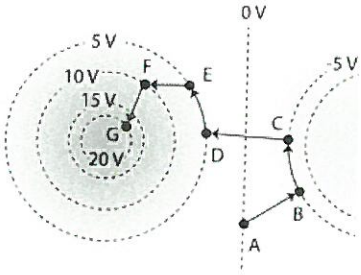
Student 7
Average 19.3/50
Best 31.5/50

12th Physics (2018 – 19)

(3rdQ, #2Mini Test)

Class	No.	Name Solutions



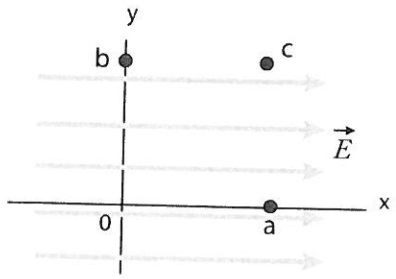
In calculation problems, describe equations clearly and systematically enough to show how to solve the problems. If not enough, you won't get any point.

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Elementary Charge	$e = 1.60 \times 10^{-19}\ C$
Electron Mass	$m_e = 9.11 \times 10^{-31}\ kg$
Proton Mass	$m_p = 1.673 \times 10^{-27}\ kg$
Coulomb's Law Constant	$k = 8.99 \times 10^9\ N \cdot m^2/C^2$
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N \cdot m^2)$
Magnetic Permeability of Free Space	$\mu_0 = 4\pi \times 10^{-7}\ T \cdot m/A$
Avogadro's Number	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Inch	$1\ in = 25.4\ mm$

4 pt/question x 13 questions = 52 pt Max 50 pt

/[Total 50 pt]

(1) A uniform electric field of magnitude 6.8×10^{-5} N/C points in the positive x direction. Find the electric potential of the following points taking the potential at origin to be zero.:
(1-a) (5.0m, 0);
(1-b) (0, 5.0);
(1-c) (5.0m, 5.0m)
(Equations)



$V = Ed = 6.8 \times 10^{-5} \times 5.0$

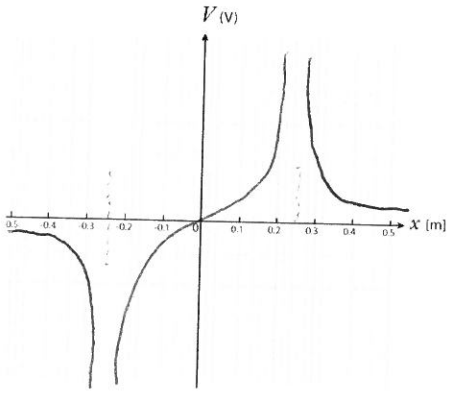
$= 34 \times 10^{-5}$

$\rightarrow 3.4 \times 10^{-4}$ [V]

(1-a) Answer -3.4×10^{-4} V
(1-b) Answer 0
(1-c) Answer -3.4×10^{-4} V

(2, 3) A dipole is formed by point charges $+3.6\,\mu$ C and $-3.6\,\mu$ C are placed on the x axis at (0.25m, 0)and (−0.25m, 0), respectively.
(2) Sketch the electric potential on the x axis for this system.

(3) At what positions on the x axis does the potential have the value 7.5 x 10^5V?
(Equations)



$$V = k\frac{Q_1}{r_1} + k\frac{Q}{r_2} = k\frac{q}{r_1} + k\frac{-q}{r_2}$$
$$= kq\left(\frac{1}{|0.25-x|} - \frac{1}{|0.25+x|}\right)$$

$$V = 7.5\times10^5\ V \Rightarrow x > 0$$

(1) $0 < x < 0.25$

$$\frac{V}{kq} = \frac{1}{0.25-x} - \frac{1}{0.25+x} = \frac{2x}{0.25^2 - x^2}$$

$$0.25^2 - x^2 = \frac{2kq}{V}x \longrightarrow x^2 + \frac{2kq}{V}x - 0.25^2 = 0$$

$$x^2 + \frac{2\times8.99\times10^9\times3.6\times10^{-6}}{7.5\times10^5}x - 0.25^2 = 0$$

$$x^2 + 8.63\times10^{-2}x - 6.25\times10^{-2} = 0$$

$$x = \frac{-0.0863 \pm \sqrt{0.0863^2 + 4\times0.0625}}{2} = 0.211 \longrightarrow 0.21[m]$$

(2) $0.25 < x <$

$$\frac{V}{kq} = \frac{1}{x-0.25} - \frac{1}{x+0.25} = \frac{0.5}{x^2 - 0.25^2}$$

$$x^2 - 0.25^2 = \frac{0.5kq}{V} = \frac{0.5\times8.99\times10^9\times3.6\times10^{-6}}{7.5\times10^5}$$

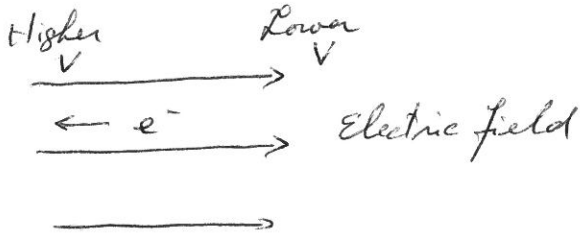
$$x = \sqrt{(2.16+6.25)\times10^{-2}} = 2.90\times10^{-1}$$

(2) Answer Sketch on the graph.

(3) Answer

0.21 m and 0.29 m

(4) An electron is released from rest in a region of space with a nonzero electric field. As the electron moves, does it experience an increasing or decreasing electric potential?

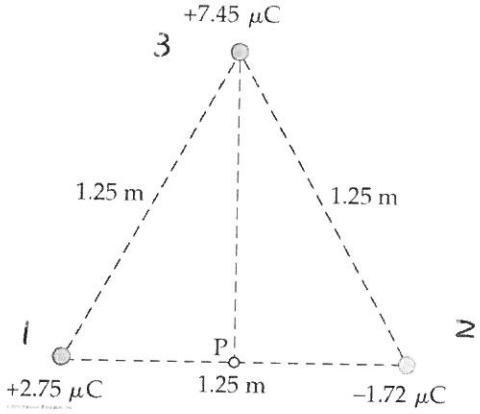


(4) Answer

Increasing

(5) Find the electric potential at point P in the figure.

(Equations)



$$V_1 = k\frac{2.75\mu}{\frac{r}{2}} = \frac{2k\mu}{r} \times 2.75$$

$$V_2 = k\frac{-1.72\mu}{\frac{r}{2}} = \frac{2k\mu}{r}(-1.72)$$

$$V_3 = k\frac{7.45\mu}{\frac{\sqrt{3}}{2}r} = \frac{2k\mu}{r} \times \left(\frac{7.45}{\sqrt{3}}\right)$$

$$V = V_1 + V_2 + V_3 = \frac{2 \times 8.99 \times 10^9 \times 10^{-6}}{1.25} \times \left(2.75 - 1.72 + \frac{7.45}{\sqrt{3}}\right)$$

$$= 14.384 \times 10^3 \times 5.3313$$

$$= 76.68 \times 10^3$$

$$\rightarrow 7.67 \times 10^4 \text{ [V]}$$

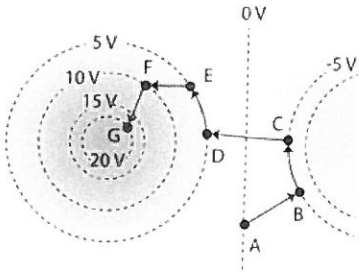
(5) Answer

7.67×10^4 V

in reference to infinity as $V = 0$

(6) The figure shows a series of equipotential surfaces in a particular section of space. When an external force exerts on a 2.0C charge and move it through the path A → B → C → D → E → F → G with a constant speed. Find the followings from the sections, AB. BC, CD, DE, EF, FG:

(6-a) The section where the work done by the external force is the largest.
(6-b) The section where the work done by the external force is zero.
(7-c) The section where the work done by the external force is negative.
(7-d) The magnitude of the work for (7-c).
(Equations)



(7-d)

$\Delta V = -5 - 0 = -5$ [V]

$W_{field} = -\Delta U = -q\Delta V$

$= -2.0 \times (-5)$

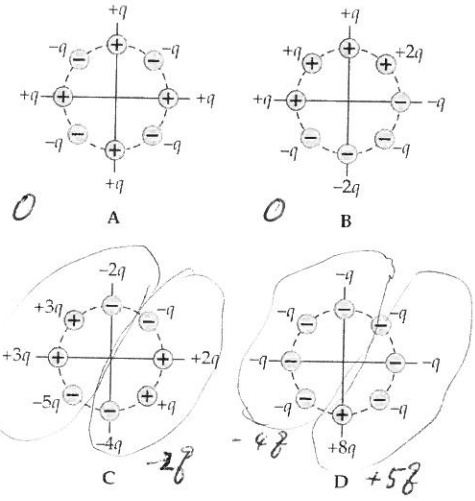
$= 10$

$W_{external} = -W_{field} = -10$ [J]

(6-a) Answer	D C F G
(6-b) Answer	D E B C

(7-c) Answer	AB
(7-d) Answer	−10 J

(8) Four different arrangements of charges are shown in the figure. In each case the charges are the same distance from the origin. Rank the four arrangements in order of the increasing electric potential at the origin, taking the potential at infinity to be zero. Indicate ties where apprpriate.
(Equations)



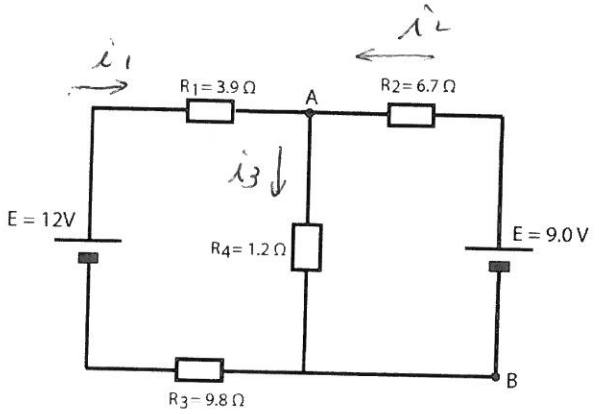
C A B D
−3q 0 0 8

(8) Answer

C < A = B < D

(9-a) Find the current and direction in R4 resistor in the figure.

(9-b) Determine the potential difference between the points A and B.
(Equations)



$i_3 = i_1 + i_2$ —①

$12 = (3.9 + 9.8)i_1 + 1.2 i_3 \rightarrow 12 = 13.7 i_1 + 1.2 i_3$ — ②

$9 = 6.7 i_2 + 1.2 i_3$ — ③

①, ② $12 = 13.7 i_1 + 1.2 i_1 + 1.2 i_2 = 14.9 i_1 + 1.2 i_2$

①, ③ $9 = 6.7 i_2 + 1.2 i_1 + 1.2 i_2 = 1.2 i_1 + 7.9 i_2$

$94.8 = 117.71 i_1 + 9.48 i_2$

$10.8 = 1.44 i_1 + 9.48 i_2$

$84 = 116.26 i_1 \rightarrow i_1 = 0.7225$

$i_2 = 1.029$

$i_3 = 1.752$

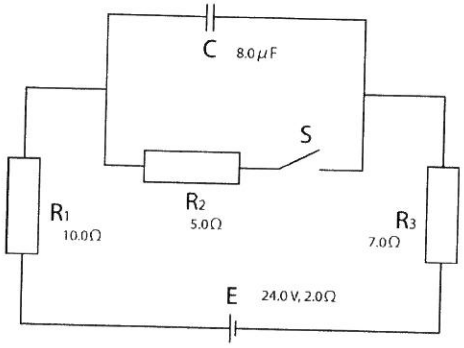
$V_4 = i_3 R_4$

$= 1.752 \times 1.2$

$= 2.10 \rightarrow 2.1$

(9-a) Answer	1.8 A downward
(9-b) Answer	2.1 V A is higher

(10~12) In the circuit at the right, E is a 24.0-V battery with 2.0-Ω internal resistance. Find followings:



(10) When the switch S is open, what is the potential difference in the capacitor C?

(11) The switch S is closed and time passes enough.
(11-a) What is the current flowing in the resistor R_1?

(11-b) What is the amount of charge stored in the capacitor?
(Equations)

(10) 24.0 V

(11-a) $i = \frac{E}{R} = \frac{24.0}{2+10+5+7} = \frac{24.0}{24.0} = 1.000 \rightarrow 1.00\,[A]$

(11-b)

$V_2 = iR_2 = 1.00 \times 5.0 = 5.00\,[V]$

$Q = CV = 8.0 \times 10^{-6} \times 5.00 = 40 \times 10^{-6}\,C$

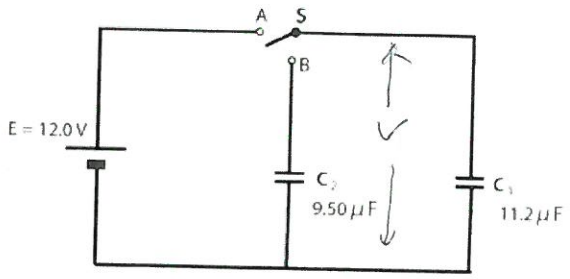
(10) Answer
24.0 V

(11-a) Answer
1.00 A
(11-b) Answer
40. μC

(12, 13)In the first stage, the switch position A, the 11.2-μF capacitor is fully charged by the 12-V battery, and the 9.50-μF capacitor is uncharged.
(12) Find the charge stored on the capacitor C1.

(13)In the second stage, the switch is now moved to position B. As a result, charge flows between the capacitors.

(13-a) Find the voltage at equilibrium.
(13-b) In the process from the first stage to the second stage, how much does the energy stored in the capacitors change?



(12) $Q = C_1 V = 11.2\times10^{-6}\times 12 = 134.4\times10^{-6} \rightarrow 1.34\times10^{-4}$

(13-a) $Q_1 = C_1 V$, $Q_2 = C_2 V$

$Q_1 + Q_2 = V(C_1 + C_2) = 1.344\times10^{-4}$ [C]

$V = \dfrac{1.344\times10^{-4}}{(11.2+9.50)\times10^{-6}} = 0.06493\times10^{2} \rightarrow 6.49$

(13-b) $U_i = \frac{1}{2}C_1 V_0^2 = \frac{1}{2}\times11.2\times10^{-6}\times12.0^2 = 806.40\times10^{-6}$

$U_f = \frac{1}{2}C_1 V^2 + \frac{1}{2}C_2 V^2 = \frac{1}{2}(11.2+9.50)\times10^{-6}\times 6.493^2$

$= 436.35\times10^{-6}$

$\Delta U = U_f - U_i = (436.35 - 806.40)\times10^{-6} = -3.70\times10^{-4}$ J

(12) Answer	1.34×10^{-4} C

(13-a) Answer	6.49 V
(13-b) Answer	-3.70×10^{-4} J