PHYSICS

BOOKS - NN GHOSH PHYSICS (HINGLISH)

GAUSS THEOREM AND ITS APPLICATION

Examples

1. A shere of radius a is uniformaly charged thoughout its volume with a volume change

density of σ. Calculate the electeric field at a distance r form the centre of the sphere when $(i)r < a(ii)whenr > a.$

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2. If the field near the earth's surface is 300V m^{-1} directed downwards , what is the surface density of change on the surface of the earth?

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3. A soap bubble of radius 3cm is chaged with 9 nC (nanocoulomb) Find the excess pressure inside the bubble surface tension of soap solution $= 3 \times 10^{-3} m^{-1}$

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4. Air given way when there is a gradient of potential of 3×10^6 valts per matre . What is the maximum voltage to which a sphere of radius 1 cm can be charged ? What is the chage required ?

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5. A sphere of radius 10 cm is chaged with 1 nC (nanocoulamb) ?Calculate the energy density of the medium at a distance of 20 cm from its centre.

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6. Calculate the mutual force of attraction between two parallel plates 1 cm apart and

maintained at a potential differnce of 100 V Aera of rach plate $= 10^{-2} m^2$

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7. Two thin parallel threads carry a uniform charge with linear densities λ and $-\lambda$. The distance between the threads is equal to l. Find the potential of the electric field and the magnitude of its strength vector at the distance $r > > l$ at the angle θ to the vector 1 (fig).

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8. A metal ball of radius $R = 1.5cm$ has a charge $q = 10\mu C$. Find the molecules of the vector fo the resultant force acting on a charge located on one half of the ball.

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Examples A

1. A small ball carring $1\mu C$ of change is suspended over an infinite horizontal conducting

plane by means of an insulating spring of force constant $100Nm^{-1}$ Calculate the increase In length of the spring if the plane has a surface density of change equal to $-8.85 \times 10^{-6}Cm^{-2}$

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2. Calculate the surface density of change at a place on the earth's surface where the rate of fall of potential is 250 volts per metre.

[Hint : rate of fall of potential =electric $= E = \frac{\sigma}{\varepsilon_0}$ by Gauss's theorm.]

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3. A spark passes though air when the potential gradient is 3×10^6 volts per metre what must be the radious of an isoated metal sphere which can be changed to a potentiial of 3 million voilts before there are sparks in the air?

$$\left[\text{Hint}: E = \frac{Q}{4\pi\varepsilon_0 r^2} \text{ and } V = \frac{Q}{4\pi\varepsilon_o r}, \therefore E = \frac{V}{r}\right]$$

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4. Calculate the change which must be placed on a sphere of radius 10 cm in order that the

repulsion per square mertre of the surface may just balance the atmospheric pressure which is $1.013 \times 10^5 Nm^{-2}$

$\left[\text{Hint}: P = \frac{\sigma}{2\varepsilon_0} \text{ and } Q = 4\pi r^2 \sigma\right]$

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5. An infinite changed sheet has $10^{-7} Cm^{-2}$ surface density of change .How far apart are the equipotential surface differing by 5 voits ?

[Hint: Elwctri intensity =rate of fall of potential .]

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6. An isolated metal sphere whose diameter is 10 cm has a potential of 8000 voits . What is the energy density at the surface of the sphere?

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7. What change must be placed on a soap bubble of radiuas 1.5 cm if the air pressure has to be the same inside and outside the bubble ? Assume the surface tension to be $27 \times 10^{-3} Nm^{-1}$

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8. An isolated sphere of radius 5cm is charged to a potential of 159 Kv (Kilovoits). Find the electrostatic force per unit area of the surface.

[Hint: Force per unit area $= \frac{\sigma^2}{2\varepsilon_0}$ and $V = \frac{Q}{(4\pi\varepsilon_0 r)} = \frac{4\pi r^2\sigma}{4\pi\varepsilon_0 r} = \frac{r\sigma}{\varepsilon_0}$]

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9. A metal plate of radius 20 cm is charged positively to a potential of 6000 volts and placed at a distance of 5 cm from a parallel earth

connected plate .Find the total pull between the plates .

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10. Two parallel plates which are 0.2 cm apart are raised to a potential diffence of 1200 voits .If the space between them is filled with air , calculate the mutual pull per unit area.

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11. The sir prssure is the same inside and outside a changed soap bubble of radius 1 cm .If the surface tension is $0.03Nm^{-1}$ aclaculate the potential in voits .

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12. A spsrk passes though air when the potential gradient at the surface of a chaged conductor is $3 \times 10^6 VM^{-1}$ What must be the radius of a metal sphere (insulated) which may be raisid to a pottential of 2×10^6 voits before spking

occurs? How much energy will be be stored just before there ios a spark?

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13. Two concentric spherical shells of radii a and b (bgt a) are uniformamly changed and carry equal changes q. Find the electric firld at a distance r from their common centre when $(i) r < a (ii) a < r < b (iii) r > r.$

[Hint: Draw coaxial cylindrical gaussion surface and appy Gauss thearem]

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14. Two concentric spherical shells of radii a and b (bgt a) are uniformamly changed and carry equal changes q. Find the electric firld at a distance r from their common centre when $(i) r < a (ii) a < r < b (iii) r > r.$

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15. Calculate the elecric flux though a hemisphere of radius R . The electric field E is unfrom and is (a) parallel,(b) perpendicular to axis of the hemisphere.

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16. Two point charges q and $-q$ are separated by a distance $2l$. Find the flux strength vector across the circle of radius R placed with its centre coinciding with the of line joining the two charges in the perpendicular plane.

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17. Show by the priciple of superpostion that is a cavity is removed from a uniformly chaged sphere the field inside the cavity is $\overrightarrow{\rho a / 3\varepsilon_0}$ where ρ is the centre ofchnages and $\overrightarrow{a}$ is the vector from the centre of the sphere to the centre of the cavity.

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18. A point changes 60nC is placed at the centre of a a thick , inssulated , metallic spherical shell has radii 10 and 12 cm Find the electric firld at distance 5 11 and 15 cm from the centre what is the force between the point changes and the shell?

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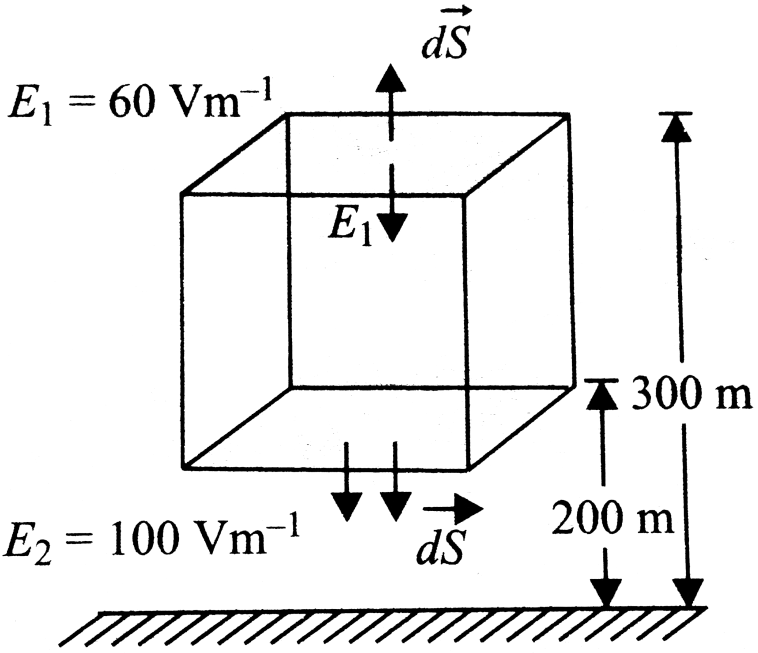
19. It has been experimentally observed that the electric field in a large region of earth's atmosphere is directed vertically down. At an

altitude of 300 m, the electric field $60Vm^{-1}$. At an altitude of 200 m, the field is 100 V m^(-1), the field is $100Vm^{-1}$. Calculate the net amount of charge contained in the cube of 100 m edge, located between 200 and 300 m altitude.



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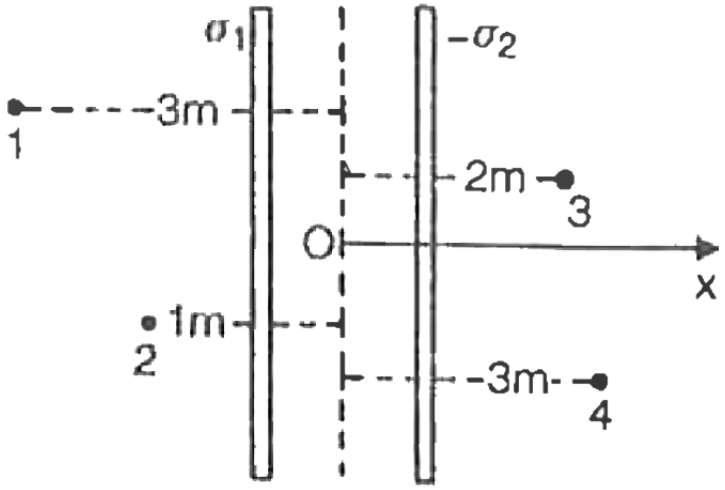
20. There is an infintely long straight wire carrying a charge of liner density $\lambda = 40\mu C/m$ Calculate the potential diffence between point 1 and 2 if point 2 is n=2 times fayher from the wire then point 1.



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21. Two parallel infinite plates are chaged oppositely with densites $+\sigma_2$ four point 1,2,3,4 are located as difference between 2 and 1 is V_{2-V_1}(a) which of the densites $(+\sigma_1$ or σ_2 is larger in magnitude? (b) what is the potential diffence beween 4 and 3 ?

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22. An infintie nonconducting sheet a surface density of change σ Around the foot og the perpendicular from a point P a circle of radius r is

drawn .Find the valume of r at which the field at P product by changes inside this circle is half of the total strength of the feld due to the entire sheet . The distance of the point P is a from the plane.

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23. A place large aluminium sheet is connected to a bettery of emf $\varepsilon = 12V$ The sheet develops surface density of charge $\sigma = 0.9nC/m^2$ Calculate the potential at apoint distant x=2

along the normal to the sheet At what distance potential is zero ?

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24. Small identical balls with equal charge are fixed at the vertices of a reggular hexagon after of N sides ,each of length a At a certain instant one of the ball is releases and after a sufficiently long time the adjacent ball is released .The kinetic energies of the two releases balls differ by k at a sufficenlty long distance from the polygon . Determine the charge on each ball.

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