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DAV PUBLIC SCHOOLS, ODISHA ZONE
HALF YEARLY EXAMINATION, 2023-24

- Please check that this question paper contains 06 printed pages.
- Check that this question paper contains 33 questions.
- Write down the Serial Number of the question in the left side of the margin before attempting it.
- 15 minutes time has been allotted to read this question paper. The question paper will be distributed 15 minutes prior to the commencement of the examination. The students will read the question paper only and will not write any answer on the answer script during this period.

CLASS-XI
SUBJECT: PHYSICS (042)

Time: 3 Hours **Maximum Marks: 70**

General Instructions:

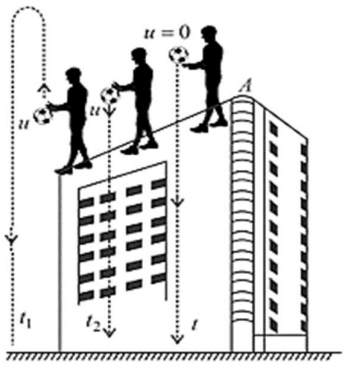
- There are 33 questions in all. All questions are compulsory.
- This question paper has five sections: Section A, Section B, Section C, Section D & Section E
- Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four mark each and Section E contains three long answer questions of five marks each.
- There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.

SECTION-A

1. The respective number of significant figures for the numbers 23.023, 0.0003 & 2.1×10^{-3} are
(a) 4, 4, 2 (b) 5, 1, 2 (c) 5, 1, 5 (d) 5, 5, 2

2. A body sliding down a smooth inclined plane slides down 1/4th distance in 2s. It will slide down the complete plane in
(a) 4s (b) 5s (c) 2s (d) 3s

3. A particle thrown upward from the top of a tower takes time t_1 to reach the ground. It takes time t_2 if thrown from the same point with the same speed in the downward direction. Then the time (let t) it will take to fall freely to the ground from the top of the tower is
(a) $\frac{1}{2}(t_1 + t_2)$ (b) $\sqrt{(t_1 + t_2)}$ (c) $\sqrt{t_1 t_2}$ (d) $\frac{t_1}{t_2}$



4. The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is
(a) 60^0 (b) 15^0 (c) 30^0 (d) 45^0

5. Two vectors $\vec{A}$ and $\vec{B}$ inclined at an angle θ have a resultant $\vec{R}$ which makes an angle α with $\vec{A}$. If the direction of $\vec{A}$ and $\vec{B}$ are interchanged, the resultant will have the same

(a) direction (b) magnitude
(c) direction as well as magnitude (d) none of these

6. A particle has an initial velocity of $(3\hat{\imath} + 4\hat{\jmath})m/sec$ and an acceleration of $(0.4\hat{\imath} + 0.3\hat{\jmath})m/sec^2$. Its speed after 10 seconds is

(a) 10 m/sec (b) 7 m/sec (c) $7\sqrt{2}$ m/sec (d) 8.5 m/sec

7. A batsman hits back a ball of mass 0.15 kg straight in the direction of the bowler without changing its initial speed of 12 ms^{-1}. If the ball moves linearly, then the magnitude of impulse imparted to the ball is

(a) 1.8 N s (b) 2.8 N s (c) 3.6 N s (d) 4.2 N s

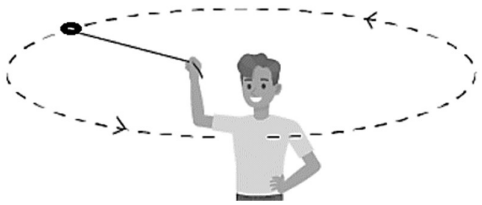
8. Rolling friction is

(a) less than sliding friction (b) more than sliding friction
(c) equal to sliding friction (d) none of these

9. The elastic potential energy of a stretched spring is given by $E = 50x^2$ where x is the displacement in meter and E is in joule, then force constant of the spring is-

(a) 50N/m (b) 100N/m (c) $100N/m^2$ (d) 100Nm

10. A stone tied to the end of a string is whirled round in a circle in a horizontal plane. If the speed of the stone is increased beyond the maximum permissible value, and the string breaks suddenly, which of the following correctly describes the trajectory of the stone after the string breaks.



(a) The stone moves radially outwards.
(b) The stone flies off tangentially from the instant the string breaks.
(c) The stone flies off at an angle with the tangent whose magnitude depends on the speed of the particle.
(d) None of these

11. Which of the following has the highest moment of inertia when each of them has the same mass and the same radius?

(a) A ring about any of its diameter.
(b) A disc about any of its diameter.
(c) A hollow sphere about any of its diameter.
(d) A solid sphere about any of its diameter.

12. A body is rotating with angular velocity $\vec{\omega} = (3\hat{\imath} - 4\hat{\jmath} + \hat{k})rad/sec$. The linear velocity of a point having position vector $\vec{r} = (5\hat{\imath} - 6\hat{\jmath} + 6\hat{k})m$ is

(a) $(6\,\hat{\imath} + 2\hat{\jmath} - 3\hat{k})$ m/sec (b) $(18\,\hat{\imath} + 3\hat{\jmath} - 2\hat{k})$ m/sec
(c) $(-18\,\hat{\imath} - 13\hat{\jmath} + 2\hat{k})$ m/sec (d) $(6\,\hat{\imath} - 2\hat{\jmath} + 8\hat{k})$ m/sec

13. 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.

(a) Both A & R are true and R is the correct explanation of A.
(b) Both A & R are true but 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 (A): Two balls of different masses are thrown vertically upward with the same speed. They will pass through their point of projection in the downward direction with the same speed.

Reason (R): The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball.

14. 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.

(a) Both A & R are true and R is the correct explanation of A.
(b) Both A & R are true but 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 (A): At highest point of a projectile, dot product of velocity and acceleration is zero.
Reason (R): At highest point, velocity and acceleration are mutually perpendicular.

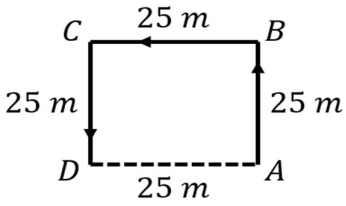
15. Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
(a) Both A & R are true and R is the correct explanation of A.
(b) Both A & R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.
Assertion (A): When a bullet is fired from a rifle, later recoils back.
Reason (R): Inertia is the property of a body by virtue of which it continues its state of rest of uniform motion unless it is acted by a net external force.

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.
(a) Both A & R are true and R is the correct explanation of A.
(b) Both A & R are true but 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 (A): Work done by centripetal force when a body is moving along a circle is always zero.
Reason (R): This is because displacement of the body is along the force.

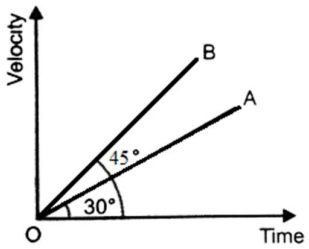
SECTION-B

17. Find the dimensions of ab in the equation $E = \frac{a-t^2}{bx}$; where E is energy, x is distance & t is time.

18. A particle moves along the sides *AB, BC & CD* of a square ABCD of side 25 *m* with a velocity of $15ms^{-1}$. Calculate its average velocity and average speed.

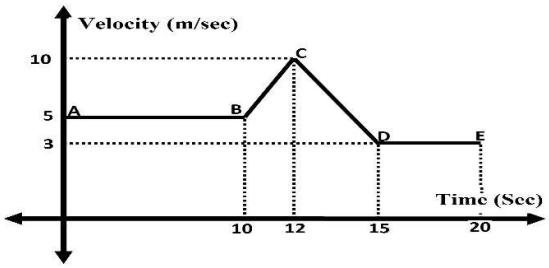


19. The velocity-time graphs for two particles A and B are straight lines inclined at angles of 30^0 and 45^0 with the time axis. Find the ratio of their accelerations $a_A : a_B$.



OR

The velocity-time graph of an object is shown in the figure. Find the distance covered by the object in 12 seconds.



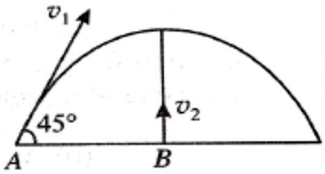
20. A projectile is projected at an angle with the horizontal. Show that it follows a parabolic path.

21. A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Find the magnitude and direction of the acceleration of the body

SECTION-C

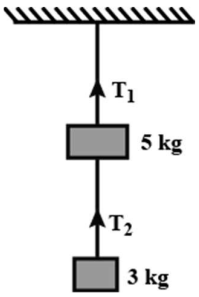
22. A body is allowed to slide down from the top of a smooth inclined plane of inclination 'θ'. Another identical body is allowed to fall vertically from the top point of the same plane. Find the ratio of the times taken by them to reach the ground.

23. A body is projected with speed v_1 at an angle of 45^0 with the horizontal from a point A. At the same instant another body is projected vertically upwards from a point B with speed v_2. The point B is vertically below the highest point of the path of the first body. For what value of $\frac{v_1}{v_2}$, the two bodies will collide?



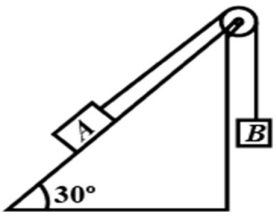
24. State parallelogram law of vector addition. Derive the expression for magnitude of the resultant vector.

25. Two masses of mass 5kg & 3kg are suspended with the help of massless inextensible strings as shown. Calculate T_1 & T_2 when the whole system is going upwards with acceleration = 2m/s^2 (use g = 10m/s^2)



OR

Block A of weight 100N rests on a frictionless inclined plane of slope angle 30^0. A flexible cord attached to A passes over a frictionless pulley & is connected to block B of weight W. Find the weight W for which the system is in equilibrium.



26. State and prove work energy theorem for a variable force.

27. (i) What do you mean by a conservative force?

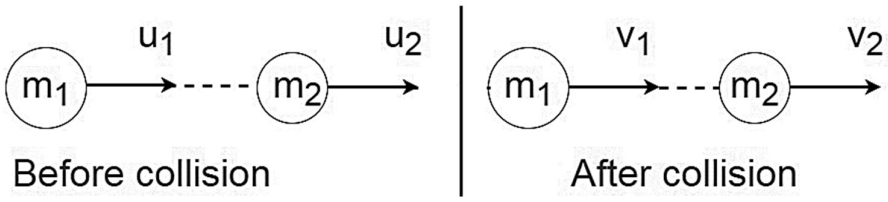
(ii) To simulate car accidents, auto manufacturers study the collisions of moving cars with mounted springs of different spring constants. Consider a typical simulation with a car of mass 1000kg moving with a speed 18.0kmh^{-1}on a smooth road and colliding with a horizontally mounted spring of spring constant 6.25 x 10^3 Nm^{-1}. What is the maximum compression of the spring?

28. To increase the speed of a fly wheel from 60 rpm to 360 rpm the energy of 484 J is spent. Find the moment of inertia of the wheel.

SECTION-D

29. **Case Study Question: Read the following paragraph and answers the questions**.

Newton's Second law relates force with the rate of change of momentum. According to the law, force is directly proportional to the rate of change in momentum. We will use this to state the law of conservation of momentum. According to this, if the net force acting on the system is zero, then the system's momentum remains conserved. In other words, the change in momentum of the system is zero.



Let's take the following example: Let two objects of mass m_1 & m_2 collide with each other. We consider m_1 and m_2 as our system. So during the collision, the net force on the system is zero and hence we can conserve the system's momentum. The equation for momentum will be:

Initial momentum $= m_1u_1 + m_2u_2$

Final momentum $= m_1v_1 + m_2v_2$

So, according to the conservation of momentum, $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

But one thing to take care is that conservation is only true for a system and not one body because if we consider only a single body m_1 or m_2, then the net force will be acting on it. So $m_1u_1 \neq m_1v_1$ or $m_2u_2 \neq m_2v_2$.

(i) A gun fires a bullet of mass 50g with a velocity of 30m/s. Because of this, the gun recoils with a velocity of 1m/s. The mass of the gun is

(a) 5.5kg (b) 3.5kg (c) 1.5kg (d) 0.5kg

(ii) A body of mass M moving with velocity v explodes into two equal parts. If one part comes to rest & the other part moves with a velocity v, what would be the value of v?

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

(iii) There are n bullets fired in 1s by a gun. The mass of each of the bullets is m. If the speed of each bullet is v, the average force of the recoil is

(a) $\frac{mv}{n}$ (b) $\frac{mv}{ng}$ (c) $\frac{m^2v^2}{n^2}$ (d) nmv

OR

A spacecraft moving in space of mass M with velocity v in free space explodes & breaks into two pieces. After the explosion, a mass m of the spacecraft is left stationary. The velocity of the other part is

(a) $\frac{mv}{M-m}$ (b) $\frac{m+M}{Mv}$ (c) $\frac{Mv}{M-m}$ (d) $\frac{Mv}{m}$

(iv) Two billiard balls of mass 0.05kg each moving in opposite directions with 10m/s collide & rebound with the same speed. If the time duration of contact is t = 0.005s, then what is the force exerted on each ball due to the other?

(a) 100N (b) 200N (c) 300N (d) 400N

30. Case Study Question: Read the following paragraph and answers the questions.

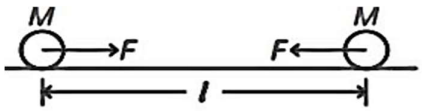
The centre of mass of a body or a system of bodies is the point which moves as though all of the mass were concentrated there and all external forces were applied to it. Hence, a point at which the entire mass of the body or system of bodies is supposed to be concentrated is known as the centre of mass.

If a system consists of more than one particle (or bodies) and net external force on the system in a particular direction is zero, then the centre of mass will not move along that direction even though some particles of the system may move.

(i) Two bodies of masses 1 kg and 2 kg are lying in xy-plane at (-1, 2) and (2, 4), respectively. What are the coordinates of the centre of mass?

(a) (1, 10/3) (b) (1, 0) (c) (0, 1) (d) None of these

(ii) Two balls of same masses start moving towards each other due to gravitational attraction, if the initial distance between them is *l*. Then, they meet at



(a) *l* /2 (b) *l* (c) *l* /3 (d) *l* /4

(iii) The centre of mass of a system of two particles divides the distance between them

(a) in inverse ratio of square of masses of particles

(b) in direct ratio of square of masses of particles

(c) in inverse ratio of masses of particles

(d) in direct ratio of masses of particles

(iv) Two particles A and B initially at rest move towards each other under a mutual force of attraction. At the instant, when the speed of A is v and the speed of B is 2v, the speed of centre of mass of the system is

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

OR

All the particles of a body are situated at a distance R from the origin. The distance of centre of mass of the body from the origin is

(a) = R (b) ≤ R (c) > R (d) ≥ R

SECTION-E

31. Use $\vec{A} = \hat{\imath} - 2\hat{\jmath} + \hat{k}, \vec{B} = 2\hat{\imath} - \hat{k}$ & $\vec{C} = \hat{\imath} - x\hat{\jmath}$ as reference vectors to answer the following. You may use the data obtained in one question to solve the subsequent questions.

(i) Find the value of *x* if the sum of $\vec{A}$ & $\vec{B}$ is perpendicular to $\vec{C}$.

(ii) Prove that dot product is distributive over addition using the above vectors.

(iii) Find a vector which is parallel to $\vec{B}$ & has a magnitude same as of $\vec{A}$.

(iv) Find a vector which is perpendicular to both $\vec{A}$ & $\vec{B}$.

OR

(i) Derive an expression for the magnitude of centripetal acceleration of a body moving with uniform speed v along a circular path of radius r.

(ii) An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and complete seven revolutions in 100 sec. What will be the angular speed and linear speed of the motion?

32. (i) Obtain an expression for the maximum speed with which a car can safely negotiate a curved road banked at angle θ. Take the co-efficient of friction between the wheels and road as μ.

(ii) Using the above expression, explain at least 3 ways you can adopt to negotiate a level curved road safely with higher velocity while moving on a motor bike.

OR

(i) How does the force of limiting friction vary with (a) Surface area of contact and (b) Normal reaction?

(ii) A block of mass m is placed on a rough inclined plane which makes an angle θ with the horizontal. A force F is exerted on the block upwards along the surface of the inclined plane which causes the block to accelerate in the direction of F. Draw a diagram showing all the relevant forces acting on the block. Taking μ as the relevant coefficient of friction, obtain an expression for the acceleration of the block.

33. A body of mass 'm' is attached to a string of length 'r'. You are trying to revolve it in a vertical circular motion. But the speed provided at the lowest point of the motion is not sufficient to complete the revolution. In such situation, derive the expression for

(i) Height (h_1) at which the body has a non-zero velocity, but the tension in the string is zero.

(ii) Height (h_2) at which the tension in the string is non-zero, but the velocity of the body is zero.

(iii) What will happen to the motion of the body if $h_1 > h_2$

OR

(i) Find the loss in kinetic energy in a one dimensional perfectly in-elastic collision.

(ii) A ball is dropped from a height h on to a floor & rebounds to a height of h/4. Calculate the coefficient of restitution between the ball & the floor.