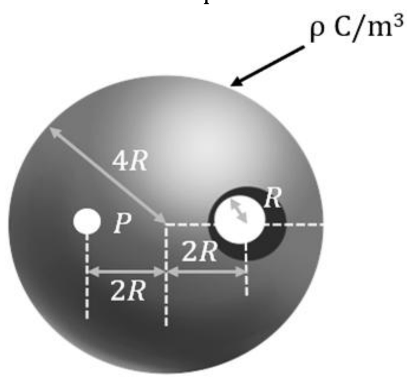
Q.1 Two metallic solid spheres of radii R and 2R are charged such that both of them have same charge density σ. If the spheres are located far away from each other and connected by a thin conducting wire, the new charge density on bigger sphere is:

(A) 5σ (B) 6σ (C) $\frac{5}{6}\sigma$ (D) 2σ

Q.2 Two concentric spherical conducting shells of radii R and $2R$ carry charges Q and $2Q$ respectively. Change in electric potential on the outer shell when both are connected by a conducting wire is: (Where $K = \frac{1}{4\pi\epsilon_0}$)

(A) Zero (B) $\frac{3KQ}{2R}$ (C) $\frac{KQ}{R}$ (D) $\frac{2KQ}{R}$

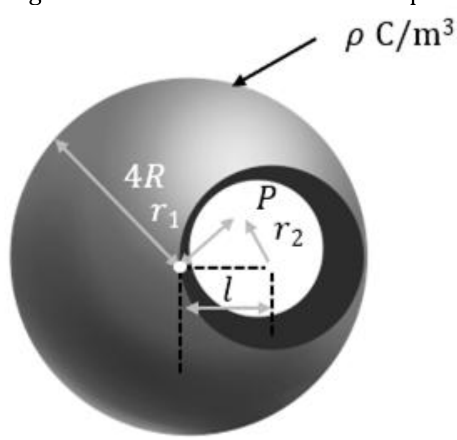
Q.3 A spherical cavity of radius R is cut from a non-conducting sphere of volume charge density ρ C/m^3 as shown in figure. Find the net electric field at point P.



(A) $\frac{27}{48}\frac{\rho R}{\varepsilon_o}$, towards left (B) $48\frac{\rho R}{\varepsilon_o}$, towards left

(C) $\frac{31}{48}\frac{\rho R}{\varepsilon_o}$, towards left (D) $\frac{12}{29}\frac{\rho R}{\varepsilon_o}$, towards right

Q.4 A spherical cavity of radius R is cut from a non-conducting sphere of volume charge density ρ C/m^3 as shown in figure. Find the magnitude of the net electric field at point P.



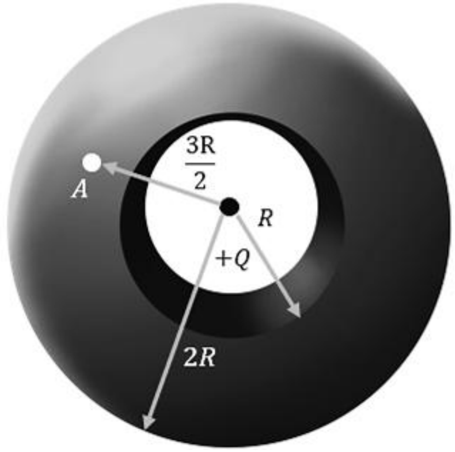
(A) $\frac{\rho l}{3\varepsilon_o}$ (B) $\frac{3\rho l}{\varepsilon_o}$ (C) $\frac{\rho R}{2\varepsilon_o}$ (D) $\frac{\rho R}{2\varepsilon_o}$

Q.5 Two concentric conducting spherical shells of radii a_1 and a_2 $(a_2 > a_1)$ are charged to potentials ϕ_1 and ϕ_2 respectively. What is the charge on the inner shell?

(A) $4\pi\epsilon_0\left(\frac{\phi_1-\phi_2}{a_2-a_1}\right)a_1a_2$ (B) $4\pi\epsilon_0\left(\frac{\phi_1+\phi_2}{a_2+a_1}\right)a_1a_2$

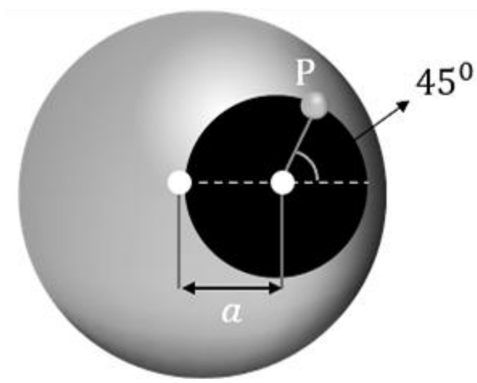
(C) $4\pi\epsilon_0\left(\frac{\phi_1-\phi_2}{a_2+a_1}\right)a_1a_2$ (D) $2\pi\epsilon_0\left(\frac{\phi_1-\phi_2}{a_2+a_1}\right)a_1a_2$

Q.6 A concentric spherical cavity is cut out from a solid conducting sphere and a charge +Q is placed at the centre of the cavity. The magnitude of net electric field E and net potential V at point A is



(A) $E = 0,\ V = 0$ **(B)** $E = 0,\ V = \frac{kQ}{2R}$ **(C)** $E = \frac{kQ}{R^2},\ V = \frac{kQ}{2R}$ **(D)** $E = 0,\ V = \frac{3kQ}{2R}$

Q.7 A cavity of radius r is made inside a solid sphere. The volume charge density of the remaining sphere is ρ. An electron (charge e , mass m) is released inside the cavity from point P as shown in figure. The center of sphere and center of cavity are separated by a distance a. The time after which the electron again touches the sphere is



(A) $\sqrt{\frac{6\sqrt{2}\ r\varepsilon_0 m}{epa}}$ **(B)** $\sqrt{\frac{\sqrt{2}\ r\varepsilon_0 m}{epa}}$ **(C)** $\sqrt{\frac{6\ r\varepsilon_0 m}{epa}}$ **(D)** $\sqrt{\frac{r\varepsilon_0 m}{epa}}$

Q.8 A positively charged sphere of radius r_0 carries a volume charge density ρ as shown in figure. A spherical cavity of radius $r_0/2$ is then scooped out and left empty. C_1 is the centre of the sphere and C_2 is the centre of the cavity. What is the direction and magnitude of the electric field at point B?

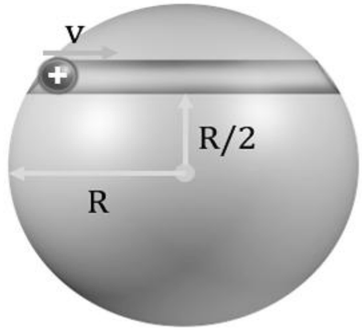
(A) $\frac{17\rho r_0}{54\epsilon_0}$,towards left **(B)** $\frac{\rho r_0}{6\epsilon_0}$, towards left

(C) $\frac{17\rho r_0}{54\epsilon_0}$, towards right **(D)** $\frac{\rho r_0}{6\epsilon_0}$,towards right

Q.9 A charge q is distributed over two concentric hollow conducting sphere of radii r and $R(> r)$ such that their surface charge densities are equal. The potential at their common centre is

(A) Zero **(B)** $\frac{q}{4\pi\epsilon_0}\frac{(r+R)}{(r^2+R^2)^2}$ **(C)** $\frac{q}{4\pi\epsilon_0}\left(\frac{1}{r}+\frac{1}{R}\right)$ **(D)** $V_c = \frac{q}{4\pi\epsilon_0}\left(\frac{r+R}{r^2+R^2}\right)$

Q.10 A unit positive point charge of mass m is projected with a velocity v inside the tunnel as shown. The tunnel has been made inside a uniformly charged non-conducting sphere. The minimum velocity with which the point charge should be projected such that it can reach the opposite end of the tunnel is equal to



(A) $\left[\frac{\rho R^2}{4m\epsilon_0}\right]^{1/2}$

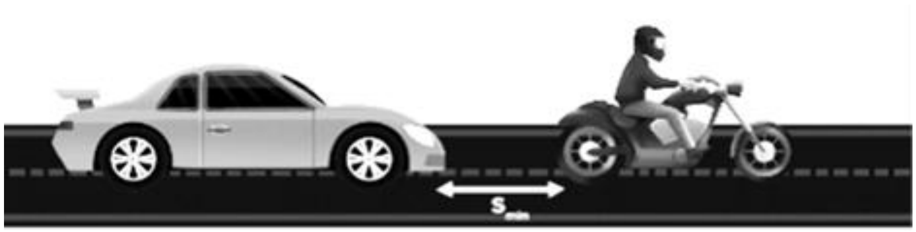
(B) $\left[\frac{\rho R^2}{24m\epsilon_0}\right]^{1/2}$

(C) $\left[\frac{\rho R^2}{6m\epsilon_0}\right]^{1/2}$

(D) Zero because the initial and the final points are at same potential

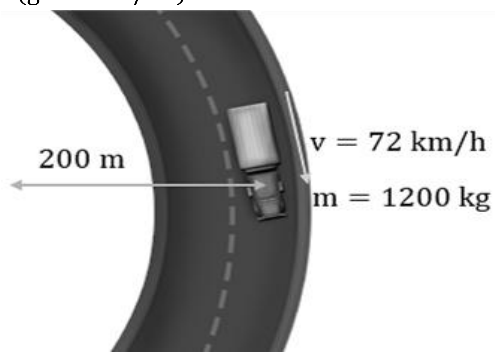
WORK SHEET

Q.1 A motorbike is being chased by a car. The motorbike moves with the speed of 20 m/sand has acceleration of 5 m/s^2. Whereas the car has a speed of 30 m/s and accelerates with 3 m/s^2. If the initial separation between motorbike and car is 80 m, find the distance by which the car will miss the motorbike.



(A)55 m **(B)**30 m **(C)**35 m **(D)**40 m

Q.2 A 1200 kg automobile rounds a level curve of radius 200 m, on an unbanked road with a velocity of 72 km/h. What is the minimum coefficient of static friction between the tyres and road in order that the automobile may not skid? ($g = 10\ m/s^2$)



(A)0.15 **(B)**0.2 **(C)**0.3 **(D)**0.4

Q.3 A cubical block is floating in a liquid with one fourth of its volume immersed in the liquid. If the whole of the system accelerates upwards with acceleration $g/4$, the fraction of volume immersed in the liquid will be

(A)$\frac{1}{4}$ **(B)**$\frac{1}{2}$ **(C)**$\frac{3}{4}$ **(D)**$\frac{3}{3}$

Q.4 Due to some force F_1, a body oscillates with period 4/5 sec and due to other force F_2, oscillates with period 3/5 sec If both forces act simultaneously, the new period will be

(A)0.72 sec **(B)**0.64 sec **(C)**0.48 sec **(D)**0.36 sec

Q.5 The compressibility of water is $5 \times 10^{-10}\ m^2/N$. If it is subjected to a pressure of 15 MPa, the fractional decrease in volume will be:

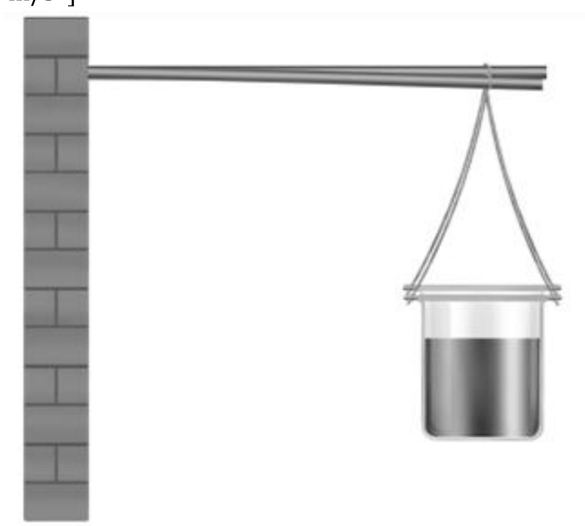
(A)3.3×10^{-5} **(B)**5.6×10^{-4} **(C)**7.5×10^{-3} **(D)**1.5×10^{-2}

Q.6 A lake is covered with ice and the atmospheric temperature above the ice is $-20°C$. Find the rate of formation of ice (incm/hr) when its thickness is 10 cm. [Thermal conductivity of ice = 0.005 cgs units, density of ice = 0.9 g/cc and latent heat of fusion of ice = 80 cal/g].

(A) $50\ \text{cmhr}^{-1}$ **(B)** $25\ \text{cmhr}^{-1}$ **(C)** $0.5\ \text{cmhr}^{-1}$ **(D)** $0.25\ \text{cmhr}^{-1}$

Q.7 A lead bar of length 50 cm and square cross-section of side 5 cm is fixed to a vertical wall as shown in figure. A massless tank is suspended from the end of the bar with the help of a massless rope. The tank is slowly filled with mercury at room temperature. Find the level of mercury in the tank so that the end of the bar deviates by 1 mm.

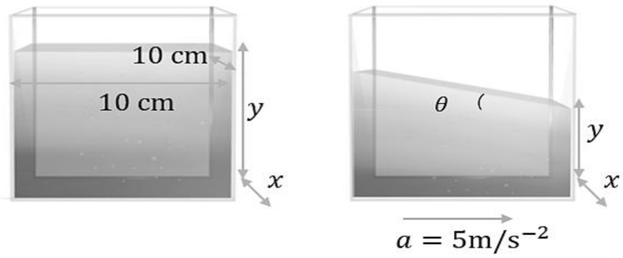
[Take modulus of rigidity for lead as 5.6 GPa and area of base of cylindrical tank as $0.42\ \text{m}^2$; $\rho_{Hg} = 13600\ \text{kg/m}^3$ & $g = 9.8\ \text{m/s}^2$]



(A)0.21m **(B)**1m **(C)**0.5m **(D)**0.42m

Q.8 A steel rod of length 1 m is fixed between two walls. If the rod is heated from 25^oC to 35^oC, the stress developed in the rod is expressed as $x \times 10^7\ \text{N/m}^2$. Find the value of x.
(coefficient of expansion for steel is $2 \times 10^{-5}/°C$, Young's modulus of steel is $2 \times 10^{11}\ \text{N/m}^2$)
(A) 2 **(B)**4 **(C)**7 **(D)**8

Q.9 Liquid is kept in a container having a square cross section. It is now accelerated from left to right with an acceleration of $5\ \text{m/s}^2$. Due to this, the free surface makes some inclination with the horizontal. If the length of the square cross section is 10 m, find the difference in heights of liquid at the left and the right wall. (Take $g = 10\ m/s^2$)

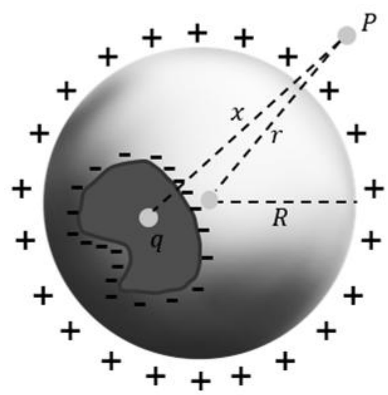


(A) 4 m **(B)**5 m **(C)**6 m **(D)**10 m

Q.10 A rectangular film of liquid is extended from (2 cm × 8 cm) to (4 cm × 16 cm). If work done is 5×10^{-4} J, the value of the surface tension of the liquid is

(A)0.06 N/m **(B)**0.06 N/m **(C)**0.06 N/m **(D)**0.06 N/m

Q.11 A cavity having a point charge q is made in a neutral conductor as shown in the figure. The net electric field at point P is



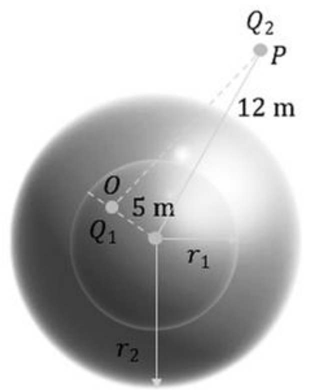
(A)$\frac{Kq}{x^2}$ **(B)**$\frac{Kq}{x^2}$ **(C)**Zero **(D)**$\frac{Kq}{r^2}$

Q.12 A charge q is placed at point O in a cavity in a spherical uncharged conductor. Point S is outside the conductor. If q is displaced from O towards S such that it is still inside the cavity, then the electric field at S will

(A)increase **(B)**decrease

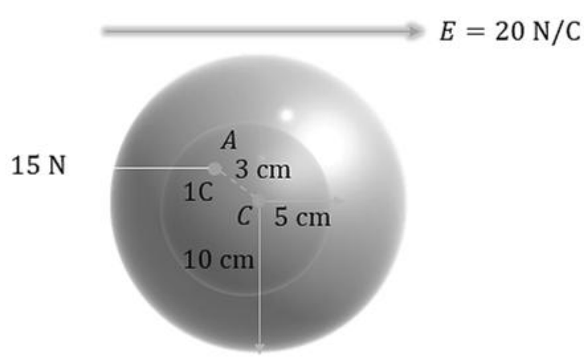
(C)first increase and then decrease **(D)**remain unchanged

Q.13 A charge Q_1 is placed at O inside a hollow conducting sphere having inner and outer radii as 10 m and 11 m as shown in the figure. The force experienced by Q_2 at P is F_1 when Q_1 is placed at the center and force experienced by Q_2 when Q_1 is placed at O is F_2. Then F_1/F_2 is equal to



(A) 1 **(B)**2 **(C)**3 **(D)**None of the above

Q.14 In a conducting hollow sphere of inner and outer radii 5 cm and 10 cm, respectively, a point charge 1 C is placed at point A, that is 3 cm from the center C of the hollow sphere. An external uniform electric field of magnitude 20 N/C is also applied. Net electric force on this charge is 15 N, away from the center of the sphere as shown in the figure. Find the magnitude of net force exerted on the charge placed at point A by the induced charges on the sphere.



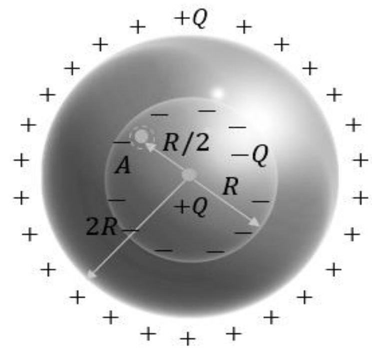
(A)15 N **(B)**20 N **(C)**5 N **(D)**35 N

Q.15 A conducting shell of inner radius R_1 and outer radius R_2 is given a charge +Q. A point charge q_1 is placed inside the shell and q_2 is placed outside the shell. Then for various locations of q_1 and q_2, match the following entries of column$-I$ with the entries of column$-II$.

Column – I	Column – II
(i) If q_1 is act center and $q_2 = 0$, then $\vec{E}$ at center of shell due to charge on outer surface of shell is	(a) $\frac{q1}{4\pi\varepsilon_0 r^2}$
(ii) If q_1 is act center and q_2 is at distance r from the center, then $\vec{E}$ at a point distant r_2 $(> r)$ from the center of the shell due to outer surface charge is	(b) Zero
(iii) If q_1 is not at center and $q_2 = 0$, then the $\vec{E}$ at point P(P is at distance r from q_1 due to charge of the inner surface of shell) is	Cant be determined

(A)i – b , ii – c , iii – a **(B)**i – b , ii – b , iii – c
(C)i – b , ii – a , iii – c **(D)**i – a , ii – b , iii – c

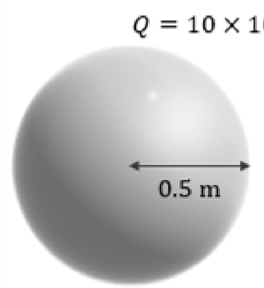
Q.16 A concentric spherical cavity is cut out from a solid conducting sphere and a charge $+Q$ is placed at the centre of the cavity. The magnitude of net electric field E and net potential V at point A is



(A) $E = \frac{4kQ}{R^2},\ V = \frac{3kQ}{2R}$ **(B)** $E = \frac{kQ}{R^2},\ V = 0$ **(C)** $E = \frac{4kQ}{R^2},\ V = \frac{kQ}{R}$ **(D)** $E = \frac{kQ}{4R^2},\ V = \frac{kQ}{2R}$

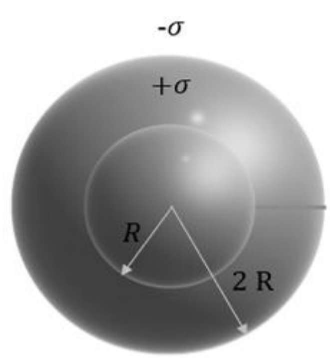
Q.17 A uniform electric field of magnitude 250 V/m is directed in the positive $x-$direction. A + 12 μC charge moves from the origin to the point $(x,\ y)$=(20.0 cm, 5.0 cm). What is the total work required in moving the charge particle to the new position?
(A)−0.6 mJ **(B)**0.4 mj **(C)**4 uj **(D)**6uj

Q.18 A non-conducting sphere of radius 0.5 m carries a total charge of 10×10^{-10} C distributed uniformly which produces an electric field. Then the value of integral $-\int_{\infty}^{0} \vec{E} \cdot \overrightarrow{dr}$ will be



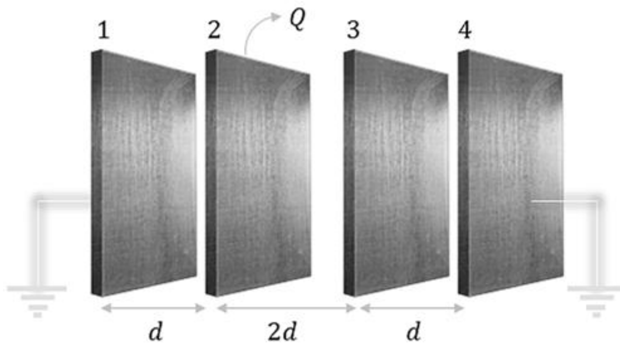
(A)27 **(B)**−27 **(C)** 40 **(D)** −9

Q.19 The surface charge densities of two thin concentric spherical shells are σ and $-\sigma$ respectively as shown in the figure. Their radii are R and 2 R. Now they are connected by a thin wire. Potential on either of the shells will be.



(A)$-\frac{3\sigma R}{2\varepsilon_\circ}$ **(B)**$-\frac{2\sigma R}{3\varepsilon_\circ}$ **(C)**$-\frac{\sigma R}{2\varepsilon_\circ}$ **(D)**zero

Q.20 Four large identical metal plates are placed as shown in the figure. Plate 2 is given a charge Q. All other plates are neutral. Now Plate 1 and 4 are earthed. Area of each plate is A. The charge appearing on the right side of plate 3 is



(A) $\frac{Q}{2}$ (B) $\frac{Q}{4}$ (C) $\frac{Q}{8}$ (D) Q

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(A)	(C)	(A)	(A)	(B)	(A)	(A)	(D)	(A)
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(B)	(A)	(C)	(C)	(C)	(C)	(B)	(B)	(C)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(D)	(D)	(A)	(D)	(A)	(A)	(A)	(A)	(A)	(B)