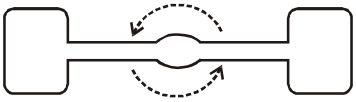
CLASS TEST

PHYSICS CLASS TEST # 23

SECTION-I

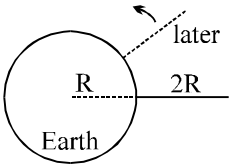
Single Correct Answer Type **6 Q. [3 M (–1)]**

1. A space station consists of two living modules attached to a central hub on opposite sides of the hub by long corridors of equal length. Each living module contains N astronauts of equal mass. The mass of the space station is negligible compared to the mass of the astronauts, and the size of the central hub and living modules is negligible compared to the length of the corridors. At the beginning of the day, the space station is rotating so that the astronauts feel as if they are in gravitational field of strength g. Two astronauts, one from each module, climb into the central hub, and the remaining astronauts now feel a gravitational of strength g'. What is the ratio g'/g in terms of N?



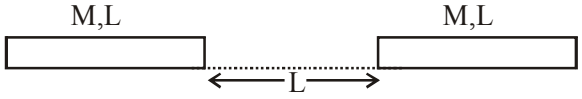
(A) $\sqrt{\frac{N}{(N-1)}}$ (B) $\frac{N}{(N-1)}$ (C) $\sqrt{\frac{(N-1)}{N}}$ (D) $\left(\frac{N}{N-1}\right)^2$

2. Consider a very long stick of length 2R, which extends from just above the surface of the earth, to a radius 3R. If initial conditions have been set up so that this stick moves in a circular orbit while always pointing radially. What is the period of this orbit. g represents acceleration due to gravity on surface of earth.



(A) $6\pi\sqrt{\frac{R}{2g}}$ (B) $2\pi\sqrt{6}\sqrt{\frac{R}{g}}$ (C) $\pi\sqrt{6}\sqrt{\frac{R}{g}}$ (D) none of these

3. Two identical thin uniform rods of mass M and length L are placed in a line at separation of L. Find the gravitational force acting between them



(A) $\frac{GM^2}{L^2}\ln\left(\frac{3}{4}\right)$ (B) $\frac{GM^2}{L^2}\ln\left(\frac{5}{3}\right)$ (C) $\frac{GM^2}{L^2}\ln 2$ (D) $\frac{GM^2}{L^2}\ln 3$

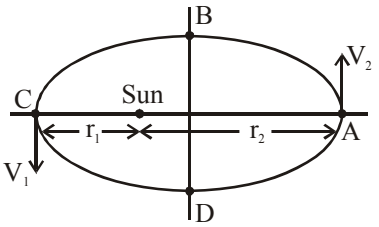
4. A smooth tunnel is dug along the radius of the earth that ends at the centre and a ball is released from the surface of earth along the tunnel. If the coefficient of restitution is 0.2 between the surface and ball then the distance travelled by the ball before second collision at the centre is :

(A) $\frac{6}{5}R$ (B) $\frac{7}{5}R$ (C) $\frac{9}{5}R$ (D) $\frac{3}{2}R$

5. An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of the escape velocity from the surface of earth. If the satellite is stopped suddenly in its orbit and allowed to fall freely, onto the earth, find the speed (in km/sec) with which it hits the surface of the earth ($g = 10\ m/s^2$ and $R = 6400$ km) :-

(A) 8 km/sec (B) $2\sqrt{6}$ km/sec (C) 2 km/sec (D) 4 km/sec

6. A planet moves around the sun in an elliptical orbit as shown.



Ecentricity of ellipse is $\frac{1}{2}$. Time taken by planet to move from D to B ($D \to A \to B$) and B to D ($B \to C \to D$) are respectively T_{DAB} and T_{BCD}

(A) $\frac{T_{DAB}}{T_{BCD}} = \frac{\pi+2}{\pi-2}$ (B) $\frac{T_{DAB}}{T_{BCD}} = \frac{2\pi+1}{2\pi-1}$

(C) Velocity of planet of point B is $\sqrt{3}V_2$ (D) Velocity of planet of point B is $\sqrt{2}V_2$

Multiple Correct Answer Type 4 Q. [4 M (–1)]

7. A ring carries a linear charge density on one half and the linear charge density of same magnitude but opposite sign on the other half.

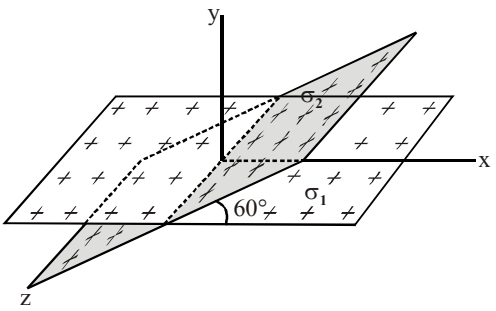
(A) the component of electric field along the axis of ring at all points on the axis is zero.

(B) the component of electric field along the axis of ring at point on the axis is zero only at the centre.

(C) the resultant field at the centre is zero.

(D) the electric field at all points on the axis of ring is perpendicular to axis.

8. An infinite plane in the xz plane carries a uniform surface charge density $\sigma_1 = 8.85$ nC/m^2. A second infinite plane carrying a uniform charge density $\sigma_2 = 17.7$ nC/m^2 intersects the xz plane at the z axis and makes an angle of 60° with the xz plane as shown in figure. The electric field in the xy plane.



(A) at x = 6m, y = 2m is $500\sqrt{3}$ N/C

(B) at x = –5m, y = 0 is $500\sqrt{3}$ N/C

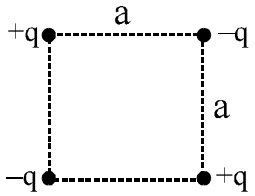
(C) at x = 2m, y = 6 m is $500\sqrt{7}$ N/C

(D) at x = –1m, y = –1m is $500\sqrt{7}$ N/C

9. Two very thin, long, insulating rods, each carrying uniform linear charge density λ, lie in perpendicular directions at a distance d from each other. The force of repulsion between them is F. Which of the following statements is/are correct ?

(A) $F \propto \lambda^2$ (B) $F \propto \frac{1}{d^2}$ (C) $F \propto \frac{1}{d}$ (D) F is independent of d.

10. In a system of two dipoles placed in the way as shown in figure:



(A) It is possible to consider a spherical surface of radius a and whose centre lies within the square shown, through which total flux is +ve.

(B) It is possible to consider a spherical surface of radius a and whose centre lies within the square shown through which total flux is –ve

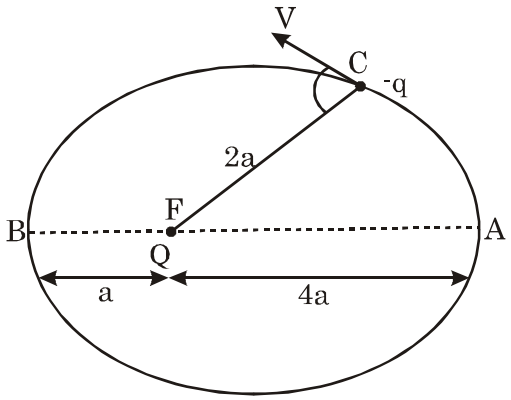
(C) There are two points within the square at which EF is zero.

(D) It is possible to consider a spherical surface of radius a and whose centre lies within the square shown, through which total flux is zero.

Linked Comprehension Type (2 Para × 2Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Questions 11 & 12

Consider a situation in which a negatively charged particle of mass M and charge –q revolves in elliptical path around a fixed charge Q. The closest and farthest distance of the moving particle from fixed charge is a and 4a respectively. Point A and B are the two extreme points of the major axis of ellipse as shown in the figure. Charge Q is present at one of the Foci of the ellipse.



11. The speed (in SI units) of revolving particle when it reaches point A, will be? Use $\left(K = \frac{1}{4\pi\varepsilon_0}\right)$ and $\left(\frac{KQq}{Ma} = 1000 \text{S.I units}\right)$

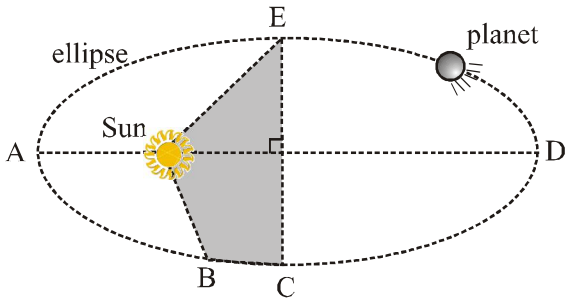
(A) 10 (B) 20 (C) 30 (D) 40

12. The radius of curvature of path (in SI units) of revolving particle at point B, will be ?
Use [a = 25(S.I units)]

(A) 40 (B) 30 (C) 20 (D) 10

Paragraph for Question no. 13 and 14

In the picture below, the planet orbits around the sun with a period of 40 months and takes 12 months to translate from the point D to point E and 1 month from point B to C. The area of the ellipse is A. Mass of the satellite is m.



13. The area of the shaded region

(A) A/20 (B) A/8 (C) A/40 (D) A/4

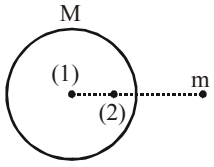
14. The angular momentum of planet per unit mass per unit area is :-

(A) 5×10^{-8} /s (B) 16×10^{-8} /s (C) 2×10^{-8} /s (D) 0

Matching List Type (4 × 4) 2 Q. [3 M (–1)]

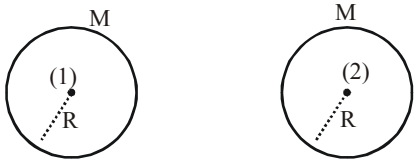
15. Assuming reference position for gravitational potential is at ∞. Consider the situation of List-I and match them with the conditions in List-II.

List-I **List-II**

(P) 

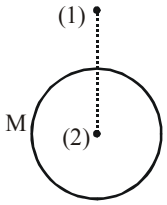
uniform hollow sphere

(1) Gravitational potential at position (1) & (2) is same

(Q) 

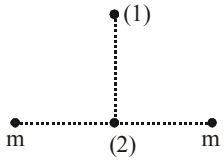
uniform hollow sphere

(2) Gravitational potential at position (1) is less than at position (2)

(R) 

uniform hollow sphere

(3) magnitude of gravitational field at position (1) is less than at position (2)

(S) 

point masses

(4) magnitude of gravitational field at position (1) is more than at position (2)

Code :

	P	Q	R	S
(A)	3	1	2	4
(B)	3	2	4	4
(C)	3	1	4	4
(D)	2	1	3	4

16. In List-I certain situations are indicated where graph can be plotted. List-II lists the comments on the modulus of physical quantity on y-axis. If the modulus of physical quantity on x-axis is increasing, then match with List-II.

	List-I		**List-II**
(P)	y-axis → Speed x-axis → Distance from centre of earth Situation : A particle projected with a speed of $\frac{3}{2}\sqrt{\frac{GM_{earth}}{R_{earth}}}$ from earth vertically	(1)	Graph first increase & then decrease
(Q)	y-axis → Electric field x-axis → Distance from centre Situation : A uniformly charged solid sphere	(2)	Continuously decreasing graph
(R)	y-axis → Temperature x-axis → Pressure Situation : Isochoric process	(3)	Graph will be parallel to x-axis
(S)	y-axis → Time period x-axis → Mass Situation : Simple pendulum	(4)	Continuously increasing graph

Code :

	P	Q	R	S
(A)	2	4	3	1
(B)	3	1	2	4
(C)	2	1	4	3
(D)	2	3	4	1

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 2 Q. [4 M (0)]

1. Binary stars of comparable masses m_1 and m_2 rotate under the influence of each other's gravity with angular velocity ω. If they are stopped suddenly in their motions, their relative velocity when they collide with each otheris $\left[\frac{2G(m_1+m_2)}{(R_1+R_2)} - 2\left(G^2(m_1+m_2)^2\omega^2\right)^{\alpha}\right]^{\beta}$ where R_1 and R_2 are radii of stars and G is the universal gravitational constant. Write down the value of $\left(\frac{1}{\alpha}+\frac{1}{\beta}\right)$

2. In some hypothetical space the gravitational field intensity is given by $\vec{g} = -2\vec{r}$, where $\vec{r}$ is position vector. If x–z plane is a rigid elastic plane and a particle of 1 kg mass is released from (1, 1, 0) position, the magnitude of change in momentum of the particle during its first eventual elastic collision with plane, is $n\sqrt{2}$ Nm. Find n.

CLASS TEST # 23 **ANSWER KEY**

SECTION-I

Single Correct Answer Type **6 Q. [3 M (–1)]**

1. Ans. (D) **2. Ans. (B)** **3. Ans. (A)** **4. Ans. (B)**

5. Ans. (A) **6. Ans. (C)**

Multiple Correct Answer Type **4 Q. [4 M (–1)]**

7. Ans. (A,D) **8. Ans. (A,C)** **9. Ans. (A,D)** **10. Ans. (A,B,D)**

Linked Comprehension Type **(2 Para × 2Q.) [3 M (-1)]**

(Single Correct Answer Type)

11. Ans. (A) **12. Ans. (A)** **13. Ans. (B)** **14. Ans. (C)**

Matching List Type (4 × 4) **2 Q. [3 M (–1)]**

15. Ans. (C) **16. Ans. (C)**

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **2 Q. [4 M (0)]**

1. Ans. 5 **2. Ans. 2**