3-31-14 test 2 solutions 4B 1

(1.) $KE_i + U_i = KE_f + U_f$

$U = q \cdot V$

$0 + \dfrac{ke^2}{(9\times10^{-15})} = 2 \cdot \frac{1}{2} m v^2$

$\dfrac{9\times10^{9} \times (1.6\times10^{-19})^2}{(9\times10^{-15})} =$

$= (1.67\times10^{-27}) v^2$

$-38+9+15$

$\Rightarrow 1.6^2 \times 10^{-14} = 1.67\times10^{-27} \cdot v^2$

$v \approx \sqrt{\dfrac{2.56}{1.67} 10^{13}}$

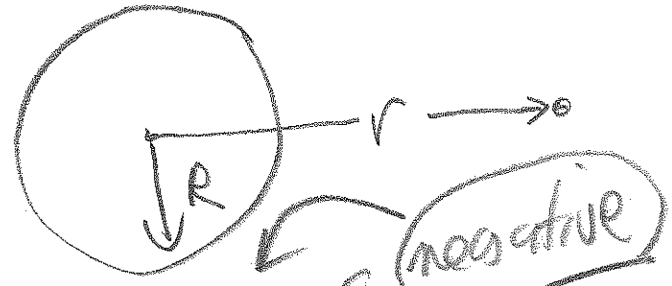
$= \sqrt{3.2\times10^{13}}$

$= \sqrt{32\times10^{12}}$

$\Rightarrow \boxed{5.7\times10^{6} \frac{m}{s}}$

(2.)

(a.)



$V(r) = \dfrac{kQ}{r} = \dfrac{-kQ}{16R}$

$= \dfrac{-Q}{64\pi\varepsilon_0 R}$

(b.) $V =$ constant if $r < R$:

$V = -\dfrac{kQ}{R}$

(c.) $V = -\dfrac{kQ}{R}$

(d.) $E = \dfrac{kQ}{r^2} = \dfrac{kQ}{256R^2}$

$= \dfrac{Q}{1024\pi\varepsilon_0 R^2}$

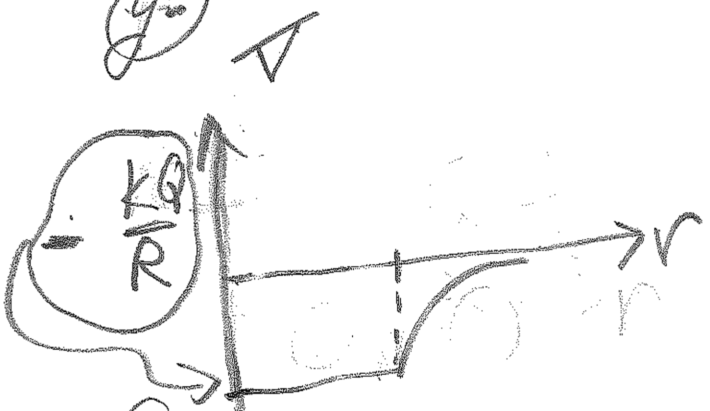
(e.) $E = 0$ (f.) $E = 0$

Test 2 solutions

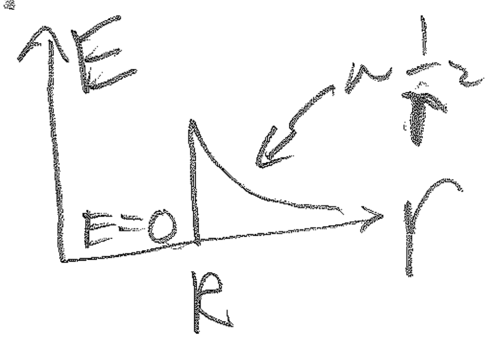
(2

(2.)

(g.)



(h.)



(3.)

$$-550 = -\frac{\lambda}{2\pi\varepsilon_0} \ln \frac{3.25}{2.25}$$

$$\lambda = \frac{550 \cdot 2\pi\varepsilon_0}{\ln \frac{3.25}{2.25}}$$

$$= \frac{550}{\left(\frac{1}{2\pi\varepsilon_0}\right) \cdot \ln \frac{3.25}{2.25}}$$

$$= \frac{550}{18\times10^9 \cdot \ln \frac{3.25}{2.25}}$$

$$= \frac{1.496\times10^3}{18\times10^9}$$

$$= 0.0831 \times 10^{-6} \text{ C/m}$$

$$= \boxed{8.31\times10^{-8} \text{ C/m}}$$

3(a.) EASY WAY: USE $\lambda \Rightarrow$

$$\Delta V = \frac{\lambda}{2\pi\varepsilon_0} \ln \frac{4.25}{3.25} = (18\times10^9)(8.31\times10^{-8}) \times (0.268)$$

$$= \boxed{401.3 \text{ (V)}}$$

ELEGANT WAY:

$$\Delta V = \frac{\lambda}{2\pi\varepsilon_0} \ln \frac{4.25}{3.25}$$

USE: $\lambda = \frac{550 \cdot 2\pi\varepsilon_0}{\ln(3.25/2.25)}$;

$$\Delta V = \frac{550 \cdot \cancel{2\pi\varepsilon_0}}{\ln \frac{3.25}{2.25}} \cdot \frac{1}{\cancel{2\pi\varepsilon_0}} \cdot \ln \frac{4.25}{3.25}$$

$$= 550 \cdot \left[\frac{\ln(4.25/3.25)}{\ln(3.25/2.25)}\right]$$

$$= 550 \cdot \left(\frac{0.268}{0.3677}\right)$$

$$= \boxed{401.3 \text{ (V)}} = \text{SAME !!}$$

(b.) $\Delta V = 0$

since $\Delta V = -\frac{\lambda}{2\pi\varepsilon_0}\ln\frac{3.25}{3.25}$

$= -\frac{\lambda}{2\pi\varepsilon_0}\cdot 0$

$= 0$

probes on equipotential surface.

(4.)

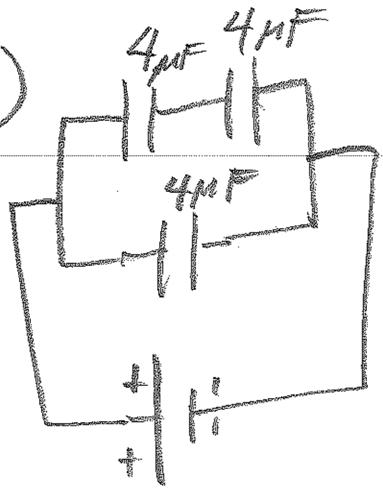


fig. 1

↓ $2\mu F = C_s$

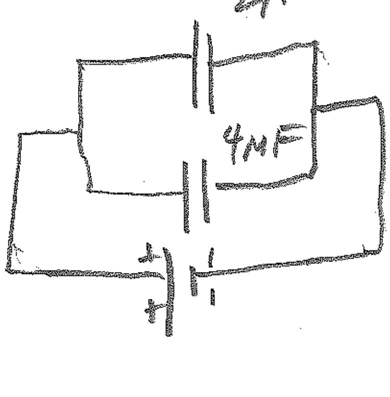


fig. 2

→

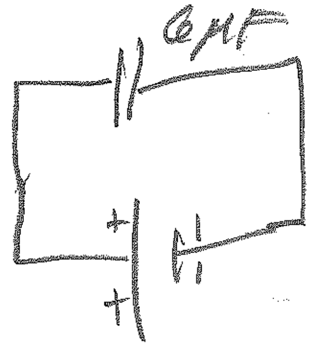


fig. 3

(b.) $Q = (6\times10^{-6})(100)$

$= 6\times10^{-4}$

$= 600\mu C$

(c.) on $4\mu F$ in fig. 2: $Q =$

$(4\times10^{-6})(100)$

$= 400\mu C$

on C_s in fig. 2,

$Q = (2\times10^{-6})(100)$

$= 200\mu C$

Thus the top 2 $4\mu F$ C_s' in fig. 1 have $Q = 200\mu F$.

#5. → see #13, CH 24

(a) $C = \frac{Q}{V} = \frac{3.30\times10^{-9}}{2.2\times10^{2}}$

$C = 1.5\times10^{-11}\,F = 15\,pF$

(b) Find a:

$$C = \frac{4\pi\varepsilon_0 ab}{b-a}$$

$$(b-a)\cdot C = 4\pi\varepsilon_0 a\cdot b$$

$$bC - aC = 4\pi\varepsilon_0 b\cdot a$$

$$a = \frac{b\cdot C}{C + 4\pi\varepsilon_0 b}$$

$= 0.031\,(m).$

(c) $E = \frac{kQ}{a^2} = \frac{(9\times10^{9})(3.3\times10^{-9})}{(0.031)^2} = \boxed{3.1\times10^{4}\ N/C}$

(d) $u_E = \frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2}(8.85\times10^{-12})(3.1\times10^{4})^2$

$u_E = \boxed{4.23\times10^{-3}}\ J/m^3$

(e) $V = \frac{kQ}{a} + \frac{(-kQ)}{b}$

$V = kQ\left[\frac{1}{a} - \frac{1}{b}\right] > 0$

(e) $V = (9\times10^{9})(3.3\times10^{-9})\left[\frac{1}{0.031} - \frac{1}{0.04}\right]$

$= \boxed{215.6\,(V)}$

(f) V = constant if $0 < r < a$:

$V = kQ\left[\frac{1}{a} - \frac{1}{b}\right]$

$= 215.6\,(V)$ SAME!!

#6.

$V = I\cdot R$

$4.5 = 17.6\cdot R$

$R = \frac{4.5}{17.6} = 0.256\ \Omega$

#7. $Q = \int_0^8 I\,dt$

$= 55t - \frac{0.65\cdot t^3}{3}\Big|_0^8$

where $t = 8$.

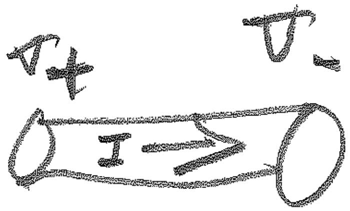
$\Rightarrow 55(8) - \frac{0.65\cdot(8)^3}{3} = \boxed{329.1\,(C)}$

(b.) $\bar{I} = \dfrac{Q}{t}$ = AVERAGE CURRENT

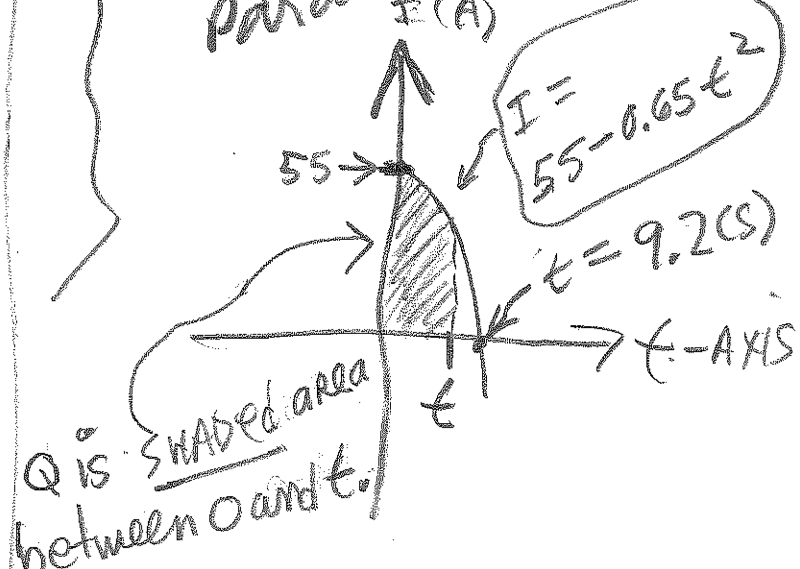
$$\bar{I} = \frac{\int_0^8 I\,dt}{(8\,\text{sec})}$$

$$= \frac{329.1(C)}{8.0(s)} = \boxed{41.14\ \text{Amps}}$$

(c.)



note: The current is an upside down parabola vs time t.



Q is the area under the I vs. t curve between 0 and t, where $t = 8.0$ (s).

$I = 0$ at $t = 9.2(s)$; set $55 - 0.65t^2 = 0$ and solve for 9.2 (s).

 3-31-14

1 a

1. When the distance between two point charges is reduced by a half, the magnitude of the potential energy is (a) doubled (b) quadrupled (c) reduced by a factor of 1/3 (d) reduced by a factor of $1/\sqrt{2}$ (e) reduced by a factor of 1/4.

2 b

3 b

2. When the magnitude of each of two interacting point charges is increased by a factor of 2, the magnitude of the potential energy is (a) doubled (b) quadrupled (c) reduced by a factor of 1/3 (d) reduced by a factor of $1/\sqrt{2}$ (e) reduced by a factor of 1/4.

4 b

3. Electric *potential* is a vector quantity. True or False. (a) True (b) False

5 a

4. The direction of an electric field *vector* is from lower to higher potential. True or False. (a) True (b) False

6 a

5. When a proton moves in the direction of the electric field, the proton's potential *energy* decreases . True or False. (a) True (b) False

7 a

6. When an electron moves in a direction opposite to the electric field, the electron's potential *energy* decreases . True or False. (a) True (b) False

8 a

7. The capacitance of a parallel plate capacitor is *inversely* proportional to its plate separation d. True or False. (a) True (b) False

9 c

8. For a given voltage difference between the plates, the electric field magnitude between the plates of a parallel plate capacitor is *inversely* proportional to the plate separation d. (a) True (b) False

$E \cdot d = \Delta V$

$E = \dfrac{\Delta V}{d}$

10 c

11 b

9. Which expression represents the potential *energy* of a capacitor with voltage difference V and charge Q on the positively charged conductor?

(a) $\frac{1}{2}CV^2$ (b) $\frac{Q^2}{2C}$ (c) all of the above (d) none of the above

10. What voltage difference will produce a current 0.25 (A) through a 4.0 ohm resistor?

(a) 16 (V) (b) 2.0 (V) (c) 1.0 (V) (d) none of the above

11. Let V(x,y) = 3x + 4y. What is the direction of the electric field? (a) 53 degrees with the positive x-axis in first quadrant (b) 53 degrees with the negative x axis in third quadrant (c) nota

$E_x = -\dfrac{\partial V}{\partial x} = -3$ and $E_y = -\dfrac{\partial V}{\partial y} = -4$