ROLL NUMBER				

SET	A

INDIAN SCHOOL MUSCAT
HALF YEARLY EXAMINATION 2022
PHYSICS
SUBJECTCODE (042)

CLASS: XI
DATE: 26-11-2022

TIME ALLOTED: 3 HRS.
MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

1. All questions are compulsory. There are 35 questions in all.

2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

3. Section A contains eighteen questions of one mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks, Section D contains three questions of five marks each and Section E contains two case study questions of four marks each.

4. There is no overall choice. However, an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.

5. You may use the following value of physical constant wherever necessary. $g = 10 m/s^2$

SECTION A

1. The mass and volume of a body are 4.237 g and 2.5 cm^3, respectively. The density of the material of the body in correct significant figures is: 1

(i) 1.6048 g cm^{-3} (ii) 1.69 g cm^{-3} (iii) 1.7 g cm^{-3} (iv) 1.695 g cm^{-3}

2. Which one of the following does not have the same dimensions? 1

(i) Tension and surface tension (ii) Impulse and momentum

(iii) Work and torque (iv) velocity and speed

3. Force on the body falling downward with an acceleration 'a' is: 1

(i) Mg (ii)) M(g+ a) (iii) M(g-a) (iv) Ma

4. A motorist travels from A to B at a speed of 40km/h and returns back at the speed of 60km/h. His average speed will be: 1

(i) 40km/h (ii) 48km/h (iii) 50km/h (iv) 60km/h

5. For an object thrown at 45^0 to horizontal, the maximum height (H) and horizontal range (R) are related as: 1

(i) R = 16H (ii) R = 8H (iii) R = 4H (iv) R = 2H

6. If the radius of revolution of a particle moving along a circular path in doubled and its angular speed is halved, then the centripetal acceleration is: 1

(i) unchanged (ii) halved (iii) doubled (iv) becomes four times

7. When a circular road is banked ———— provides the necessary centripetal force. 1

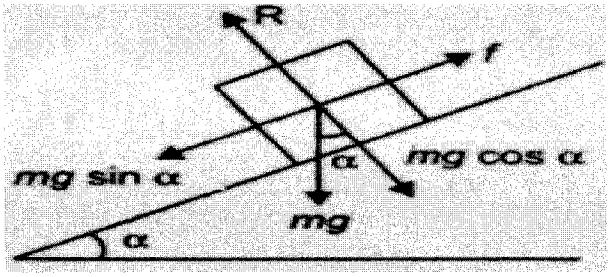
(i) Friction between the vehicle and road

(ii) Horizontal component of normal reaction

(iii) Weight of the vehicle

(iv) Normal reaction which acts at an angle Θ with vertical

8. A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is μ. Let the mass of the box be 'm', 'f 'the force of friction and 'N' the normal reaction. What is the force needed to be applied upwards along the plane to make the box just move up with uniform speed? 1



(i) mg (sinα + μcosα) (ii) mg (μcosα - sinα)

(iii) μ mg cosα (iv) μ mg sinα

9. A body at rest breaks into two pieces of equal masses. The parts will_____. 1

(i) Move in opposite direction (ii) Move in opposite directions with equal speeds

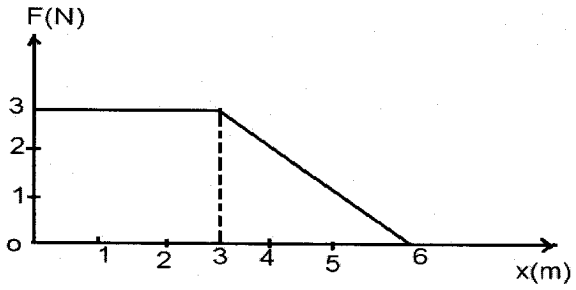
(iii) Move in opposite directions with unequal speeds (iv) Remain at rest

10. The work performed on an object does not depend upon: 1

(i) Force applied (ii) Angle at which force is inclined to the displacement

(iii) Initial velocity of the object (iv) displacement

11. A force F acting on an object varies with distance 'x' as shown in the figure. 1



The force is in Newton and distance 'x' is in metre. The work done by the force in moving the object from x = 0m to x = 6m is:

(i) 18.0J (ii) 13.5J (iii) 9.0J (iv) 4.5J

12. Two bodies of masses m and 4m are moving with equal kinetic energies. The ratio of their linear momenta is: 1

(i) 1:4 (ii) 4:1 (iii) 1:2 (iv) 2:1

13. A particle moves in a circular path with decreasing speed. Choose the correct statement. 1

(i) The magnitude of angular momentum remains constant.

(ii) The acceleration is along the tangent.

(iii) Particle moves in a spiral path with decreasing radius.

(iv) The direction of angular momentum remains constant.

14. Two circular discs have masses in the ratio of 1:2 and diameter in the ratio 2:1. The ratio of their moment of inertia is: 1

(i) 1 (ii) 2 (iii) 4 (iv) 8

15. 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? Assume that there is no slipping. 1

(i) $2.5 m/s^2$ (ii) $25 m/s^2$ (iii) $10 m/s^2$ (iv) $0.25 m/s^2$

16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

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

b) Both A and R are true, and R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false and R is also false.

Assertion: Displacement of a body may be zero when distance travelled by it is not zero.

Reason: The displacement is the longest distance between initial and final position. Motion in a straight line.

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Assertion: When a body moves along a circular path, no work is done by the centripetal force.

Reason: At any instant, the motion of the body is along the tangent to the circle whereas the centripetal force is along the radius vector towards the centre of the circle.

18. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

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Assertion: If no external force acts on a system of particles, then the centre of mass will not move in any direction.

Reason: If net external force is zero, then the linear momentum of the system remains constant.

SECTION B

19. Write any four limitations of the method of dimensional analysis. 2

20. A planet moves around the sun in nearly circular orbit. Its period of revolution T depends upon: (i) radius r of orbit (ii) mass M of the sun and (iii) the gravitational constant G. Show dimensionally that $T^2 \alpha r^3$. 2

OR

Find the value of 1000 J in a system that has 10 g, 100 cm and 50 s as units.

21. Draw the following graphs for an object projected upward with a velocity v_0, which comes back to the same point after some time: 2

(i) Acceleration versus time graph.

(ii) Speed versus time graph.

22. (a) State parallelogram law of vector addition. 2

(b) Give two conditions necessary for a given physical quantity to be a vector.

23. State and prove impulse-momentum theorem 2

24. Write any two difference between conservative and non – conservative forces. 2

25. (a) Explain why the speed of whirl wind in a tornado is alarmingly high? 2

(b) State the law of conservation of angular momentum.

OR

(a) Define radius of gyration of a rigid body.

(b) Standing is not allowed in double decker bus. Why?

SECTION C

26. From the velocity-time graph of a uniformly accelerated motion, derive the given equation of motion $v^2 - u^2 = 2as$ 3

27. Derive an expression for acceleration of a body moving in a circular path of radius 'r' with uniform speed 'v'. What will be the direction of the centripetal acceleration at any instant? 3

OR

(a) Derive a relation between linear velocity and angular velocity in a uniform circular motion.

(b) What is the angle between velocity vector and acceleration vector in a uniform circular motion?

28. State and prove work energy theorem. 3

29. Define torque and angular momentum. Obtain a relation between torque and angular momentum. 3

30. Define centre of mass of a system. Obtain an expression for the centre of mass of a system of two particles. 3

OR

(a) Derive an expression for rotational kinetic energy of a rigid body rotating with an angular velocity ω.

(b) A planet moves around the sun under the effect of gravitational force exerted by the sun. What is the torque on the planet due to the gravitational force?

SECTION D

31. (a) A projectile is fired with a certain velocity 'u' making an angle Θ with the horizontal. Show that the trajectory of the projectile is a parabola. 5

(b) Prove that there are two angles of projection for a projectile for which the horizontal range is the same.

OR

(a) A projectile is fired at an angle θ with the horizontal. Derive an expression for

(i) maximum height (ii) time of flight and (iii) horizontal range.

(b) A body is projected such that its kinetic energy at the top is $3/4^{th}$ of its initial kinetic energy. What is the angle of projection of the projectile with the horizontal?

32. (a) Which is easier, pushing or pulling a lawn mower? Explain with the help of free body Diagrams. 5

(b) A body of mass 10 kg is sliding down a rough inclined plane which makes an angle of 30^0 with the horizontal. If the coefficient of friction is 0.25, find the acceleration of the body? $g = 10\ m/s^2$

OR

(a) Obtain an expression for the maximum safe velocity of a car moving in a banked circular road. Coefficient of static friction between the car and the road is μ_s.

(b) Two bodies of masses 4 kg and 3 kg respectively are connected by a light string passing over a smooth frictionless pulley. Calculate the acceleration of the masses and tension in the string.

33. (a) Prove that in an elastic collision in one dimension, the relative velocity of approach before impact is equal to the relative velocity of separation after impact. 5

(b) A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15 min. If the tank is 40 m above the ground, the efficiency of the pump is 30%, how much electric power is consumed by the pump? (density of water = $1000kg/m^3$)

OR

(a) Derive an expression for the potential energy stored in a system of a block attached to a

massless spring, when the block is pulled from its mean position.

(b) A mass of 2 kg attached to a spring is vibrated horizontally by displacing the mass 40 cm from its equilibrium position and releasing it. Find the maximum velocity of the mass. Spring constant is 24.5 N/m.

SECTION E

34. The first law refers to the simple case when the net external force on a body is zero. The second law of motion refers to the general situation when there is net external force acting on the body. It relates the net external force to the acceleration of the body.

These qualitative observations lead to the second law of motion expressed by Newton as follow:

The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts. Thus, if under the action of a force F for time interval Δt, the velocity of a body of mass m changes from u to v.

Change of momentum = final momentum – initial momentum

$$\Delta\vec{p} = m\vec{v} - m\vec{u}$$

According to the Second Law

$$\vec{F} \propto \frac{\Delta\vec{p}}{\Delta t} = k\,\frac{\Delta\vec{p}}{\Delta t}$$

$$\vec{F} = k\,\frac{(m\vec{v} - m\vec{u})}{\Delta t}$$

$$\vec{F} = m.\vec{a}$$

Where k is a constant of proportionality.

The unit of force is **kg-m/s²** or Newton, which has the symbol N.

(i) A cricket player lowers his hands to catch the ball safely. Explain why?

(ii) Deduce the Newton's first law of motion from Newton's second law of motion. 1

(iii) A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m/s. How long does the body take to stop? 1

OR 2

A constant force acting on a body of mass 3 kg changes its speed from 2 m/s to 3.5 m/s in 25 s. The direction of the force remains unchanged. What is the magnitude of the force?

35. The rotational analogue of force in linear motion is moment of force. It is also referred to as torque or couple. If a force acts on a single particle at a point, whose position with respect to the origin is given by the position vector **r**, the moment of the force acting on the particle with respect to the origin is defined as the vector product of $\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$. The moment of force (or torque) is a vector quantity. The magnitude of of torque is $\tau = r F \sin(\theta)$. Where $r \sin(\theta)$ is the perpendicular distance of the line of action of force **F** from the origin and $F \sin(\theta)$ is the component of **F** in the direction perpendicular to **r**.

Note that $\tau = 0$ if $\mathbf{r} = 0$, $\mathbf{F}=0$ or $\theta = 0^0$ or 180^0. Thus the moment of a force vanishes if either the magnitude of the force is zero or if the line of action of the force passes through the origin.

(i) Torque and work are both defined as force times distance. Explain, how do they differ. 1

(ii) While turning the page of a book. We usually apply force perpendicular to the plane of the page at farthest end. Explain. 1

(iii) The width of a door is 40 cm. If it is released by exerting a force of 2 N at its edge (away from the hinges). Compute the torque produced which causes the door to open. 2

OR

A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5g are put one on top of the other at 12.0 cm mark, the stick is found to be balanced at 45.0 cm. Find the mass of the metre stick.

******END OF THE QUESTION PAPER******

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SECTION A

1. A particle moves in a circular path with decreasing speed. Choose the correct statement. 1
   (i) The magnitude of angular momentum remains constant.
   (ii) The acceleration is along the tangent.
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2. Two circular discs have masses in the ratio of 1:2 and diameter in the ratio 2:1. The ratio of their moment of inertia is: 1
   (i) 1 (ii) 2 (iii) 4 (iv) 8

3. 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? Assume that there is no slipping. 1
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4. The work performed on an object does not depend upon: 1

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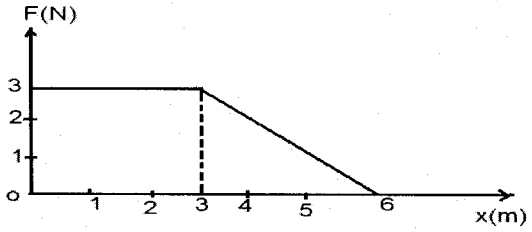
5. A force F acting on an object varies with distance 'x' as shown in the figure. 1



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8. Which one of the following does not have the same dimensions? 1

(i) Tension and surface tension (ii) Impulse and momentum

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9. Force on the body falling downward with an acceleration 'a' is: 1

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10. A motorist travels from A to B at a speed of 40km/h and return back at the speed of 60km/h. His average speed will be: 1

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(i) R = 16H (ii) R = 8H (iii) R = 4H (iv) R = 2H

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(i) unchanged (ii) halved (iii) doubled (iv) becomes four times

13. When a circular road is banked ———— provides the necessary centripetal force. 1

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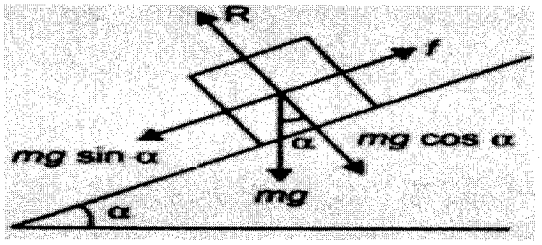
14. A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is μ. Let the mass of the box be 'm', 'f 'the force of friction and 'N' the normal reaction. What is the force needed to be applied upwards along the plane to make the box just move up with uniform speed? 1



(i) mg (sinα + μcosα) (ii) mg (μcosα - sinα)

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(i) Move in opposite direction (ii)Move in opposite directions with equal speeds

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16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

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Assertion: If no external force acts on a system of particles, then the centre of mass will not move in any direction.

Reason: If net external force is zero, then the linear momentum of the system remains constant.

SECTION B

19. Write any four limitations of the method of dimensional analysis. 2

20. Convert one Newton into dyne using dimensional analysis. 2

OR

Assuming that the mass M of the largest stone that can be moved by a flowing river depends upon the velocity v, the density of water ρ and the acceleration due to gravity g. Show that M varies with the sixth power of the velocity of flow.

21. Draw the following graphs for an object projected upward with a velocity v_0, which comes back to the same point after some time: 2

(i) acceleration versus time graph.

(ii) velocity versus time graph.

22. (a) State triangle law of vector addition. 2

(b) Define: (i) Equal vectors (ii) Unit vector

23. (a) Why passengers are thrown forward from their seats when a speeding bus stops suddenly? 2

(b) Proper inflation of tyres of vehicles save fuel. Why?

24. Write any two difference between elastic collision and inelastic collision. 2

25. (a) A person is sitting in the compartment of a train moving with uniform velocity on smooth track. How will the velocity of centre of mass of compartment change if person begins to run in compartment? 2

(b) Define moment of inertia of a rigid body.

OR

(a) Explain why the speed of whirl wind in a tornado is alarmingly high?

(b) Does the centre of mass of a solid necessarily lie within body? If not, give an example.

SECTION C

26. From the velocity-time graph of a uniformly accelerated motion, derive the following equation of motion 3

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

27. Derive an expression for acceleration of a body moving in a circular path of radius 'r' with uniform speed 'v'. What will be the direction of the centripetal acceleration at any instant? 3

OR

(a) Derive a relation between linear velocity and angular velocity in a uniform circular motion.

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28. State and prove work energy theorem. 3

29. Define torque and angular momentum. Obtain a relation between torque and angular momentum. 3

30. Define centre of mass of a system. Obtain an expression for the centre of mass of a system of two particles. 3

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SECTION D

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(b) A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15 min. If the tank is 40 m above the ground, the efficiency of the pump is 30 %, how much electric power is consumed by the pump? (density of water = $1000kg/m^3$)

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SECTION E

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(iii) The width of a door is 40 cm. If it is released by exerting a force of 2 N at its edge (away from the hinges). Compute the torque produced which causes the door to open. 2

OR

A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5g are put one on top of the other at 12.0 cm mark, the stick is found to be balanced at 45.0 cm. Find the mass of the metre stick.

35. The first law refers to the simple case when the net external force on a body is zero. The second law of motion refers to the general situation when there is net external force acting on the body. It relates the net external force to the acceleration of the body.

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The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts. Thus, if under the action of a force F for time interval Δt, the velocity of a body of mass m changes from u to v.

Change of momentum = final momentum – initial momentum

$$\Delta\vec{p} = m\vec{v} - m\vec{u}$$

According to the Second Law

$$\vec{F} \propto \frac{\Delta\vec{p}}{\Delta t} = k\,\frac{\Delta\vec{p}}{\Delta t}$$

$$\vec{F} = k\,\frac{(m\vec{v} - m\vec{u})}{\Delta t}$$

$$\vec{F} = m.\vec{a}$$

Where k is a constant of proportionality.

The unit of force is **kg-m/s^2** or Newton, which has the symbol N.

(i) A cricket player lowers his hands to catch the ball safely. Explain why?

(ii) Deduce the Newton's first law of motion from Newton's second law of motion.

(iii) A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m/s. How long does the body take to stop? 1

OR

A constant force acting on a body of mass 3 kg changes its speed from 2 m/s to 3.5 m/s in 25 s. The direction of the force remains unchanged. What is the magnitude of the force? 2

******END OF THE QUESTION PAPER******

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INDIAN SCHOOL MUSCAT
HALF YEARLY EXAMINATION 2022
PHYSICS (042)

CLASS: XI
DATE: 26-11-2022

TIME ALLOTED: 3 HRS.
MAXIMUM MARKS: 70

GENERAL INSTRUCTIONS:

1. All questions are compulsory. There are 35 questions in all.

2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

3. Section A contains eighteen questions of one mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks, Section D contains three questions of five marks each and Section E contains two case study questions of four marks each.

4. There is no overall choice. However, an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.

5. You may use the following value of physical constant wherever necessary. $g = 10 m/s^2$

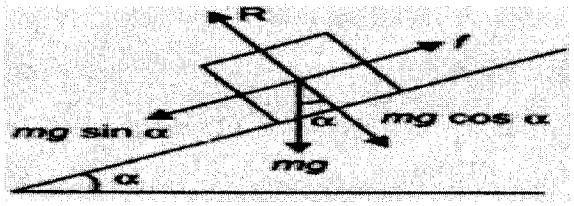
SECTION A

1. A body at rest breaks into two pieces of equal masses. The parts will: 1

(i) Move in opposite direction (ii)Move in opposite directions with equal speeds

(iii) Move in opposite directions with unequal speeds (iv)Remain at rest

2. A rectangular box lies on a rough inclined surface. The co-efficient of friction between the surface and the box is μ. Let the mass of the box be 'm', 'f 'the force of friction and 'N' the normal reaction. What is the force needed to be applied upwards along the plane to make the box just move up with uniform speed? 1



(i) $mg(\sin\alpha + \mu\cos\alpha)$ (ii) $mg(\mu\cos\alpha - \sin\alpha)$

(iii) $\mu mg\cos\alpha$ (iv) $\mu mg\sin\alpha$

3. If the radius of revolution of a particle moving along a circular path in doubled and its angular speed is halved then the centripetal acceleration is: 1

(i) unchanged (ii) halved (iii) doubled (iv) becomes four times

4. When a circular road is banked ———— provides the necessary centripetal force. 1

(i) Friction between the vehicle and road (ii) Horizontal component of normal reaction

(iii) Weight of the vehicle (iv) Normal reaction which acts at an angle Θ with vertical

5. The mass and volume of a body are 4.237 g and 2.5 cm^3, respectively. The density of the material of the body in correct significant figures is: 1

(i) 1.6048 g cm^{-3} (ii) 1.69 g cm^{-3} (iii) 1.7 g cm^{-3} (iv) 1.695 g cm^{-3}

6. Which one of the following does not have the same dimensions? 1

(i) Tension and surface tension (ii) Impulse and momentum

(iii) Work and torque (iv) velocity and speed

7. Force on the body falling downward with an acceleration 'a' is: 1

(i) Mg (ii)) M(g+ a) (iii) M(g-a) (iv) Ma

8. Two bodies of masses m and 4m are moving with equal kinetic energies. The ratio of their linear momenta is: 1

(i) 1:4 (ii) 4:1 (iii) 1:2 (iv) 2:1

9. A particle moves in a circular path with decreasing speed. Choose the correct statement. 1

(i) The magnitude of angular momentum remains constant.

(ii) The acceleration is along the tangent.

(iii) Particle moves in a spiral path with decreasing radius.

(iv) The direction of angular momentum remains constant.

10. Two circular discs have masses in the ratio of 1:2 and diameter in the ratio 2:1. The ratio of their moment of inertia is: 1

(i) 1 (ii) 2 (iii) 4 (iv) 8

11. 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? Assume that there is no slipping. 1

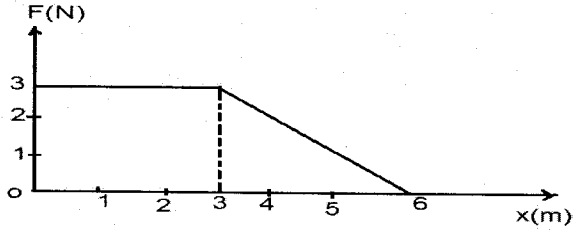
(i) 2.5m/s^2 (ii) 25m/s^2 (iii) 10m/s^2 (iv) 0.25m/s^2

12. The work performed on an object does not depend upon: 1

(i) Force applied (ii) Angle at which force is inclined to the displacement

(iii) Initial velocity of the object (iv) displacement

13. A force F acting on an object varies with distance 'x' as shown in the figure. 1



The force is in Newton and distance 'x' is in metre. The work done by the force in moving the object from x = 0m to x = 6m is:

(i) 18.0J (ii) 13.5J (iii) 9.0J (iv) 4.5J

14. A motorist travels from A to B at a speed of 40km/h and return back at the speed of 60km/h. 1

His average speed will be:

(i) 40km/h (ii) 48km/h (iii) 50km/h (iv) 60km/h

15. For an object thrown at 45^0 to horizontal, the maximum height (H) and horizontal range (R) are 1

related as:

(i) R = 16H (ii) R = 8H (iii) R = 4H (iv) R = 2H

16. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

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

b) Both A and R are true, and R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false and R is also false.

Assertion: Displacement of a body may be zero when distance travelled by it is not zero

Reason: The displacement is the longest distance between initial and final position. Motion in a straight line

17. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

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

b) Both A and R are true, and R is NOT the correct explanation of A.

c) A is true but R is false.

d) A is false and R is also false.

Assertion: When a body moves along a circular path, no work is done by the centripetal force.

Reason: At any instant, the motion of the body is along the tangent to the circle whereas the centripetal force is along the radius vector towards the centre of the circle.

18. **Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.** 1

a) Both A and R are true, and R is the correct explanation of A.
b) Both A and R are true, and R is NOT the correct explanation of A.
c) A is true but R is false.
d) A is false and R is also false.

Assertion: If no external force acts on a system of particles, then the centre of mass will not move in any direction.

Reason: If net external force is zero, then the linear momentum of the system remains constant.

SECTION B

19. (a) State triangle law of vector addition. 2

(b) Define: (i) Equal vectors (ii) Unit vector

20. (a) Why passengers are thrown forward from their seats when a speeding bus stops suddenly? 2

(b) Proper inflation of tyres of vehicles save fuel. Why?

21. Write any two difference between elastic collision and inelastic collision. 2

22. (a) A person is sitting in the compartment of a train moving with uniform velocity on smooth track. How will the velocity of centre of mass of compartment change if person begins to run in compartment? 2

(b) Define moment of inertia of a rigid body.

OR

(a) Explain why the speed of whirl wind in a tornado is alarmingly high?

(b) Does the centre of mass of a solid necessarily lie within body? If not, give an example.

23. Draw the following graphs for an object projected upward with a velocity v_0, which comes back to the same point after some time: 2

(i) Acceleration versus time graph.

(ii) Speed versus time graph.

24. Write any four advantages of SI system over other systems of unit. 2

25. Convert one Joule into erg using dimensional analysis. 2

OR

The period of oscillation of the simple pendulum depends on its length 'l' and acceleration due to gravity 'g'. Derive the expression for period of oscillation by method of dimensions.

SECTION C

26. From the velocity-time graph of a uniformly accelerated motion, derive the given equation of motion $v^2 - u^2 = 2as$. 3

27. Derive an expression for acceleration of a body moving in a circular path of radius 'r' with uniform speed 'v'. What will be the direction of the centripetal acceleration at any instant? 3

OR

(a) Derive a relation between linear velocity and angular velocity in a uniform circular motion.

(b) What is the angle between velocity vector and acceleration vector in a uniform circular motion?

28. State and prove work energy theorem. 3

29. Define torque and angular momentum. Obtain a relation between torque and angular momentum. 3

30. Define centre of mass of a system. Obtain an expression for the centre of mass of a system of two particles. 3

OR

(a) Derive an expression for rotational kinetic energy of a rigid body rotating with an angular velocity ω.

(b) A planet moves around the sun under the effect of gravitational force exerted by the sun. What is the torque on the planet due to the gravitational force?

SECTION D

31. (a) Which is easier, pushing or pulling a lawn mower? Explain with the help of free body diagrams. 5

(b) A body of mass 10 kg is sliding down a rough inclined plane which makes an angle of 30^0 with the horizontal. If the coefficient of friction is 0.25, find the acceleration of the body? ($g = 10\ m/s^2$)

OR

(a) Obtain an expression for the maximum safe velocity of a car moving in a banked circular road. Coefficient of static friction between the car and the road is μ_s.

(b) Two bodies of masses 4 kg and 3 kg respectively are connected by a light string passing over a smooth frictionless pulley. Calculate the acceleration of the masses and tension in the string.

32. (a) Prove that in an elastic collision in one dimension, the relative velocity of approach before impact is equal to the relative velocity of separation after impact. 5

(b) A pump on the ground floor of a building can pump up water to fill a tank of volume $30m^3$ in 15 min. If the tank is 40 m above the ground, the efficiency of the pump is 30 %, how much electric power is consumed by the pump?
(Take g = $10m/s^2$, density of water = $1000kg/m^3$)

OR

(a) Derive an expression for the potential energy stored in a system of a block attached to a massless spring on horizontal surface, when the block is pulled from its mean position.

(b) A mass of 2 kg attached to a spring is vibrated horizontally by displacing the mass 40 cm from its equilibrium position and releasing it. Find the maximum velocity of the mass. Spring constant is 24.5 N/m

33. (a) A projectile is fired with a certain velocity 'u' making an angle Θ with the horizontal. Show that the trajectory of the projectile is a parabola. 5

(b) Prove that there are two angles of projection for a projectile for which the horizontal range is the same.

OR

(a) A projectile is fired at an angle θ with the horizontal. Derive an expression for
(i) maximum height (ii) time of flight and (iii) horizontal range.

(b) A body is projected such that its kinetic energy at the top is $3/4^{th}$ of its initial kinetic energy. What is the angle of projection of the projectile with the horizontal?

SECTION E

34. The first law refers to the simple case when the net external force on a body is zero. The second law of motion refers to the general situation when there is net external force acting on the body. It relates the net external force to the acceleration of the body.

These qualitative observations lead to the second law of motion expressed by Newton as follow:

The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts. Thus, if under the action of a force F for time interval Δt, the velocity of a body of mass m changes from u to v.

Change of momentum = final momentum – initial momentum

$$\Delta\vec{p} = m\vec{v} - m\vec{u}$$

According to the Second Law

$$\vec{F} \propto \frac{\Delta\vec{p}}{\Delta t} = k\frac{\Delta\vec{p}}{\Delta t}$$

$$\vec{F} = k\frac{(m\vec{v} - m\vec{u})}{\Delta t}$$

$$\vec{F} = m.\vec{a}$$

Where k is a constant of proportionality.

The unit of force is **kg-m/s^2** or Newton, which has the symbol N. 1

(i) A cricket player lowers his hands to catch the ball safely. Explain why?

(ii) Deduce the Newton's first law of motion from Newton's second law of motion. 1

(iii) A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m/s. How long does the body take to stop? 2

OR

A constant force acting on a body of mass 3 kg changes its speed from 2 m/s to 3.5 m/s in 25 s. The direction of the force remains unchanged. What is the magnitude of the force?

35. The rotational analogue of force in linear motion is moment of force. It is also referred to as torque or couple. If a force acts on a single particle at a point, whose position with respect to the origin is given by the position vector **r**, the moment of the force acting on the particle with respect to the origin is defined as the vector product of **τ= r x F**. The moment of force (or torque) is a vector quantity. The magnitude of of torque is $\tau = r F \sin(\theta)$. Where $r \sin(\theta)$ is the perpendicular distance of the line of action of force **F** from the origin and $F \sin(\theta)$ is the component of **F** in the direction perpendicular to **r**.

Note that $\tau = 0$ if **r** = 0, **F**=0 or $\theta = 0^0$ or 180^0. Thus the moment of a force vanishes if either the magnitude of the force is zero or if the line of action of the force passes through the origin.

(i) Torque and work are both defined as force times distance. Explain, how do they differ. 1

(ii) While turning the page of a book. We usually apply force perpendicular to the plane of the page at farthest end. Explain. 1

(iii) The width of a door is 40 cm. If it is released by exerting a force of 2 N at its edge (away from the hinges). Compute the torque produced which causes the door to open. 2

OR

A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5g are put one on top of the other at 12.0 cm mark, the stick is found to be balanced at 45.0 cm. Find the mass of the metre stick.

******END OF THE QUESTION PAPER******