KENDRIYA VIDYALAYA SANGATHAN, LUCKNOW REGION

CUMMULATIVE EXAMINATION : 2023-24

CLASS – XI

SUBJECT – PHYSICS (THEORY) Set - 1

Time: 3 hour **Max.Marks: 70**

General Instructions:

(i) There are 33 questions in all. All questions are compulsory.

(ii) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(iii) 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 4 marks each and Section E contains three long answer questions of five marks each

(iv) There is no overall choice. However, an internal choice has been provided in one question of section B, one question of section C, one question in each CBQ of section D and in all three questions of section E. You have to attempt only one of the choices in such questions.

(v) Use of calculator is not allowed.

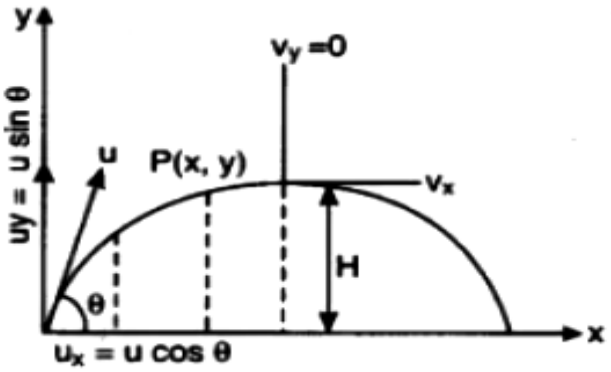
SECTION – A: OBJECTIVE TYPE QUESTIONS (16 Ques. × 01 Mark each = 16 Marks)		
1	A force is given by: $F = a\,t + b\,t^2$ (where t is time interval). What are the dimensions of a and b? (a) $[M\,L\,T^{-3}]$ and $[M\,L\,T^{-2}]$ (b) $[M\,L\,T^{-2}]$ and $[M\,L\,T^{0}]$ (c) $[M\,L\,T^{-4}]$ and $[M\,L\,T]$ (d) $[M\,L\,T^{-3}]$ and $[M\,L\,T^{-4}]$	**1**
2	The SI unit of universal gravitational constant is - (a) Kg m s^{-1} (c) N m^{-1} s (b) N m^2 kg^{-2} (d) Kg m s	**1**
3	A particle(A) is dropped from a tower of height of 50m and another	**1**

	particle(B) is thrown in horizontal direction with speed of 5 m/s from the same height. The correct statement is(neglect air resistance) (a) both particles will reach at ground simultaneously (b) both particles will reach at ground with same speed (c) particle (A) will reach at ground first with respect to particle(B) (d) particle (B) will reach at ground first with respect to particle(A)	
4	The area under velocity –time graph is equal to ….. (a) Acceleration (b) Force (c) Displacement (d) Linear Momentum	**1**
5	A cyclist is moving with a velocity v turns a circular path of radius r. His inclination with the vertical is given by (a) $\tan\theta = v^2/rg$ (b) $\tan\theta = v^2g/r$ (c) $\tan\theta = v^2rg$ (d) none of the above	**1**
6	One end of a string of length l is connected to a particle of mass m and the other end to a small peg on a smooth horizontal table. If the particle moves in a circle with speed v the net force on the particle(directed towards the centre is: (a) T (b) $T - (mv^2/l)$ (c) $T + (mv^2/l)$ (d) 0 (T is the tension in the string)	**1**
7	A body is initially at rest. It undergoes one dimensional motion with constant acceleration. The power delivered to it at time t is proportional to : (a) $t^{1/2}$ (b) t (c) $t^{3/2}$ (d) t^2	**1**

8	A man is sitting on a rotating stool with his arms outstretched. Suddenly he folds his arms. The angular velocity (a) decreases (b) increases (c) becomes zero (d) remains constant	**1**
9	The moment of inertia of a circular disc having mass M and radius R, about an axis passing through its centre and perpendicular to its plane is (a) $\frac{1}{2}MR^2$ (b) MR^2 (c) $2MR^2$ (d) $\frac{5}{4}MR^2$	**1**
10	Angular momentum is equal to the product of (a) linear momentum and moment of Inertia (b) moment of inertia and angular velocity (c) linear momentum and angular velocity (d) linear velocity and radius vector	**1**
11	Two satellites of mass M_1 and M_2 are revolving around the earth in circular orbits of radii r_1 and r_2 respectively. The ratio of their orbital speeds v_1/v_2 = (a) r_1/r_2 (b) r_2/r_1 (c) $\sqrt{\frac{r_1}{r_2}}$ (d) $\sqrt{\frac{r_2}{r_1}}$	**1**
12	A satellite of mass m is orbiting around the earth at a height equal to the radius of the earth(R). Its potential energy is given by: (a) – 2mgR (b) - mgR (c) - mgR/2 (d) - mgR/4	**1**

13	**Assertion:** The magnitude of average velocity of the object over an interval of time is either smaller than or equal to the average speed of the object over the same interval. **Reason:** Velocity is a vector quantity and speed is a scalar quantity. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion. (b) If both assertion and reason are true but reason is not the correct explanation of the assertion. (c) If assertion is true but reason is false. (d) If the assertion and reason both are false.	**1**
14	**Assertion:** Comets move around the sun in elliptical orbits. The gravitational force on the comet due to sun is not normal to the comet's velocity but the work done by the gravitational force over every complete orbit of the comet is zero. **Reason:** Gravitational force is a non-conservative force. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion. (b) If both assertion and reason are true but reason is not the correct explanation of the assertion. (c) If assertion is true but reason is false. (d) If the assertion and reason both are false.	**1**
15	**Assertion:** The value of acceleration due to gravity does not depend upon mass of the body on which force is applied. **Reason:** Acceleration due to gravity is a constant quantity. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion. (b) If both assertion and reason are true but reason is not the correct explanation of the assertion. (c) If assertion is true but reason is false. (d) If the assertion and reason both are false.	**1**
16	**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. (a) If both assertion and reason are true and the reason is the correct explanation of the assertion.	**1**

	(b) If both assertion and reason are true but reason is not the correct explanation of the assertion. (c) If assertion is true but reason is false. (d) If the assertion and reason both are false.	
SECTION – B: SHORT ANSWER TYPE-I **(05 Ques. × 02 Marks each = 10 Marks)**		
17	The mass and volume of a body are 4.237 g and 2.5 cm^3 respectively. Find The density of the material of the body in correct significant figures. **OR** A new unit of length is chosen such that the speed of light in vacuum is unity. What is the distance between the sun and the earth in terms of the new unit if light takes 8 minute and 20 second to cover this distance?	**2**
18	Find the unit vector in the direction of $\vec{2i}+\vec{3j}+\vec{k}$.	**2**
19	Two billiard balls each of mass 0.05 kg moving towards each other with speed 6 m/s collide and rebound with the same speed. What is the impulse imparted to each ball due to other?	**2**
20	State and prove work energy theorem.	**2**
21	Obtain an expression for position vector of centre of mass of two particles system.	**2**
SECTION – C: SHORT ANSWER TYPE-II **(07 Ques. × 03 Marks each = 21 Marks)**		
22	Find the dimension of a, b & a/b in the relation F = $a\sqrt{x}$ + bt^2 where F is force, x is distance & t is time interval.	**3**
23	Two bodies are thrown with the same initial speed at angles α and (90-α) with the horizontal. Calculate the ratio of : i). Maximum heights attained by them and ii). Horizontal ranges? (neglect air resistance)	**3**
24	Derive kinematic equations (i) velocity – time relation and (ii) displacement – time relation, by using v-t graph for uniformly accelerated motion of a particle.	**3**
25	Explain why, (a) a horse cannot pull a cart and run in empty space,	**3**

	(b) a cricketer moves his hands backwards while holding a catch.	
26	Write the relation between torque and angular momentum. State and explain with an example the law of conservation of angular momentum.	**3**
27	Define radius of gyration of a body and state the factors on which it depends. Obtain an expression for the radius of gyration of a solid sphere about its diameter.	**3**
28	Consider earth as a solid sphere of uniform mass density and derive an expression for acceleration due to gravity at depth d from its surface. **OR** The radius of two planets is R and 2R and their uniform mass densities are ρ and ρ/2. What is the ratio of acceleration due to gravity at their surfaces? Draw the graph to show the variation of acceleration due to gravity with distance from the centre of the earth.	**3**
	SECTION – D: CASE STUDY BASED **(02 Ques. × 04 Marks each = 08 Marks)**	
29	**Case Study :** **Read the following paragraph and answer the questions.** 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 a projectile is called its trajectory, which is shown below. When a projectile is projected obliquely, then its trajectory is as shown in the figure below.  Here velocity u is resolved into two components, we get (a) u cosθ along X-direction and (b) u sinθ along Y- direction. **Answer the following Questions:** i) The example of such type of motion is (a) motion of car on a banked road	**4**

	(b) motion of boat in sea (c) a javelin thrown by an athlete (d) motion of ball dropped from a height. ii) The acceleration of the object in horizontal direction is (a) 9.8 m s^{-2} (b) decreasing (c) increasing (d) zero iii) The vertical component of velocity at the highest point of the path is (a) maximum (b) zero (c) double to that of initial velocity (d) equal to horizontal component iv) A cricket ball is thrown at a speed of 28 m/s in a 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 **OR** In above case, the distance from the thrower to the point where the ball returns to the same level will be (a)39m (b)69m (c)61m (d) 22m	
30	**Case Study :** **Read the following paragraph and answer the questions.** 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.	**4**

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 v to v + Δv i.e. its initial momentum

p = m v changes by Δp = m Δv. According to the Second Law

$$F \alpha \frac{\Delta P}{\Delta t} \quad \text{or} \quad F = k \frac{\Delta P}{\Delta t}$$

Where k is a constant of proportionality. Mathematically,

F = ma, the unit of force is kg-m/s^2 or Newton, which has the symbol N. Let us note at this stage some important points about the second law:

- In the second law, F = 0 implies a = 0. The second law is obviously consistent with the first law.
- The second law of motion is a vector law.
- The second law of motion given by is applicable to a single point particle as well as to the rigid body but internal forces is not considered in F.
- The second law of motion is a local relation which means that force F at a point in space (location of the particle) at a certain instant of time is related to a at that point at that instant.

Answer the following Questions:

i) SI unit of force is
   a) N
   b) newton
   c) Kg m s^{-2}
   d) All of the above

ii) According to second law of motion The rate of change of momentum of a body is directly proportional to
   a) Velocity of body b)Applied force
   c) Only mass of body d) None of the above.

iii) Define 1 newton force on the basis of second law of motion.

iv) State second law of motion.

OR

	State law of inertia (i.e. first law of motion).	
	SECTION – E: LONG ANSWER TYPE **(03 Ques. × 05 Marks each = 15 Marks)**	
31	Define the centripetal acceleration. Derive an expression for centripetal acceleration of a particle moving with uniform speed v along circular path of radius r explain how it acts along the radius towards the centre of circular path? **OR** What is meant by banking of roads? What is it necessary? Find the expression for the maximum speed of a vehicle of mass m on a banked road of banking angle θ, if coefficient of static friction of the wheels of vehicle with the road is μ?	**5**
32	Define elastic collision in one dimension. Obtain expressions for velocities of the two bodies after such a collision in terms of their masses and initial velocities. **OR** What do you mean by conservative force? Spring force is conservative or non-conservative in nature. Find the expression for total energy stored in a spring. Draw the graphical variation of kinetic and potential energy in case of a spring.	**5**
33	What is escape speed? Obtain an expression for the escape speed on earth. Why is atmosphere not available around the moon but available around the earth? Explain the reason. **OR** (a) Define Orbital speed of a satellite and establish an expression for it. (b) A body weighs 63N on the surface of earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth?	**5**

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