Sri Chaitanya IIT Academy, India

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A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR-HYD

Sec: Sr.IPLCO	JEE–ADVANCE	Date: 01-11-15
Time: 3 Hours	2014-P2-Model	Max Marks: 180

PAPER-II
KEY & SOLUTIONS

PHYSICS

1	C	2	B	3	C	4	B	5	B	6	B
7	B	8	B	9	B	10	A	11	A	12	C
13	A	14	A	15	A	16	B	17	A	18	C
19	B	20	D								

CHEMISTRY

21	C	22	A	23	D	24	C	25	D	26	B
27	C	28	B	29	D	30	A	31	B	32	C
33	B	34	D	35	D	36	D	37	A	38	B
39	D	40	A								

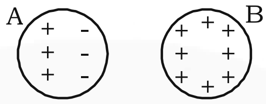
MATHS

41	A	42	B	43	D	44	A	45	A	46	C
47	D	48	C	49	C	50	C	51	B	52	D
53	D	54	C	55	A	56	C	57	A	58	A
59	A	60	A								

PHYSICS

1. Conceptual

2. Charge will induce on A but total charge on A will remain zero. Negative charge of A will be more closer to B than positive charge on A. So potential of B will decrease



3. When q is just outside $\phi = 0$

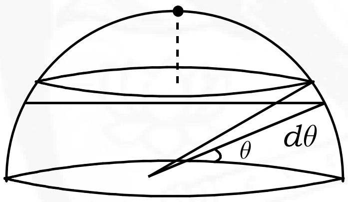
Is just inside $\phi = \dfrac{q}{\varepsilon_0}$

Is on apex $\phi = \dfrac{q}{2\varepsilon_0}\left(1-\cos\theta\right)$

It is a discontinuous function

4. Here ρ is surface charge density

$dq = \left(2\pi R\cos\theta\right)Rd\theta\rho$



$$dV = \frac{1}{4\pi\varepsilon_0}\frac{dq}{R\sqrt{\left(1-\sin\theta\right)^2+\cos^2\theta}}$$

$$V_{N.P} = \frac{1}{2\varepsilon_0}\frac{\rho R}{\sqrt{2}}\int\frac{\cos\theta d\theta}{\sqrt{1-\sin\theta}}$$

$$= \frac{1}{2\varepsilon_0}\frac{\rho R}{\sqrt{2}}\left(-2\sqrt{1-\sin\theta}\right)\Big]_0^{\pi/2}$$

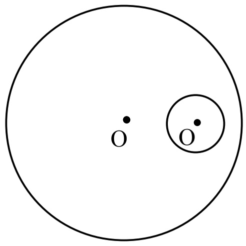
$$= \frac{1}{2\pi\varepsilon_0}\rho R\sqrt{2}$$

$$V_{centre} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R} = \frac{1}{4\pi\varepsilon_0}\frac{\rho 2\pi R^2}{R} = \frac{\rho R}{2\varepsilon_0}$$

$$\therefore \Delta V = \frac{\rho R}{2\varepsilon_0}\left(\sqrt{2}-1\right)$$

5. $$E_{inside} = \frac{\delta\left(00'\right)}{3\in_O} = E_o$$

$$\Rightarrow \delta = \frac{3\in_o E_o}{\left(\frac{R}{2}\right)} = \frac{6\in_o E_o}{R}$$



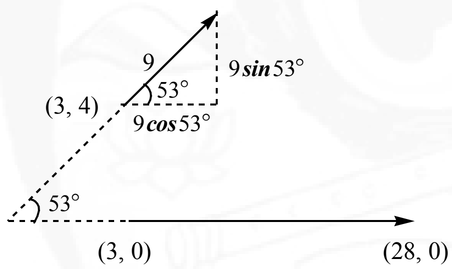
Electric flux = $\dfrac{\text{charge enclosed}}{\epsilon_o}$

$$= \frac{\delta \frac{4\pi}{3}\left(\left(\frac{3R}{4}\right)^3 - \left(\frac{R}{4}\right)^3\right)}{\epsilon_o}$$

$$= \frac{\rho\pi(26)R^3}{48\epsilon_o} = \frac{13\pi R^3}{24\epsilon_o}\left(\frac{6\epsilon_o E_o}{R}\right)$$

$$= \frac{13}{4}E_o\pi R^2$$

6.



$E \propto \frac{1}{r^2} \Rightarrow$ if AD = 25 then BC = 9

$\therefore C = (3 + 9\cos 53°, 4 + 9\sin 53°)$

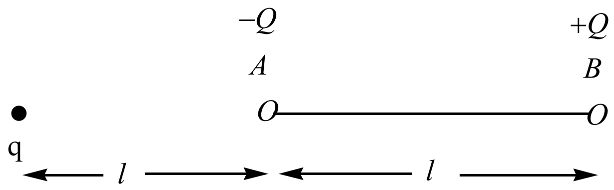
7. For A, $\frac{q}{4\pi\epsilon_o r_A} = 7, \frac{q}{4\pi\epsilon_o r_A^2} = 3$

$\Rightarrow r_A = 7/3$

For B, $\frac{3q}{4\pi\epsilon_0 r_B^2} \Rightarrow 3 \Rightarrow r_B = \sqrt{3}r_A$

So, $\frac{3q}{4\pi\epsilon_0 r_B} = \frac{\sqrt{3}q}{4\pi\epsilon_0 r_A} = 7\sqrt{3} \simeq 12V$

8.



Potential at centre of A

$$=\frac{1}{4\pi\varepsilon_0}\left[\frac{q}{\ell}+\frac{Q}{\ell}-\frac{Q}{r}\right]------(1)$$

Potential at centre of B

$$=\frac{1}{4\pi\varepsilon_0}\left[\frac{q}{2\ell}+\frac{Q}{r}-\frac{Q}{r}\right]-------(2)$$

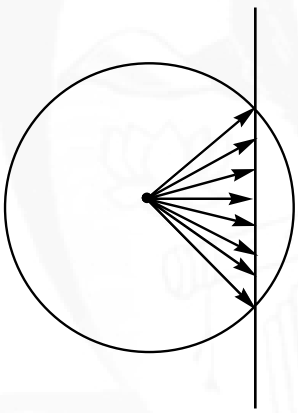
$$(1)=(2)\Rightarrow\frac{q}{2\ell}=2Q\left[\frac{1}{r}-\frac{1}{\ell}\right]$$

$$\Rightarrow\frac{q}{2\ell}=\frac{2Q}{r}\quad(\text{neglecting}\,\frac{1}{\ell})$$

9. Flux due to point charge at centre of sphere

$$=\frac{q}{2\varepsilon_0}$$

Flux due to given situation doesn't have the lines shown in the diagram so. Required flux



$$=\frac{q}{2\varepsilon_0}-\frac{q}{2\varepsilon_0}(1-\cos\theta)$$

$$=\frac{q}{2\varepsilon_0}\cos\theta$$

$$=\frac{\sigma 4\pi R^2}{2\varepsilon_0}\frac{x}{R}=\frac{\sigma 2\pi Rx}{\varepsilon_0}$$

10. $\vec{E}$ inside cavity $=\frac{4\pi}{3}G\delta(00')$

$$=\frac{GM}{2R^2}\ (\text{uniform})$$

$$F_{contact}=F_{Gravity}=\left(\frac{GM}{2R^2}\right)\left(\frac{M}{8}\right)=\frac{GM^2}{16R^2}$$

11-12 Reduce earth to a point mass at its centre

Solution (Q No. 13 & 14)

$$E_x = -\frac{\delta V}{\delta x} = -3Vm^{-1};\ E_y = -\frac{\delta V}{\delta y} = -4Vm^{-1}$$

$$a_x = \frac{qE_x}{m} = -\frac{1\times 10^{-6}\times 3}{0.1} = -3\times 10^{-5}ms^{-2}$$

$$a_y = \frac{qE_y}{m} = -\frac{1\times 10^{-6}\times 4}{0.1} = -4\times 10^{-5}ms^{-2}$$

Time taken to cross the x-axis:

Using $s = ut + \frac{1}{2}at^2$

$$3.2 = \frac{1}{2}\times 4\times 10^{-5}\times t^2$$

$$t = 400s$$

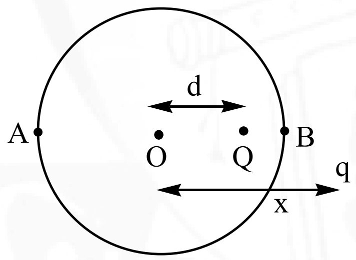
$$v_x = a_x t = -3\times 10^{-5}\times 400$$

$$v_y = a_y t = -4\times 10^{-5}\times 400$$

$$= 16\times 10^{-3}ms^{-1}$$

$$v = \sqrt{v_x^2 + v_y^2} \quad = 20\times 10^{-3}ms^{-1}$$

15-16



Let the image charge be q outside the sphere at a distance x from centre.

$$V_A = 0 \Rightarrow \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R+d} + \frac{q}{R+x}\right) = 0 - - - - - (1)$$

$$V_B = 0 \Rightarrow \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{R-d} + \frac{q}{x-R}\right) = 0 - - - - - (2)$$

$$\frac{R+d}{Q} = \frac{-(R+x)}{q} \quad and \quad \frac{R-d}{Q} = \frac{-(x-R)}{q}$$

Showing by subtracting

$$\frac{2d}{Q} = \frac{-2R}{q} \Rightarrow q = \left(-\frac{R}{q}\right)Q$$

And substituting back,

$$\frac{R+d}{Q} = \frac{(R+x)}{RQ}d$$

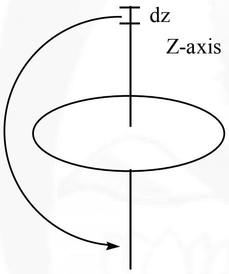
$\Rightarrow R(R+d)=(R+x)d$

$R^2 = xd \Rightarrow x = \dfrac{R^2}{d}$

So $F = \dfrac{Qq}{4\pi\varepsilon_0 (x-d)^2} = \dfrac{Qqd^2}{4\pi\varepsilon_0 \left(R^2-d^2\right)^2} = \dfrac{Q^2Rd}{4\pi\varepsilon_0 \left(R^2-d^2\right)^2}$

18. Electric field is uniform in all our cases. Equipotential lines in x-y plane shall be normal to corresponding electric lines of forces. Also direction of electric field is from region of higher potential to lower potential.

19. For a small displacement we can assume it is equivalent to moving an end 'dz' element of the rod to the other end without changing the rest of the rod.
So dU or δU as mentioned can now be calculated as the change in potential energy in moving a change $'\lambda 2dz'$ by distance of z to z+dz on z axis.



U per unit charge = $\dfrac{Q}{4\pi \in_o \left(R^2+Z^2\right)^{1/2}}$

dU per unit charge = $\dfrac{Q2Z}{4\pi \in_o \left(R^2+Z^2\right)^{3/2}} 2dZ$

So $dU = \dfrac{Q(2z)(\lambda dz)2dz}{4\pi \in_o \left(R^2+Z^2\right)^{3/2}}$

Here $2z\lambda = q, dU = \delta U, dz = x$ and Z=R

So $\delta U = \dfrac{Qqx^2}{4\sqrt{2}\pi \in_0 R^3}$

$|F| = \left|\dfrac{dU}{dZ}\right| = \dfrac{2Qqx}{8\sqrt{2}\pi \in_o R^3} \Rightarrow SHM$

So $T = 2\pi\sqrt{\dfrac{4\sqrt{2}\pi \in_o R^3 m}{Qq}}$

20. Using dimensional Analysis we can write $v_1 \alpha \dfrac{q}{a}$ and $4v_2 \alpha \dfrac{4q}{2a}$ (considering 4 sheets together)

$\Rightarrow \dfrac{v_1}{v_2} = 2$ Similar Analysis for hollow cube gives $v_3 = \dfrac{3v_1}{2} + \dfrac{v_2}{4} = 3v_2 + \dfrac{v_3}{4}$.