OSDAV Public School, Kaithal
Half yearly Exams (2024-25)
Class : XI
Subject : Physics

SET -A

Time: 3 Hrs . **M.M. : 70**

General Instructions:-

(1) *There are 33 questions in all. All questions are compulsory.*

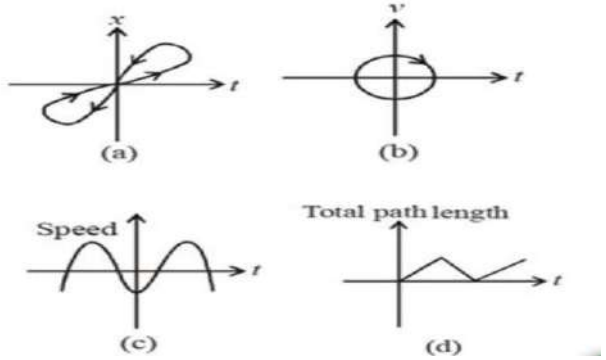
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) All the sections are compulsory.

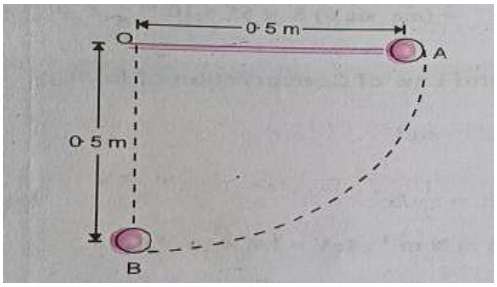
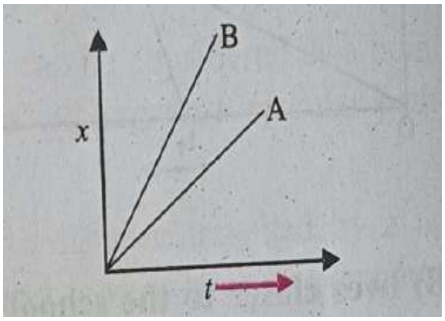
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.

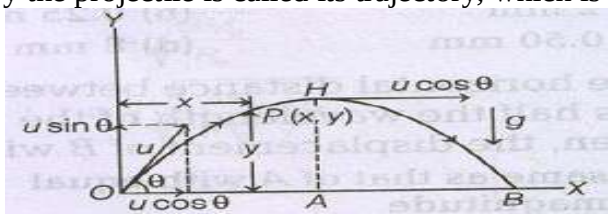
(5) There is no overall choice.

(6) Use of calculators is not allowed.

Q. N.	Questions	Marks
	SECTION - A	
1	If momentum (P), Area(A) and time (T) are taken to be fundamental quantities, then energy has dimensional formula a) $[P^1A^{-1}T^1]$ b) $[P^2A^1T^1]$ c) $[P^1A^{-½}T^1]$ d) $[P^1A^{½}T^{-1}]$	1
2	A student plots the graphs related to motion of four objects as given in figures. Which figure/ figures cannot possible represent one dimensional motion?  (a) Figure a only (b) Figure b only (c) Figure d only (d) Figures (a), (b) and (c)	1
3	A satellite is moving around the earth in circular orbit. In such case , what is conserved? (a) Velocity (b) Linear momentum (c) Angular momentum (d) None of these	1
4	If $\vec{A}=2\hat{\imath}-3\hat{\jmath}+\hat{k}$ and $\vec{B}=3\hat{\imath}+4\hat{\jmath}+n\hat{k}$ are perpendicular to each other, then the value of n is a) 2 b) 4 c) 6 d) 7	1
5	Two bodies of different masses of 2 Kg and 4 Kg moving with velocities 2 m/s and 10 m/s towards each other due to mutual gravitational attraction. The velocity of their centre of mass is a) 5 m/s b) 8 m/s c) 10 m/s d) zero	1
6	In the standard equation $S_{nth}=u + a/2(2n-1)$, what dimensions do you view for S_{nth}? a) $M^0L^1T^{-1}$ b) $M^0L^{-1}T^1$ c) $M^0L^0T^1$ d) $M^0L^1T^1$	1
7	If the linear momentum is increased by 50% then K.E. will be increased by: a) 50%. b) 100%. c) 125%. d) 25%	1

8	A particle moves in a straight line with a uniform acceleration a. Initial velocity of the particle is zero. The average velocity of the particle in first s distance will be a) $\sqrt{as/2}$ b) $\sqrt{as/3}$ c) $\sqrt{as/4}$ d) $\sqrt{as}$	1
9	Which of the following equations does not represent the position of an object moving in a plane with a non-zero constant acceleration? (a) $r_1 = 1.0\,t\,\hat{i} + 3\,t^2\,\hat{j}$ (b) $r_2 = (5.0+3.0t)\hat{i} + 5\,t^2\,\hat{j}$ (c) $r_3 = 5\,t\,\hat{j}$ (d) $r_4 = 3.0\,t^2\,\hat{i} - 4\,t^3\,\hat{j}$	1
10	A man of mass m squatting on the ground gets straight up and stand. The force of reaction of ground on the man during the process is a) constant and equal to mg in magnitude b) Constant and greater than mg in magnitude c) variable but always greater than mg d) At first greater than mg and later becomes equal to mg	1
11	A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal, the minimum tension required to completely straighten the rope is a) Mg /2 b) Mg cos Θ c) 2 Mg cos Θ d) infinite	1
12	A ball of 1 kg is projected under gravity from origin in x-y plane with a velocity v= (30î+40ĵ) m/s. The power delivered to the ball by the gravitational force at t=7s is (g= 10m/s^2) (a) +400W (b) -400W (c) -300W (d) +300W	1
	Q13 to 16 are Assertion Reason Questions. 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 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.*	
13	Assertion- Uniform circular motion is accelerated motion. Reason - In uniform circular motion speed is not constant.	1
14	Assertion (A):A cyclist is always seen bending inwards while negotiating a curve during a race. Reason (R): By bending , he lowers his centre of gravity.	1
15	Assertion - Work done by the force of friction in a closed path is zero. Reason - The force of friction is a conservative force.	1
16	Assertion- In the absence of external force no change in velocity of centre of mass occur Reason- When all internal forces cancel each other only effect of external force is there.	1
	SECTION -B	
17	If 500g be the unit of mass, 50s the unit of time and acceleration due to gravity 980 cm/s² be the unit of acceleration, find what will be the new unit of energy.	2
18	A bus moving on a straight road with a speed of 126 km/h is brought to rest after 200 m. Calculate (i) acceleration of the bus (ii) time taken by bus to come to rest.	2
19	If $\lvert\vec{A} + \vec{B}\rvert = \lvert\vec{A} - \vec{B}\rvert$ find the angle between $\vec{A}$ and $\vec{B}$.	2
20	A force of 10 N gives a mass m_1 an acceleration of 10 m/s² and mass m_2, an acceleration of 20 m/s².What acceleration would it give if both the masses are tied together.	2

21	The Bob of a simple pendulum is held in the horizontal position as shown in figure. calculate the speed of the Bob of the pendulum at the lowest position B, when released. The length of the pendulum is 0.5 meter, and it is assumed that there is no loss of energy. 	2
	SECTION - C	
22	Prove that magnitude of ratio of difference in speeds after collision, to the difference in speeds before collision, for one – dimensional elastic collision is equal to one.	3
23	An insect trapped in a circular groove of radius 10cm moves along the groove of radius 10cm moves along the groove steadily and completes 7 revolutions in 44s. (a) What is the angular speed of insect's motion? (b) Is the acceleration vector a constant vector? (c) Calculate the magnitude of acceleration	3
24	Find the magnitude and direction of the resultant of two vectors acting simultaneously on a particle, the angle between two vectors being Θ.	3
25	a)Can a body have zero velocity, but still have acceleration? Give example. b)The displacement time graph of two objects A and B are shown in figure. Which of the two objects moves faster than other. 	3
26	A man is standing on the top of a building 100m high. He throws two balls vertically upwards, one at t=0 with velocity 2u and other at t=Ts (less than 2 seconds) with a velocity u. At t=2s, the vertical gap between first and second ball is found to be 15m. The gap is found to remain constant. Calculate the value of u and T. (given $g=10m/s^2$)	3
27	a)What does the area under the force-time graph represents? b)A bird is sitting on the floor of a wire cage and cage is in the hand of a boy. The bird starts flying in the cage. Will the boy experience any change in the weight of the cage? Why or why not?	3
28	A bullet of mass 0.012 kg moving with horizontal speed of 70 m/s strikes a block of wood of mass 0.4 kg and comes to rest. The block is suspended from the ceiling by means of a thin wire. Calculate the height to which the block rises. Also calculate the amount of heat produced in the block.	3
	SECTION - D	

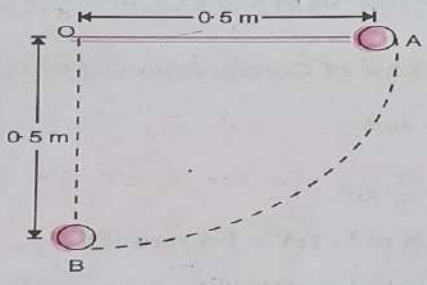
29	Projectile motion Projectile motion is a form of motion in which an object or particle is thrown with some initial velocity near the earth's surface and it moves along a curved path under the action of gravity alone. The path followed by the projectile is called its trajectory, which is shown below.  (i) The example of such type of motion is (a) Motion of car on banked road (b) Motion of boat in sea (c) Motion of ball thrown vertically upward (d) A javelin thrown by an athlete (ii) The acceleration of an object in horizontal direction is (a) Constant (b) decreasing (c) increasing (d) zero (iii) The vertical component of the velocity at point H is (a) Maximum (b) zero (c) double to that at o (d) equal to horizontal component (iv) A cricket ball is thrown at the speed of 28m/s in direction 30° with the horizontal. The time taken by the ball to return to the same level will be (a) 2.0 s (b) 3.0 s (c) 4.0 s (d) 2.9 s	4
30	The moment of a force also referred as Torque ,is rotational analogue of force in motion.The quantity angular momentum is the rotational analogue of linear momentum. Like the moment of force, angular momentum is also a vector product . It could moment of momentum. From this term one could guess how angular momentum is defined (i) A force $F= F_0\hat{j}$ is acting on a particle moving in x-y plane. The torque acting on the particle when it is at $r= x_0\hat{i} +y_0\hat{j}$ will be (a) $x_0f_0\,\hat{k}$ (b) $-x_0f_0\,\hat{k}$ (c) $x_0f_0\,\hat{j}$ (d) $-x_0f_0\,\hat{j}$ (ii)A particle performs uniform circular motion with angular momentum L. If the angular frequency ω of the particle is doubled and kinetic energy K is halved, its angular momentum becomes (a) 4L (b) 2L (c) L/2 (d) L/4 (iii) If rotational kinetic energies of two bodies having moments of inertia of $9kg/m^2$ and $1kg/m^2$ are the same then ratio of their angular momentum is (a) 9:1 (b) 1:9 (c) 1:3 (d) 3:1 (iv)A mass m moving with a constant velocity along a line parallel to x axis, away from the origin. Its angular momentum with respect to the origin Is zero b) remains constant c) goes on increasing d) goes on decreasing	4
	SECTION - E	
31	Define banking of roads and what is the need of banking a road. Obtain an expression for the maximum velocity of a vehicle on the banked circular rough road taking friction into account.	5
32	Show that the velocity of body is minimum at highest point and maximum at lowest point in the vertical circle. Derive expressions for tension in the string at lowest and highest points of circle. Also calculate the minimum speed of body at lowest and highest point for looping the loop.	5
33	a)Derive an expression for the position of centre of mass of a two particle system. b)A bus of mass 10,000 Kg is standing on a horizontal road. The distance between the front and the rear axles is 1.5 m. The centre of gravity of bus is at 1m behind the front axle. Find the force exerted by ground on each front wheel and rear wheel.	5

Answer Key
Physics XI [Set -A]

1	D	1
2	D	1
3	C	1
4	C	1
5	D	1
6	A	1
7	C	1
8	A	1
9	D	1
10	D	1
11	D	1
12	C	1
13	C	1
14	B	1
15	D	1
16	A	1

17	Mass [M] = 500 g Time, [T] = 50 s Acceleration, $[a] = [LT^{-2}] = 980\ cm\ s^{-2}$ or $\frac{L}{T^2} = 980\ cm\ s^{-2}$ $\therefore L = 980 \times T^2\ cm\ s^{-2}$ $= 980 \times (50\ s)^2\ cm\ s^{-2}$ $= 980 \times 2500\ cm$ Now, unit of energy, $E = ML^2T^{-2} = \frac{ML^2}{T^2}$ $= \frac{500\,g\ (980 \times 2500\,cm)^2}{(50\,s)^2}$ $= 1{\cdot}2 \times 10^{12}\ g\ cm^2\ s^{-2}$ $= \mathbf{1{\cdot}2 \times 10^{12}\ erg}$	1 1
18	Here, $u = 126\ km\ h^{-1} = 126 \times \frac{5}{18}\ m\ s^{-1}$ $= 35\ m\ s^{-1}$ $v = 0$ ($\because$ finally bus is at rest) $S = 200$ m. **STEP 1. To find 'a':** Using $v^2 - u^2 = 2aS$, we have $a = \frac{v^2 - u^2}{2S} = \frac{0 - (35)^2}{2 \times 200} = -3{\cdot}06\ m\ s^{-2}$ **STEP 2. To find 't':** Using $v = u + at$, we have $t = \frac{v - u}{a} = \frac{0 - 35}{-3{\cdot}06} = 11{\cdot}4\ s$	1 1
19	or $\lvert\vec{A} + \vec{B}\rvert^2 = \lvert\vec{A} - \vec{B}\rvert^2$ Since $\vec{A} \cdot \vec{A} = \lvert\vec{A}\rvert^2$ $\therefore (\vec{A} + \vec{B}) \cdot (\vec{A} + \vec{B}) = (\vec{A} - \vec{B}) \cdot (\vec{A} - \vec{B})$ or $\vec{A} \cdot \vec{A} + \vec{A} \cdot \vec{B} + \vec{B} \cdot \vec{A} + \vec{B} \cdot \vec{B} = \vec{A} \cdot \vec{A} - \vec{A} \cdot \vec{B} - \vec{B} \cdot \vec{A} + \vec{B} \cdot \vec{B}$ Since $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$ $\therefore 2\vec{A} \cdot \vec{B} = -2\vec{A} \cdot \vec{B}$ or $4\vec{A} \cdot \vec{B} = 0$ Since $4 \neq 0$, therefore, $\vec{A} \cdot \vec{B} = 0$ Since $\vec{A} \cdot \vec{B} = 0$, therefore, $\vec{A}$ and $\vec{B}$ are perpendicular to each other. That is, angle between $\vec{A}$ and $\vec{B}$ is **90°**.	0.5 0.5 0.

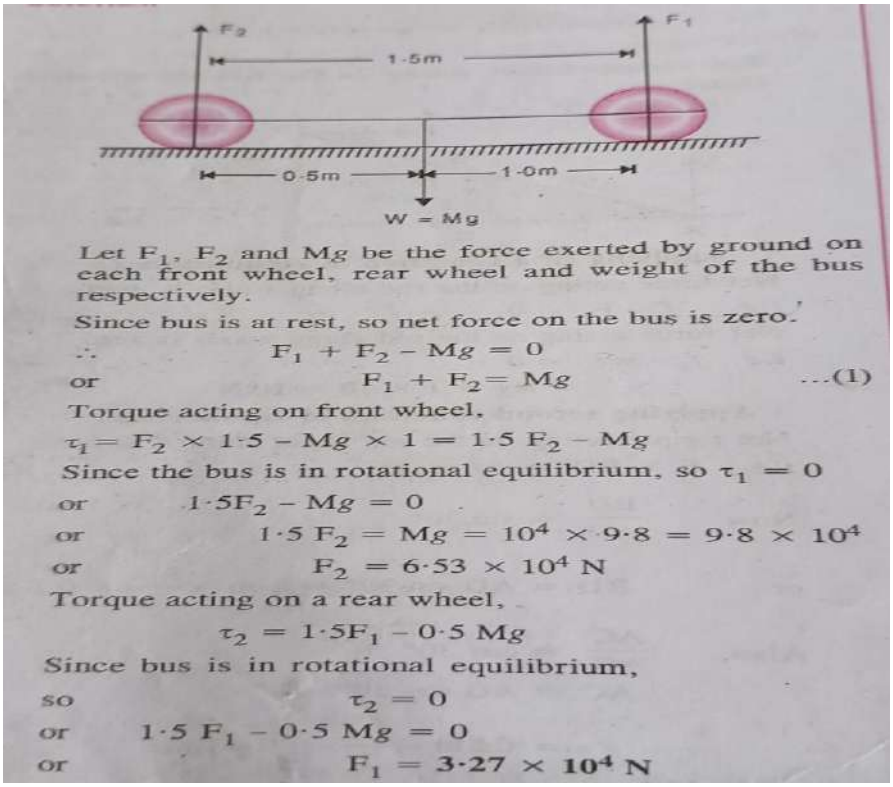
		5 0.5
20	We know, $m = \frac{F}{a}$ $\therefore \quad m_1 = \frac{F}{a_1} = \frac{10}{10} = 1 \text{ kg}$ and $\quad m_2 = \frac{F}{a_2} = \frac{10}{20} = 0{\cdot}5 \text{ kg}$ Thus, $m_1 + m_2 = 1 + 0{\cdot}5 = 1{\cdot}5 \text{ kg}$ If a be the acceleration of both the masses tied together then, $a = \frac{F}{m_1 + m_2} = \frac{10}{1{\cdot}5} = \mathbf{6{\cdot}66\ ms^{-2}}$	0.5 0.5 0.5 0.5

21	At point A, the energy of the pendulum is entirely P.E. At point B, the energy of the pendulum is entirely K.E. It means as the bob of the pendulum lowers from A to B position, P.E. is converted into K.E. Thus, at B, K.E. = P.E.  or $\frac{1}{2} m v^2 = mgh$ or $v^2 = 2gh = 2 \times 9{\cdot}8 \times 0{\cdot}5$ $= 9{\cdot}8$ $\therefore \quad v = \sqrt{9{\cdot}8} = 3{\cdot}13 \text{ m s}^{-1}$	1 1
22	Derivation only	3
23	a) $\omega = \frac{2\pi}{T}$ $= 2 \times \frac{22}{7} \times \frac{7}{44}$ $= 1 \text{ rad/s}$ b) Since, direction of velocity changes continuously acceleration is not a constant vector. c) $a = \omega^2 R$ $= (1)^2 \times (10 \text{ cm})$ $= 10 \text{ cm s}^{-2}$	3
24	Derivation only	3
25	a) Yes, a body can have zero velocity still having acceleration for example when a	1

	body is thrown vertically upwards then at the highest point it will be having zero velocity but acceleration due to gravity will be acting on it. b) B moves faster than A	+1 1
26	Let the speed of ball 1 = u_1 = 2u m/s Then the speed of ball 2 = u_2 = um/s Let the height covered by ball 1 before coming to rest = h_1 Let the height covered by ball 2 before coming to rest = h_2 At the top their velocities becomes zero $u^2 = 2gh \Rightarrow h = \frac{u^2}{2g} \Rightarrow h_1 = \frac{u_1^2}{2g}$ $h_1 = \frac{4u^2}{2g}$ and $h_2 = \frac{u^2}{2g}$ A.T.Q $h_1 - h_2 = 15$ m (given) $\frac{4u^2}{2g} - \frac{u^2}{2g} = 15$ $\frac{u^2}{2g}[4-1] = 15$ $\Rightarrow u^2 = \frac{15 \times 2 \times 10}{3}$ $\Rightarrow u^2 = 100$ u = 10 m/s ∴ For ball 1, $v_1 = u_1 + gt$ $0 = 20 - 10\, t_1$ $t_1 = 2s$ For ball 2, $v_2 = u2 + gt_2$ $0 = 10 - 10\, t_2$ $t_2 = 1s$ ∴ Velocities of ball 1 and 2 are 20 m/s and 10m/s respectively. Time interval between two balls $= t_1 - t_2$ = (2-1) = 1 second	1 1 0.5 0.5

27	a) Impulse or Momentum change b) Since the cage is made of wire, the air inside the cage is not bound with the cage, rather it is in contact with the atmospheric air . Therefore the boy will not experience the weight of the bird when it flies in the cage.Thus, the cage will appear lighter when bird starts flying in the cage.	1 2
28	$mu + M u_1 = m v + MV$ $0{\cdot}012 \times 70 + 0{\cdot}4 \times 0 = 0{\cdot}012 \times 0 + 0{\cdot}4\ V$ $\therefore \quad V = \frac{0{\cdot}012 \times 70}{0{\cdot}4} = 2{\cdot}1\ ms^{-1}$ **STEP 2.** Now, K.E. of block $= \frac{1}{2} MV^2$ $= \frac{1}{2} \times 0{\cdot}4 \times (2{\cdot}1)^2 = 0{\cdot}882\ J$ Let, height through which block rises after collision $= h$ $\therefore$ P.E. of block at height $h = Mgh$ $= 0{\cdot}4 \times 9{\cdot}8\ h\ J$ Now according to the law of conservation of energy, K.E. = P.E. *i.e.* $0{\cdot}882 = 0{\cdot}4 \times 9{\cdot}8 \times h$ $\therefore \quad h = \frac{0{\cdot}882}{0{\cdot}4 \times 9{\cdot}8} = 0{\cdot}225\ m$ **STEP 3.** Now, heat produced in the block = K.E. of bullet − K. E of block $= \frac{1}{2} m u^2 - \frac{1}{2} M V^2$ $= \frac{1}{2} \times 0{\cdot}012 \times (70)^2 - \frac{1}{2} \times 0{\cdot}4 \times (2{\cdot}1)^2$ $= 29{\cdot}4 - 0{\cdot}882 = 28{\cdot}52\ J$	1 1 1
29	i) d ii) d iii) b iv) d	1 1 1 1
30	i) a ii) d iii) b iv) d	1 1 1 1
31	Banking of roads means to raise the outer edge of the road a little above the inner edge.Banking of road is done as some times frictional force alone is not capable to provide the required centripetal force to keep the body in circular motion.So banking adds one more component of normal reaction to enhance the centripetal force. Derivation	1 + 1 3
32	Derivation	5
33	a) Derivation	3 0

b)



Let F_1, F_2 and Mg be the force exerted by ground on each front wheel, rear wheel and weight of the bus respectively.

Since bus is at rest, so net force on the bus is zero.

$\therefore \quad F_1 + F_2 - Mg = 0$

or $\quad F_1 + F_2 = Mg \quad \ldots(1)$

Torque acting on front wheel,

$\tau_1 = F_2 \times 1{\cdot}5 - Mg \times 1 = 1{\cdot}5\, F_2 - Mg$

Since the bus is in rotational equilibrium, so $\tau_1 = 0$

or $\quad 1{\cdot}5F_2 - Mg = 0$

or $\quad 1{\cdot}5\, F_2 = Mg = 10^4 \times 9{\cdot}8 = 9{\cdot}8 \times 10^4$

or $\quad F_2 = 6{\cdot}53 \times 10^4\ \text{N}$

Torque acting on a rear wheel,

$\tau_2 = 1{\cdot}5F_1 - 0{\cdot}5\, Mg$

Since bus is in rotational equilibrium,

so $\quad \tau_2 = 0$

or $\quad 1{\cdot}5\, F_1 - 0{\cdot}5\, Mg = 0$

or $\quad F_1 = \mathbf{3{\cdot}27 \times 10^4\ N}$

.5

0.5

0.5

0.5

OSDAV Public School, Kaithal
Half yearly Exams (2024-25)
Class : XI
Subject : Physics

SET -B

Time: 3 Hrs . **M.M. : 70**

General Instructions:-

(1) *There are 33 questions in all. All questions are compulsory.*

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

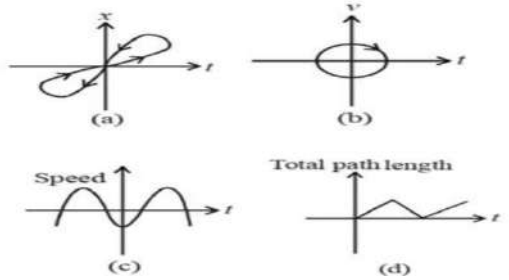
(3) All the sections are compulsory.

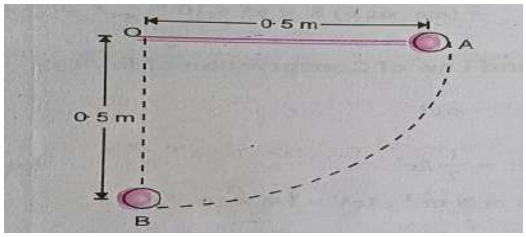
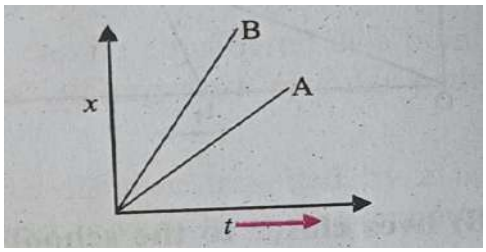
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.

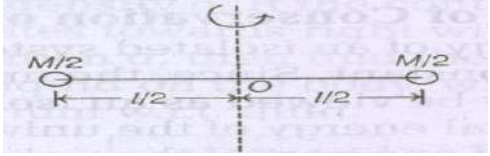
(5) There is no overall choice.

(6) Use of calculators is not allowed.

Q.N.	Questions	Marks
	SECTION - A	
1	The no. of significant figures in 0.00530 is a) 5 b) 4 c) 3 d) 2	1
2	The displacement of a particle is given by $x = (t-3)^2$ where x is in metres and t in seconds. The distance covered by the particle in first 4 seconds is a) 4 m b) 8 m c) 10 m d) 12 m	1
3	A man throws ball into the air one after the other. Throwing one when other is at the highest point. How high the balls rise if he throws twice a second? a) 2.45 m b) 1.225 m c) 19.6 m d) 4.9 m	1
4	The horizontal range of a projectile fired at an angle of 15° is 50 m. If it is fired with the same speed at an angle of 45°, its range will be a) 60 m b) 71 m c) 100 m d) 141 m	1
5	A constant force is acting perpendicular to the velocity of a particle. For this situation which one is correct? a) Velocity is constant b) Acceleration is constant c) Momentum will be constant d) particle will follow elliptical path	1
6	A particle moves in a straight line with a uniform acceleration a. Initial velocity of the particle is zero. The average velocity of the particle in first s distance will be $\sqrt{as/2}$ b) $\sqrt{as/3}$ c) $\sqrt{as/4}$ d) $\sqrt{as}$	1
7	In the standard equation $S_{nth}=u + a/2(2n-1)$, what dimensions do you view for S_{nth}? a) $M^0L^1T^{-1}$ b) $M^0L^{-1}T^1$ c) $M^0L^0T^1$ d) $M^0L^1T^1$	1
8	car Starts from rest, moves with an acceleration 'a' and then decelerates at a constant rate 'b' for sometimes to come to rest. If the total time taken is 't'. The maximum velocity of car is given by abt/(a+b) b) a^2t / (a+b) c)at/(a+b) d) ab^2t/(a+b)	1

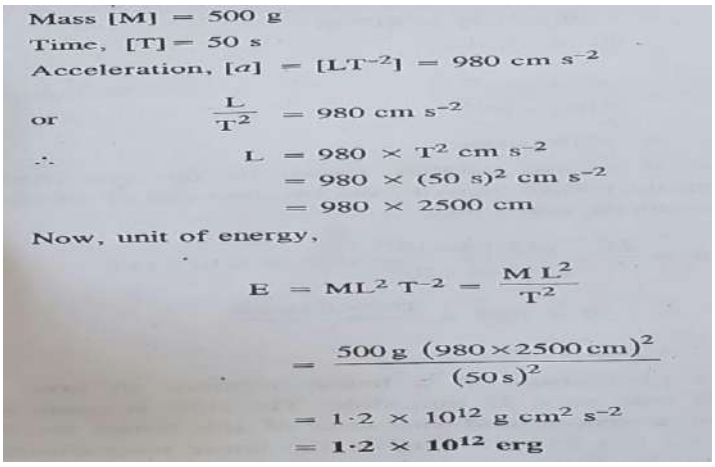
9	If momentum (P), Area(A) and time (T) are taken to be fundamental quantities, then energy has dimensional formula a) $[P^1A^{-1}T^1]$ b) $[P^2A^1T^1]$ c) $[P^1A^{-½}T^1]$ d) $[P^1A^{½}T^{-1}]$	1
10	A student plots the graphs related to motion of four objects as given in figures. Which figure/ figures cannot possible represent one dimensional motion?  (a) Figure a only (b) Figure b only (c) Figure d only (d) Figures (a), (b) and (c)	1
11	Which of the following equations does not represent the position of an object moving in a plane with a non-zero constant acceleration? (a) $r_1 = 1.0\,t\,\hat{i} + 3\,t^2\,\hat{j}$ (b) $r_2 = (5.0+3.0t)\hat{i} + 5\,t^2\,\hat{j}$ (c) $r_3 = 5\,t\,\hat{j}$ (d) $r_4 = 3.0\,t^2\,\hat{i} - 4\,t^3\,\hat{j}$	1
12	A ball of 1 kg is projected under gravity from origin in x-y plane with a velocity $v = (30\hat{i}+40\hat{j})$ m/s. The power delivered to the ball by the gravitational force at t=7s is ($g = 10 m/s^2$) (a) +400W (b) -400W (c) -300W (d) +300W	1
	Q13 to 16 are Assertion Reason Questions. 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 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.*	
13	Assertion - For the uniform motion, the slope of position-time graph will be constant. Reason - The slope of position-time graph represent velocity of the object and for uniform motion it is constant.	1
14	Assertion - A body under the influence of concurrent forces in equilibrium either remain at rest or moves with the constant velocity. Reason - Concurrent forces are said to be in equilibrium when the magnitude of the resultant force is zero.	1
15	Assertion- Uniform circular motion is accelerated motion. Reason - In uniform circular motion speed is not constant.	1
16	Assertion: The centre of mass can be inside or outside the rigid body at which whole mass is assumed to be concentrated. Reason : Centre of mass of the body depends on the distribution of mass.	1
	SECTION -B	
17	If 500g be the unit of mass, 50s the unit of time and acceleration due to gravity 980 cm/s^2 be the unit of acceleration, find what will be the new unit of energy.	2
18	A bus moving on a straight road with a speed of 126 km/h is brought to rest after 200 m. Calculate (i) acceleration of the bus (ii) time taken by bus to come to rest.	2

19	If $\|\vec{A} + \vec{B}\| = \|\vec{A} - \vec{B}\|$ find the angle between $\vec{A}$ and $\vec{B}$.	2
20	A force of 10 N gives a mass m_1 an acceleration of 10 m/s^2 and mass m_2, an acceleration of 20 m/s^2.What acceleration would it give if both the masses are tied together.	2
21	The Bob of a simple pendulum is held in the horizontal position as shown in figure. calculate the speed of the Bob of the pendulum at the lowest position B, when released. The length of the pendulum is 0.5 meter, and it is assumed that there is no loss of energy. 	2
	SECTION - C	
22	Obtain an expression for the maximum velocity of a vehicle on the banked circular rough road taking friction into account.	3
23	An insect trapped in a circular groove of radius 10cm moves along the groove of radius 10cm moves along the groove steadily and completes 7 revolutions in 44s. (a) What is the angular speed of insect's motion? (b) Is the acceleration vector a constant vector? (c) Calculate the magnitude of acceleration	3
24	Find the magnitude and direction of the resultant of two vectors acting simultaneously on a particle, the angle between two vectors being Θ.	3
25	a)Can a body have zero velocity, but still have acceleration? Give example. b)The displacement time graph of two objects A and B are shown in figure. Which of the two objects moves faster than other. 	3
26	A man is standing on the top of a building 100m high. He throws two balls vertically upwards, one at t=0 with velocity 2u and other at t=Ts (less than 2 seconds) with a velocity u. At t=2s, the vertical gap between first and second ball is found to be 15m. The gap is found to remain constant. Calculate the value of u and T. (given g=10m/s^2)	3
27	a)What does the area under the force-time graph represents? b)A bird is sitting on the floor of a wire cage and cage is in the hand of a boy. The bird starts flying in the cage. Will the boy experience any change in the weight of the cage? Why or why not?	3
28	A bullet of mass 0.012 kg moving with horizontal speed of 70 m/s strikes a block of wood of mass 0.4 kg and comes to rest. The block is suspended from the ceiling by means of a thin wire. Calculate the height to which the block rises. Also calculate the amount of heat produced in the block.	3

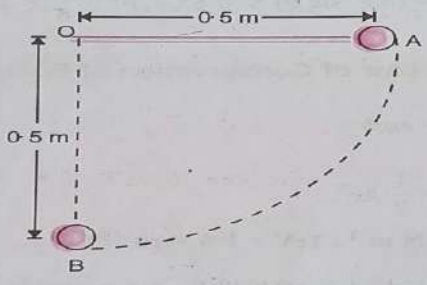
	SECTION - D	
29	Work is said to be done when a force applied on a body displaces. The body travels a certain distance in the direction of applied force. It is measured by the product of force and distance moved in the direction of force, it is represented as $W=FS\cos\theta$ .Let us perform an activity to find the work done by moving a block for 12 m where force applied is 7 N and the angle between displacement and force is 60°. i) What will be the value of work done when displacement is 12 m, force applied is 7 N and the angle between displacement and force is 60° a) 42 J b) 24 J c) 39 J d) 93 J ii) What should be the angle between force and displacement to obtain maximum work done? a) 90° b) 0° c) 60° d) 45° iii) What will be the expression of work done when force applied on block is F and displacement is S and the angle between them is 180° a) W = 2F.S b). W= F.S c) W= - F.S d) W= F.S /2 iv) What is the dimensional formula of work done? a) $[M^2L^2T^2]$ b) $[M^1L^1T^1]$ c) $[M^1L^2T^{-2}]$ d) $[M^0L^2T^{-2}]$	4
30	<u>MOMENT OF INERTIA</u> A heavy wheel called flywheel is attached to the shaft of steam engine, automobile engine etc., because of its large moment of inertia , the flywheel opposes the sudden increase or decrease of the speed of the vehicle. It allows a gradual change in the speed and prevents jerky motion and hence ensure smooth ride of passangers. (i) Analogue of mass in rotational motion is (a) moment of inertia (b) angular momentum (c) gyration (d)none of above (ii) Moment of inertia of body depends upon (a) axis of rotation (b) torque (c) angular momentum (d)angular velocity (iii) If a girl rotating on chair bends her hands as shown in figure, the  (a) moment of inertia of girl will reduce (b) moment of inertia of girl will increase (c) angular velocity of girl will reduce (d) none of these (iv) Two masses are joined with a light rod and the system is rotating about the fixed axis as shown in figure. The moment of inertia of the system about the axis is  $ML^2/2$ (b) $ML^2/4$ (c) ML^2 (d) $ML^2/6$	4

	SECTION - E	
31	Show that a projectile fired at an angle θ with the horizontal follows a parabolic path. Also calculate the time of flight, maximum height and horizontal range for this projectile.	5
32	a)What do you understand by radius of gyration. Derive its expression. b)A bus of mass 10,000 Kg is standing on a horizontal road. The distance between the front and the rear axles is 1.5 m. The centre of gravity of bus is at 1m behind the front axle. Find the force exerted by ground on each front wheel and rear wheel.	5
33	Show that the velocity of body is minimum at highest point and maximum at lowest point in the vertical circle. Derive expressions for tension in the string at lowest and highest points of circle. Also calculate the minimum speed of body at lowest and highest point for looping the loop.	5

Answer Key
Physics XI [Set -B]

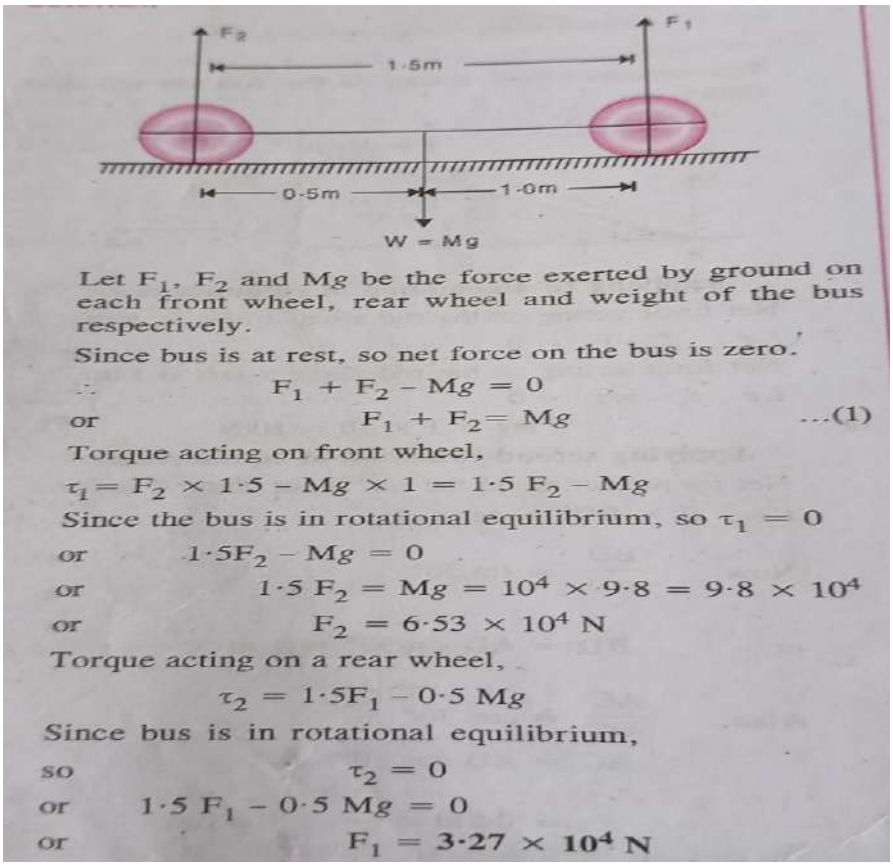
1	C	1
2	C	1
3	B	1
4	C	1
5	D	1
6	A	1
7	A	1
8	A	1
9	D	1
10	D	1
11	D	1
12	C	1
13	A	1
14	A	1
15	C	1
16	A	1
17		0.5 0.5 0.5 0.5

18	Here, $u = 126 \text{ km h}^{-1} = 126 \times \frac{5}{18} \text{ m s}^{-1}$ $= 35 \text{ m s}^{-1}$ $v = 0$ ($\because$ finally bus is at rest) $S = 200$ m. **STEP 1. To find 'a':** Using $v^2 - u^2 = 2aS$, we have $a = \frac{v^2 - u^2}{2S} = \frac{0 - (35)^2}{2 \times 200} = -3{\cdot}06 \text{ m s}^{-2}$ **STEP 2. To find 't':** Using $v = u + at$, we have $t = \frac{v - u}{a} = \frac{0 - 35}{-3{\cdot}06} = 11{\cdot}4$ s	0.5 0.5 0.5 0.5
19	or $\lvert\vec{A} + \vec{B}\rvert^2 = \lvert\vec{A} - \vec{B}\rvert^2$ Since $\vec{A} \cdot \vec{A} = \lvert\vec{A}\rvert^2$ $\therefore (\vec{A} + \vec{B}) \cdot (\vec{A} + \vec{B}) = (\vec{A} - \vec{B}) \cdot (\vec{A} - \vec{B})$ or $\vec{A} \cdot \vec{A} + \vec{A} \cdot \vec{B} + \vec{B} \cdot \vec{A} + \vec{B} \cdot \vec{B} = \vec{A} \cdot \vec{A} - \vec{A} \cdot \vec{B} - \vec{B} \cdot \vec{A} + \vec{B} \cdot \vec{B}$ Since $\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$ $\therefore 2\vec{A} \cdot \vec{B} = -2\vec{A} \cdot \vec{B}$ or $4\vec{A} \cdot \vec{B} = 0$ Since $4 \neq 0$, therefore, $\vec{A} \cdot \vec{B} = 0$ Since $\vec{A} \cdot \vec{B} = 0$, therefore, $\vec{A}$ and $\vec{B}$ are perpendicular to each other. That is, angle between $\vec{A}$ and $\vec{B}$ is **90°**.	0.5 0.5 0.5 0.5
20	We know, $m = \frac{F}{a}$ $\therefore m_1 = \frac{F}{a_1} = \frac{10}{10} = 1$ kg and $m_2 = \frac{F}{a_2} = \frac{10}{20} = 0{\cdot}5$ kg Thus, $m_1 + m_2 = 1 + 0{\cdot}5 = 1{\cdot}5$ kg If a be the acceleration of both the masses tied together then, $a = \frac{F}{m_1 + m_2} = \frac{10}{1{\cdot}5} = 6{\cdot}66 \text{ ms}^{-2}$	0.5 0.5 0.5 0.5

21	At point A, the energy of the pendulum is entirely P.E. At point B, the energy of the pendulum is entirely K.E. It means as the bob of the pendulum lowers from A to B position, P.E. is converted into K.E. Thus, at B, K.E. = P.E.  or $\frac{1}{2} m v^2 = mgh$ or $v^2 = 2gh = 2 \times 9{\cdot}8 \times 0{\cdot}5$ $= 9{\cdot}8$ $\therefore \quad v = \sqrt{9{\cdot}8} = 3{\cdot}13 \text{ m s}^{-1}$	0.5 0.5 0.5 0.5
22	Derivation only	3
23	a) $\omega = \frac{2\pi}{T}$ $= 2 \times \frac{22}{7} \times \frac{7}{44}$ $= 1 \text{ rad/s}$ b) Since, direction of velocity changes continuously acceleration is not a constant vector. c) $a = \omega^2 R$ $= (1)^2 \times (10 \text{ cm})$ $= 10 \text{ cm s}^{-2}$	1 1 1
24	Derivation only	3
25	a) Yes, a body can have zero velocity still having acceleration for example when a body is thrown vertically upwards then at the highest point it will be having zero velocity but acceleration due to gravity will be acting on it.	1.5

	b) B moves faster than A	1.5
26	Let the speed of ball 1 = $u_1 = 2u$ m/s Then the speed of ball 2 = $u_2 = u$m/s Let the height covered by ball 1 before coming to rest = h_1 Let the height covered by ball 2 before coming to rest = h_2 At the top their velocities becomes zero $u^2 = 2gh \Rightarrow h = \frac{u^2}{2g} \Rightarrow h_1 = \frac{u_1^2}{2g}$ $h_1 = \frac{4u^2}{2g}$ and $h_2 = \frac{u^2}{2g}$ A.T.Q $h_1 - h_2 = 15$ m (given) $\frac{4u^2}{2g} - \frac{u^2}{2g} = 15$ $\frac{u^2}{2g}[4-1] = 15$ $\Rightarrow u^2 = \frac{15 \times 2 \times 10}{3}$ $\Rightarrow u^2 = 100$ $u = 10$ m/s ∴ For ball 1, $v_1 = u_1 + gt$ $0 = 20 - 10\, t_1$ $t_1 = 2$s For ball 2, $v_2 = u2 + gt_2$ $0 = 10\text{-}10\, t_2$ $t_2 = 1$s ∴ Velocities of ball 1 and 2 are 20 m/s and 10m/s respectively. Time interval between two balls $= t_1 - t_2$ $= (2\text{-}1)$ = 1 second	1 1 1
27	a) Impulse or Momentum change b) Since the cage is made of wire, the air inside the cage is not bound with the cage, rather it is in contact with the atmospheric air . Therefore the boy will not experience the weight of the bird when it flies in the cage.Thus, the cage will appear lighter when bird starts flying in the cage.	1 2

28	$mu + M u_1 = m v + MV$ $0{\cdot}012 \times 70 + 0{\cdot}4 \times 0 = 0{\cdot}012 \times 0 + 0{\cdot}4\ V$ $\therefore \quad V = \frac{0{\cdot}012 \times 70}{0{\cdot}4} = 2{\cdot}1\ ms^{-1}$ **STEP 2.** Now, K.E. of block $= \frac{1}{2} MV^2$ $= \frac{1}{2} \times 0{\cdot}4 \times (2{\cdot}1)^2 = 0{\cdot}882\ J$ Let, height through which block rises after collision $= h$ $\therefore$ P.E. of block at height $h = Mgh$ $= 0{\cdot}4 \times 9{\cdot}8\ h\ J$ Now according to the law of conservation of energy, K.E. = P.E. *i.e.* $0{\cdot}882 = 0{\cdot}4 \times 9{\cdot}8 \times h$ $\therefore \quad h = \frac{0{\cdot}882}{0{\cdot}4 \times 9{\cdot}8} = \mathbf{0{\cdot}225\ m}$ **STEP 3.** Now, heat produced in the block = K.E. of bullet − K. E of block $= \frac{1}{2} m u^2 - \frac{1}{2} M V^2$ $= \frac{1}{2} \times 0{\cdot}012 \times (70)^2 - \frac{1}{2} \times 0{\cdot}4 \times (2{\cdot}1)^2$ $= 29{\cdot}4 - 0{\cdot}882 = \mathbf{28{\cdot}52\ J}$	1 1 1
29	i) a ii) b iii) c iv) c	1 1 1 1
30	i) a ii) a iii) a iv) b	1 1 1 1
31	a) Derivation	5
32	Radius of gyration is the distance of centre of mass from the axis of rotation Derivation	3

	a)  Let F_1, F_2 and Mg be the force exerted by ground on each front wheel, rear wheel and weight of the bus respectively. Since bus is at rest, so net force on the bus is zero. $\therefore \quad F_1 + F_2 - Mg = 0$ or $\quad F_1 + F_2 = Mg \quad \ldots(1)$ Torque acting on front wheel, $\tau_1 = F_2 \times 1{\cdot}5 - Mg \times 1 = 1{\cdot}5\, F_2 - Mg$ Since the bus is in rotational equilibrium, so $\tau_1 = 0$ or $\quad 1{\cdot}5F_2 - Mg = 0$ or $\quad 1{\cdot}5\, F_2 = Mg = 10^4 \times 9{\cdot}8 = 9{\cdot}8 \times 10^4$ or $\quad F_2 = 6{\cdot}53 \times 10^4$ N Torque acting on a rear wheel, $\tau_2 = 1{\cdot}5F_1 - 0{\cdot}5\, Mg$ Since bus is in rotational equilibrium, so $\quad \tau_2 = 0$ or $\quad 1{\cdot}5\, F_1 - 0{\cdot}5\, Mg = 0$ or $\quad F_1 = \mathbf{3{\cdot}27 \times 10^4}$ **N**	P.5 0.5 0.5 0.5
33	Derivation	5