 marks each and Section E has 3 questions of 5 marks each.
iv. There is no overall choice.

SECTION- A

1. Three vectors A, B and C satisfy the relation A.B = 0 and A.C = 0. The vector A is parallel to
   a) B b) C c) B × C d) B.C
2. A projectile is projected with a linear momentum p making angle θ with the horizontal. The change in momentum of the projectile on return to the ground will be
   a) 2p b) 2p sin θ c) 2p tan θ d) 2p cos θ
3. If a body A of mass M is thrown with velocity v at angle of 30° to the horizontal and another body B of the same mass is thrown with the same speed at an angle of 60° to the horizontal, the ratio of the horizontal ranges of A and B will be
   a) 1 : 3 b) 1 : 1 c) √3 : 1 d) 1 : √3
4. A wheel is subjected to uniform angular acceleration about its axis. Initially its angular velocity is zero. In the first two seconds, it rotates through angle θ_1. In the next two seconds, it rotates through angle θ_2. What is the ratio θ2/θ1
   a) 1 b) 2 c) 3 d) 4
5. A particle is moving eastward with a velocity of 5 ms^{-1}. In 10 seconds, the velocity changes to 5 ms^{-1} northward. The average acceleration in this time is
   a) zero b) $1/\sqrt{2}$ ms^{-2} towards north
   c) $1/\sqrt{2}$ ms^{-2} towards north-east d) $1/\sqrt{2}$ ms^{-2} towards north-west
6. A rocket is fired upward from the earth's surface such that it creates an acceleration of 19.6 ms^{-2}. If after 5 s, its engine is switched off, the maximum height of the rocket from earth's surface would be
   a) 980 m b) 735 m c) 490 m d) 245 m
7. The moment of inertia about the diameter of the thin circular ring of radius R is given by
   a) MR^2
   b) MR
   c) $1/2MR^2$
   d) None
8. If dL/dt = 0 then
   a) P is constant
   b) L is constant
   c) F is constant
   d) W is constant
9. The coefficient of restitution e for a perfectly inelastic collision is
   (a) 1

(b) 0
(c) infinity
(d) –1

10. According to work-energy theorem, the work done by the net force on a particle is equal to the change in its
    (a) kinetic energy
    (b) potential energy
    (c) linear momentum
    (d) angular momentum
11. Law of conservation of momentum follows from
    (a) Newton's first law of motion
    (b) Newton's second law of motion
    (c) Newton's third law of motion
    (d) Both (b) & (c)
12. A satellite is orbiting around the Earth with a period T. If the Earth suddenly shrinks to half its radius without change in mass, the period of revolution of the satellite will be
    a) T b) T/2 c) T/√2 d) 2T

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R).
Select the correct answer to these questions from the options as given below.
a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) If Assertion is true but Reason is false.
d) If both Assertion and Reason are false.

13. Assertion: Smaller the orbit of the planet around the sun, shorter is the time it takes to complete one revolution.
    Reason: According to Kepler's third law of planetary motion, square of time period is proportional to cube of mean distance from sun.
14. Assertion: An ice-skater stretches out arms-legs during performance.
    Reason: Stretching out arms-legs helps the performer to balance his or her body so that he or she does not fall.
15. Assertion: A spring has potential energy, both when it is compressed or stretched.
    Reason: In compressing or stretching, work is done on the spring against the restoring force.
16. Assertion: Frictional forces are conservating forces.
    Reason: Potential energy can be associated with frictional forces.

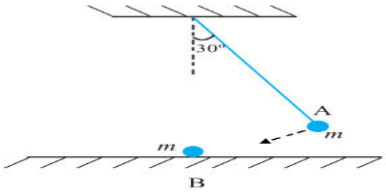
SECTION- B

17. What is the ratio of the distance travelled by a body falling freely from rest in the first, second, and third second of its fall?
18. State the laws of limiting friction.
19. If the velocity at the maximum height of a projectile is half its initial velocity of projection u, then find its range on the horizontal plane.
20. Why there are two propellers in a helicopter?
21. A body of mass 2 kg makes an elastic collision with another body at rest and continues to move in the original direction with a speed equal to 1/3 of its original speed. Find the mass of the second body.

SECTION- C

22. Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to the centre of the earth if it weighed 250 N on the surface?
23. A rope of negligible mass is wound round 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? What is the linear acceleration of the rope? Assume that there is no slipping.

24. The bob A of a pendulum released from 30o to the vertical hits another bob B of the same mass at rest on a table as shown in figure. How high does the bob A rise after the collision? Neglect the size of the bobs and assume the collision to be elastic.



25. Two masses 8 kg and 12 kg are connected at the two ends of a light inextensible string that goes over a frictionless pulley. Find the acceleration of the masses, and the tension in the string when the masses are released.
26. A hoop of radius 2 m weighs 100 kg. It rolls along a horizontal floor so that its centre of mass has a speed of 20 cm/s. How much work has to be done to stop it?
27. Read each of the below statement carefully and state, with reasons, if it is true or false:
    (a) The net acceleration of a particle in circular motion is always along the radius of the circle towards the center.
    (b) The velocity vector of a particle at a point is always along the tangent to the path of the particle at that point.
    (c) The acceleration of the particle in uniform circular motion averaged over one cycle is a null vector.
28. Consider a simple pendulum. The period of oscillation of the simple pendulum depends on its length 'l' and acceleration due to gravity 'g'. Derive the expression for its period of oscillation by the method of dimensions.

SECTION- D

29. An object that is in flight after being thrown or projected is called a **projectile**. Such a projectile might be a football, a cricket ball, a baseball or any other object. The motion of a projectile may be thought of as the result of two separate, simultaneously occurring components of motions. One component is along a horizontal direction without any acceleration and the other along the vertical direction with constant acceleration due to the force of gravity. It was Galileo who first stated this independency of the horizontal and the vertical components of projectile motion in his **Dialogue on the great world systems** (1632). Answer the following
    i. The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is
    (a) 60° (b) 15° (c) 30° (d) 45°
    ii. A missile is fired for maximum range with an initial velocity of 20 m/s. If g = 10 m/s^2 , the range of the missile is
    (a) 40 m (b) 50 m (c) 60 m (d) 20 m
    iii. the horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is
    (a) $\theta = \tan^{-1}(1/4)$ (b) $\theta = \tan^{-1}(4)$ (c) $\theta = \tan^{-1}(2)$ (d) $\theta = 45°$
    iv. Two projectiles of same mass and with same velocity are thrown at an angle 60° and 30° with the horizontal, then which will remain same
    (a) time of flight (b) range of projectile (c) maximum height acquired (d) all of them
30. A useful way to visualise the deformation during collision is in terms of a 'compressed spring'. If the 'spring' connecting the two masses regains its original shape without loss in energy, then the initial kinetic energy is equal to the final kinetic energy but the kinetic energy during the collision time D*t* is not constant. Such a collision is called an elastic collision. On the other hand the deformation may not be relieved and the two bodies could move together after the collision. A collision in which the two particles move together after the collision is

called a completely inelastic collision. The intermediate case where the deformation is partly relieved and some of the initial kinetic energy is lost is more common and is appropriately called an inelastic collision.

Answer the following

i. A ball is thrown vertically downwards from a height of 20 m with an initial velocity v_0. It collides with the ground, loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity v_0 is (Take g = 10 m s^{-2})

(a) 28 m s^{-1} (b) 10 m s^{-1} (c) 14 m s^{-1} (d) 20 m s^{-1}

ii. On a frictionless surface, a block of mass M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed v/3. The second block's speed after the collision is

(a) 3 v /√2 (b) √3 v /2 (c) 2√2 v / 3 (d) 3 v /4

iii. A rubber ball is dropped from a height of 5 m on a plane. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of

(a) 3/5 (b) 2/5 (c) 16/25 (d) 9/25

iv. A metal ball of mass 2 kg moving with speed of 36 km/h has a head on collision with a stationary ball of mass 3 kg. If after collision, both the balls move as a single mass, then the loss in K.E. due to collision is

(a) 100 J (b) 140 J (c) 40 J (d) 60 J.

SECTION- E

31. Answer the following

a) Derive an expression for acceleration due to gravity at a height 'h' above the surface of earth.

b) A satellite orbits the earth at a height of 400 km above the surface. How much energy must be expended to rocket the satellite out of the earth's gravitational influence? Mass of the satellite = 200 kg; 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}.

c) Define gravitational potential.

32. Explain why

a) a horse cannot pull a cart and run in empty space.

b) passengers are thrown forward from their seats when a speeding bus stops suddenly.

c) it is easier to pull a lawn mower than to push it.

d) a cricketer moves his hands backwards while holding a catch.

e) the stone flies off tangentially from the instant the string breaks.

33. Answer the following

a) Find the centre of mass of a thin rod of length 'l'.

b) A child stands at the centre of a turntable with his two arms outstretched. The turntable is set rotating with an angular speed of 40 rev/min. How much is the angular speed of the child if he folds his hands back and thereby reduces his moment of inertia to 2/5 times the initial value? Assume that the turntable rotates without friction.

c) Define moment of inertia.