CH 25 1, 3, 5, 7, 9, 11, 14, 18, 24, 28, 36-37, 40, 43, 44, 45, 46, 47, 50, 51, 75

(1) a) $E = \frac{|\Delta V|}{d} = \frac{600}{5.33\times10^{-3}} = 1.13\times10^{5}\ N/C$ b) $F = |q|E = (1.6\times10^{-19})(1.13\times10^{5}) = \boxed{1.80\times10^{-14}\ N}$

c) $W = F\cdot x\cdot\cos 0 = (1.80\times10^{-14})(5.33-2.00)\times10^{-3}) = \boxed{4.37\times10^{-17}\ J}$

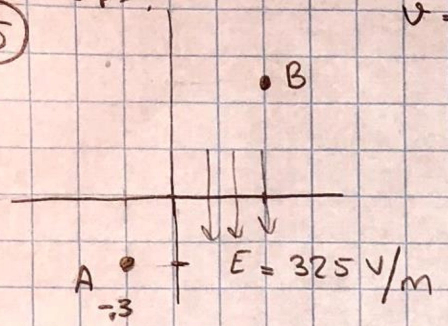
$K_f = q_e(V_0 - V_f)$ $(-e)(-120)$

(3) $\Delta V = 120V$ $v_e = ?$ $v_p = ?$

a) $\Delta K = -q\Delta V$ $K_f = q(V_0 - V_f)$ 120 $v = \sqrt{\frac{2qV_0}{m}}$ $\Rightarrow v_p = \sqrt{\frac{2(1.6\times10^{-19})(120)}{1.67\times10^{-27}}}$ $v_p = 1.52\times10^{5}\ m/s$

b) $v_e = \sqrt{\frac{2(-1.6\times10^{-19})(-200)}{9.11\times10^{-31}}}$ $\boxed{v_e = 6.49\times10^{6}\ m/s}$ 5

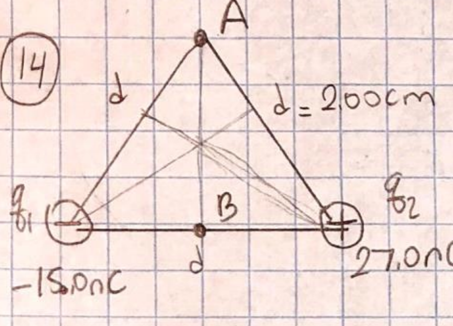
(5)



$V_B - V_A = -\int_A^B E\cdot dr = -E\,dr\cdot\cos 180 \int_A^B = Er\Big|_{-3}$

$V_B - V_A = 325\ V/m \cdot .8m = \boxed{260\ V}$

(14)



$V_A = \frac{k}{d}(-Q_1 + Q_2)$

$= \frac{8.99\times10^{9}}{0.02}(27-15)\times10^{-9}$

$\boxed{V_A = 5394\ V} = 5.39\times10^{3}\ V$

$V_B = \frac{2k}{d}(Q_2 - Q_1) = \boxed{10788\ V} = 1.08\times10^{4}\ V$

(7) $v_0 = 3.70\times10^{6}\ m/s$
$v = 1.40\times10^{5}\ m/s$
$\Delta x = 2.00cm$
$\Delta V = ?$
$q = e^-$

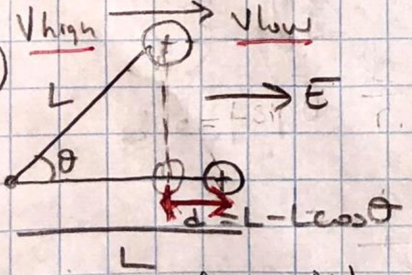
$\Delta K = -\Delta U = -q\Delta V = q(V_0 - V_f)$

$\frac{1}{2}m(v_f^2 - v_0^2) = q(V_0 - V_f)$

$V_0 - V_f = \frac{m(v_f^2 - v_0^2)}{2q} = \frac{(9.11\times10^{-31})((1.4\times10^{5})^2 - (3.7\times10^{6})^2)}{2(-1.60\times10^{-19})}$

$V_0 - V_f = 38.9V \Rightarrow V_0$ is at the higher potential

(9)



$\Delta K = -\Delta U$

$K_f - \cancel{K_0} = q(V_0 - \cancel{V_f})$

$\frac{1}{2}mv^2 = q(Ed)$

$v = \sqrt{\frac{2qE(L - L\cos\theta)}{m}} = \boxed{0.300\ m/s}$

(11) $\lambda = 40.0\ \mu C/m$
$\mu = 0.100\ kg/m$
$E = 100\ V/m$
$d = 2m$
$v = ?$

$\frac{\lambda}{\mu} = \frac{C}{\cancel{m}}\cdot\frac{\cancel{m}}{kg} = \frac{q}{m}$

$K_f - \cancel{K_i} = q(V_0 - \cancel{V_f})$

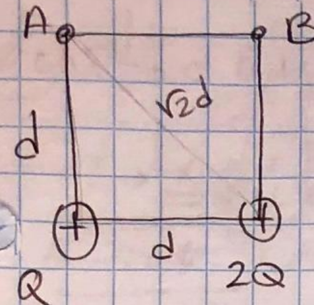
$\frac{1}{2}mv^2 = qEd$

$v^2 = \frac{2qEd}{m}$

$v = \sqrt{\frac{2\lambda Ed}{\mu}}$

$\boxed{v = 0.400\ m/s}$

(18)



$$V_A = k\frac{Q}{d} + \frac{k2Q}{\sqrt{2}d} = \frac{kQ}{d}\left(1+\frac{2}{\sqrt{2}}\right)$$

$$\frac{8.99\times10^{\cancel{9}}\cdot 5\times10^{\cancel{-9}}}{2\times10^{-2}}\left(2.414\right)$$

$Q = 5.00\,nC$

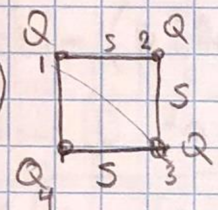
$$V_A = 5426\ V$$

$$V_B = k\frac{Q}{\sqrt{2}d} + k\frac{2Q}{d} = \frac{kQ}{d}\left(\frac{1}{\sqrt{2}}+2\right) = \frac{(8.99)(5)}{2\times10^{-2}}\left(\frac{1}{\sqrt{2}}+2\right)$$

$$V_B = 6084\ V$$

$$V_B - V_A = 6084 - 5426 = \boxed{658\ V}$$

(24)

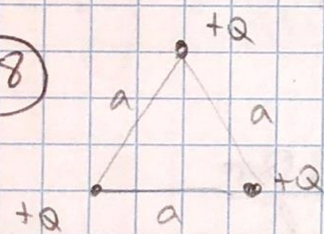


$$U = \overset{\text{1st charge}}{0} + \overset{\text{2nd charge}}{k\frac{Q^2}{s}} + \overset{\text{3rd charge}}{\left(\frac{kQ^2}{s} + \frac{kQ^2}{\sqrt{2}s}\right)} + \overset{\text{4th charge}}{\left(2\frac{kQ^2}{s} + \frac{kQ^2}{\sqrt{2}s}\right)}$$

$$U = \frac{kQ^2}{s}\left(1+1+\frac{1}{\sqrt{2}}+2+\frac{1}{\sqrt{2}}\right) \quad 4+2\sqrt{2}$$

$$\boxed{U = 5.41\ \frac{kQ^2}{s}}$$

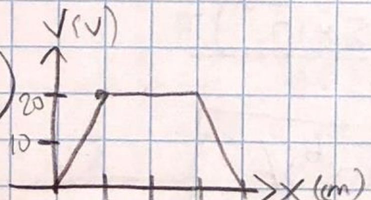
(28)



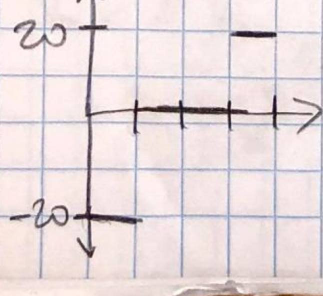
$V \neq 0$ anywhere except ∞

$$V_p = 2\frac{kQ}{a}$$

(36)



$$V = -E\cdot x \qquad \boxed{E_x = -\frac{\partial V}{\partial x}}$$



$$V = \int E\,dr$$

$$\frac{dV}{dr} = E \qquad \frac{\partial V}{\partial x} = E_x \qquad \frac{\partial V}{\partial y} = E_y \ - - -$$

(37) $V = a + bx$ btw $x = 0 - 6.00\,m$ $a = 10.0\,V$ $b = -7.00\,V/m$

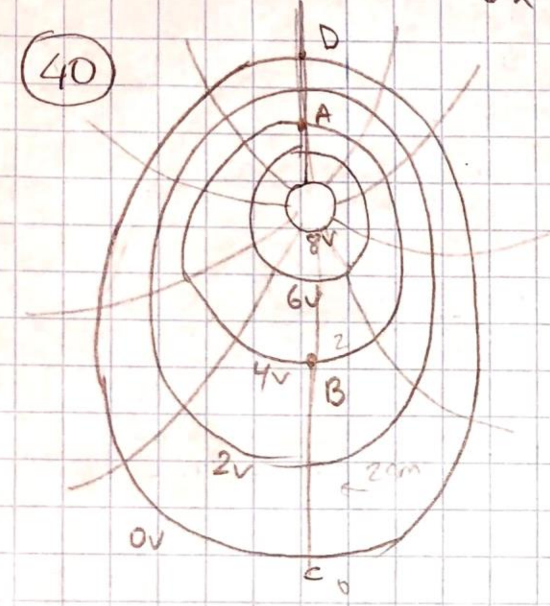
a) $V = 10.0V + (-7\,V/m)\cdot 0 = 10.0V$

$V = 10V + (-7\,V/m)(3\,m) = -11.0\,V$

$V = 10V + -7\,V/m\,(6m) = -32\,V$

b) $E = -\dfrac{\partial V}{\partial x} = -\dfrac{\partial}{\partial x}\, a + bx = -b = +7\,V/m$ constant

(40)



$V_B - V_0 = -\int_C^B E \cdot dr\,(\cos 180)$

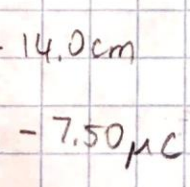
$4V = +E\,r\Big|_0^{2cm}$

$E = \dfrac{4}{0.02}$

$\boxed{E = 200\,V/m \downarrow}$

$E_A = -\dfrac{\Delta V}{\Delta x} = -\dfrac{V_{AD}}{AD}$ $AD < BC$ so $E_A > E_B$

(44)



$V_0 = \int k \dfrac{dq}{r} = \dfrac{kQ}{r} = \dfrac{kQ\pi}{\ell}$

$= \dfrac{(8.99\times10^{9})(-7.5\times10^{-6})\pi}{0.14}$

$\boxed{V_0 = 1.51\times10^{6}\,V}$

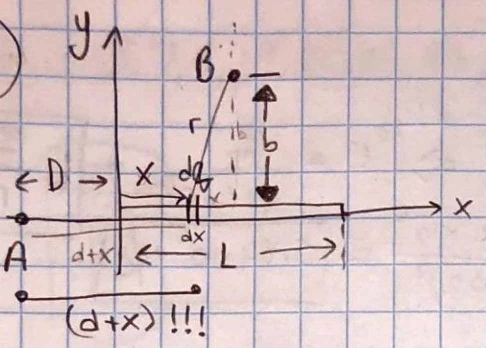
$\ell = 14.0\,cm$

$Q = -7.50\,\mu C$

$\left(dq = \dfrac{Q}{L}\cdot dx = \dfrac{Q}{L} r\,d\theta \right)$

$\ell = \pi r \Rightarrow r = \dfrac{\ell}{\pi}$

(45)



$$dq = \lambda\, dx$$

$$dq = (\alpha x)\, dx$$

$$D + x = u$$
$$du = dx$$
$$x = u - D$$

$$V_A = \int_0^L k\,\frac{dq}{r} = \int k\,\frac{\alpha x\, dx}{D+x}$$

$$V_A = k\alpha \int \frac{x}{D+x}\,dx$$

$$k\alpha \int \frac{u-D}{u}\,du$$

$$k\alpha \int 1 - \frac{D}{u}\,du$$

$$k\alpha\left(u - D\ln u\right)$$

$$k\alpha\left(D+x\Big|_0^L - D\ln(D+x)\right]_0^L$$

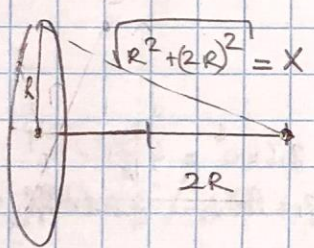
$$k\alpha\left[(\cancel{D}+L-\cancel{D}) - (D\ln(D+L) - D\ln D)\right]$$

$$k\alpha\left[L - (D(\ln(D+L) - \ln D))\right]$$

$$k\alpha\left[L - \left(D\ln\left(\frac{D+L}{D}\right)\right)\right]$$

$$\boxed{k\alpha\left(L - D\ln\left(1+\frac{L}{D}\right)\right)}$$

(43)



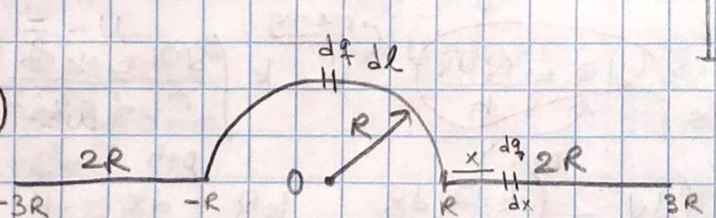
$$V_{0-2R} = V_{2R} - V_0$$

$$= k\int\frac{dq}{x} - k\int\frac{dq}{R}$$

$$= \frac{kQ}{\sqrt{R^2+4R^2}} - \frac{kQ}{R} = \frac{kQ}{R}\left(\frac{1}{\sqrt{5}} - 1\right)$$

$$\boxed{\Delta V = -0.553\,\frac{kQ}{R}}$$

(47)



$$\lambda \quad V_0 = ? \qquad \lambda = \frac{dq}{dx} = \frac{dq}{dl}$$

b/c symmetry!

$$V_0 = 2V_{straight} + V_{curve}$$

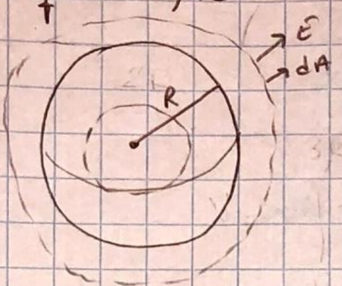
$$= 2k\int\frac{dq}{x} + k\int\frac{dq}{R} = 2k\int_R^{3R}\frac{\lambda\,dx}{x} + k\int_0^L \frac{\lambda\,dl}{R}$$

$$L = \pi R$$

$$= 2k\lambda\ln\left(\frac{3R}{R}\right) + k\lambda\frac{\pi R}{R} = \boxed{k\lambda(2\ln 3 + \pi)}$$

(50) $R = 14.0\,cm$

$q = 26.0\,\mu C$



b) $r = 20\,cm$, $r > R$ $\quad \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\epsilon_0}$

$E\, 4\pi r^2 = \frac{q}{\epsilon_0} \Rightarrow E = \frac{q}{4\pi\epsilon_0 r^2} = \boxed{k\frac{q}{r^2}}$

$E = 8.99\times10^9 \frac{26\times10^{-6}}{(0.2)^2} = \boxed{5.84\times10^6\ N/C}$

$V_{r\infty} = \int_r^{\infty} E \cdot dr = \int_r^{\infty} \frac{kq}{r^2}\,dr = -\frac{kq}{r}\Big|_r^{\infty} = kq\left(\frac{1}{r} - \frac{1}{\infty}\right)$

same

$V = \frac{k \cdot q}{r} = \frac{8.99\times10^9\,(26\times10^{-6})}{0.2} = \boxed{1.17\times10^6\ V}$

a) $r = R$

$E = 0$ b/c $Q_{in} = 0$

$V_{r\infty} = \int_r^R \cancel{E}\cdot dr + \int_R^{\infty} E \cdot dr = \frac{kq}{R} = \frac{8.99\times10^9 \cdot 26\times10^{-6}}{0.14} = \boxed{1.67\times10^6\ V}$

c) $r = R$ same $\Rightarrow E = \frac{kQ}{R^2} = 11.9\times10^6\ N/C$ & $V = \frac{kQ}{R}$ same!

(51) Both sphres are at the same potential b/c connected!

$q_1 + q_2 = 1.20\,\mu C$ $\qquad V = k\frac{q_1}{r_1} = k\frac{q_2}{r_2}$

$r_1 = 6.00\,cm$

$r_2 = 2.00\,cm$ $\qquad \frac{q_1}{3\,6} = \frac{1.2\,\mu C - q_1}{\cancel{2}} \Rightarrow 3.6\times10^{-6} = 4q_1$

$q_1 = .9\,\mu C \quad q_2 = .3\,\mu C$

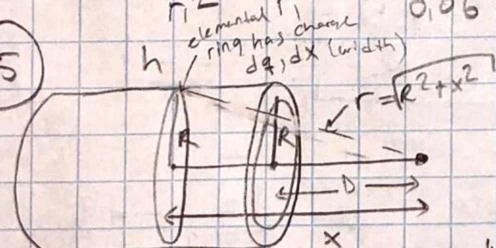
a) $V_1 = ?$

b) $E_1 = ?\ E_2 = ?$

$V = k\frac{q_1}{r} = \frac{8.99\times10^9\,(0.9\times10^{-6})}{0.06} = \boxed{1.35\times10^5\ V}$

$E_1 = k\frac{q_1}{r_1^2} = \frac{V}{r_1} = \frac{1.35\times10^5}{0.06} = \boxed{2.25\times10^6\ V/m}$ $\qquad \boxed{E_2 = \frac{V_2}{r_2} = 6.74\times10^6\ V/m}$

(75)



$\frac{Q}{\cancel{2\pi R}h} = \frac{dQ}{\cancel{2\pi R}dx}$ $\qquad dQ = \frac{Q\,dx}{h}$

one ring

$V = k\int \frac{dQ}{r} = \frac{kQ}{\sqrt{R^2+x^2}}$

whole cylinder: $V = \int dV = \int_D^{D+h} \frac{kQ\,dx}{\sqrt{R^2+x^2}\,h} = \frac{kQ}{h}\int_D^{D+h} \frac{dx}{\sqrt{R^2+x^2}}$

$= \frac{kQ}{h} \ln\left(x + \sqrt{R^2+x^2}\right)\Big|_D^{D+h}$

$$\boxed{V = \frac{kQ}{h} \ln\left(\frac{D+h+\sqrt{R^2+(D+h)^2}}{D+\sqrt{R^2+D^2}}\right)}$$