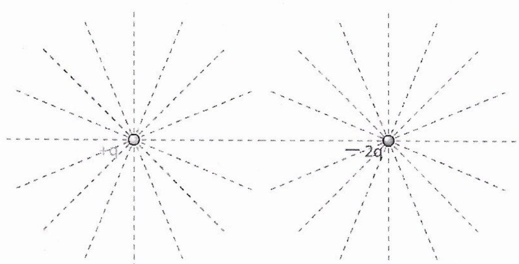
Student 7
Average 23.8 / 50
Best 38.0 / 50

12th Physics (2018 – 19)

(3rdQ, #1Mini 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 points.

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	$N_A = 6.02 \times 10^{23}\ mol^{-1}$
Inch	1 in = 25.4 mm

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

／[Total 50 pt]

(1) A charged rod is brought near a suspended object, which is repelled by the rod. Can we conclude that the suspended object is charged? Answer with yes" or "no" first and explain using technical terms of physics.

(1) Answer

Yes.

If the suspended object is a neutral insulator, it is attracted toward the charged rod due to polarization. If the suspended object is a neutral conductor, it is also attracted toward the charged rod due to induction. Therefore, if the suspended object is repelled by the charged rod, the suspended object is inevitably charged.

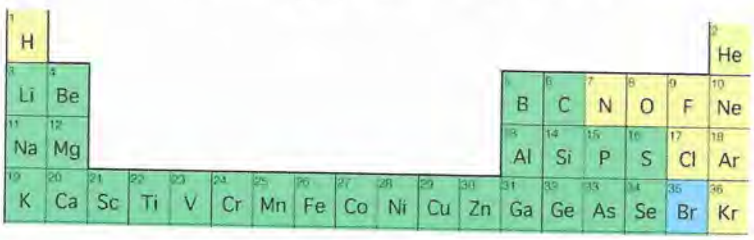
(48%)

(4) Find the amount of negative electric charge in one mole of neutral magnesium atoms. (Equations)

$$1\,\text{mol} \times \frac{6.022 \times 10^{23}\,\text{atom}}{1\,\text{mol}} \times \frac{12\,\text{electrons}}{1\,\text{atom}} \times \frac{-1.60 \times 10^{-19}\,\text{C}}{1\,\text{electron}}$$

$$= -115.6 \times 10^{23-19}$$

$$= -1.156 \times 10^{6}\,(\text{C}) \rightarrow -1.16 \times 10^{6}\,\text{C}$$

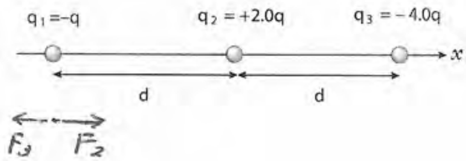


(58%)

(2) Answer

$-1.16 \times 10^{6}\,\text{C}$

(3) Given that q = +12 μ C and d = 16 cm, find the direction and the magnitude of the total electrostatic force exerted on the charge q_1. (Equations)



$$F = F_2 - F_3$$

$$= k\frac{|-q||2q|}{d^2} - k\frac{|-q||-4q|}{(2d)^2}$$

$$= \frac{k \cdot 2q^2}{d^2} - \frac{k \cdot 4q^2}{4d^2}$$

$$= \frac{kq^2}{d^2}(2-1)$$

$$= \frac{8.99\times10^9 \times 12^2 \times 10^{-12}}{16^2 \times 10^{-4}}$$

$$= 5.057 \times 10^{9-12+4}$$

$$= 50.57 \longrightarrow 51$$

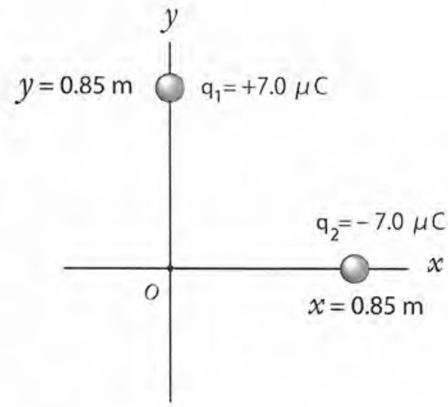
(3) Answer

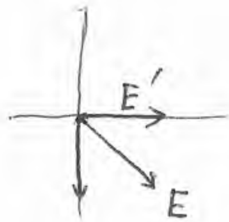
51 N

To positive x

(33%)

(4) An electric charge q1 = +7.0 μ C is placed on the y axis at y = 0.85 m. Anther charge q2 = −7.0 μ C is placed on the x axis at x = 0.85 m. Find the magnitude and direction of the total electric field at the origin due to the two charges.
(Equations)





$$E = \sqrt{2}\,E'$$
$$= \sqrt{2} \cdot k \frac{|q|}{d^2}$$
$$= \sqrt{2} \times 8.99 \times 10^9 \times \frac{7.0 \times 10^{-6}}{0.85^2}$$
$$= 123.2 \times 10^{9-6}$$
$$= 1.232 \times 10^5 \rightarrow 1.2 \times 10^5$$

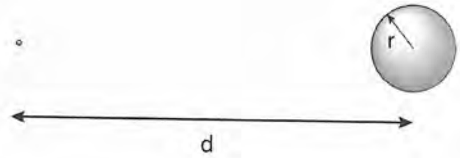
(4) Answer

1.2×10^5 N/C

−45° from positive x axis

(64%)

(5) A sphere of radius 4.22 cm and uniform surface charge density + 12.1 μ C /m2 exerts an electrostatic force of magnitude 46.9 x 10−3 N on a point charge of+1.95 μ C. Find the separation between the point charge and the center of the sphere.



(Equations)

$r = 4.22\,cm = 4.22\times10^{-2}\ m$

$\sigma = 12.1\ \mu C/m^2$

$F = 46.9\times10^{-3}\ N$

$q = 1.95\times10^{-6}\ C$

$Q = \sigma A = 12.1\times10^{-6}\times 4\pi r^2 = 12.1\times10^{-6}\times4\pi\times4.22^2\times10^{-4}$

$= 2708\times10^{-10} = 2.708\times10^{-8}$

$F = k\dfrac{|q||Q|}{d^2}$

$d = \sqrt{\dfrac{k|q||Q|}{F}}$

$= \sqrt{\dfrac{8.99\times10^{9}\times1.95\times10^{-6}\times12.1\times10^{-6}\times4\pi\times4.22^2\times10^{-4}}{46.9\times10^{-3}}}$

$= \sqrt{1012.27\times10^{9-6-6-4+3}}$

$= \sqrt{1012.27\times10^{-4}}$

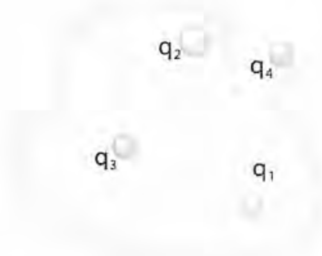
$= 31.82\times10^{-2} \rightarrow 0.318$

(5) Answer

$0.318\ m$

(30%)

(6) Three charges, $q_1 = 3.2\,\mu$ C, $q_2 = 3.9\,\mu$ C, and $q_3 = -9.1\,\mu$ C, are enclosed inside a surface while a charge, $q_4 = -7.5\,\mu$ C is outside the surface. Find the electric flux through this surface.



(Equations)

$$\Phi = \frac{\text{Enclosed Charge}}{\varepsilon_0} = \frac{(3.2+3.9-9.1)\times 10^{-6}}{8.85\times 10^{-12}}$$

$$= -0.2260\times 10^{6}$$

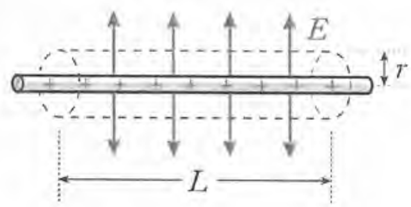
$$= -2.260\times 10^{5} \longrightarrow -2.3\times 10^{5}$$

(3) Answer $-2.3\times 10^{5}\ N\cdot m^2/C$ (4%)

(7) Charges are uniformly distributed on a long and thin rod at a charge density 8.8 μ C/m. Suppose a cylinder with a radius r = 1.0 cm and length L = 10.0 cm.

(7-a) Find the total number of electric field lines crossing the surface of the cylinder.

(7-b) Find the magnitude of electric field at the side surface of the cylinder.



(Equations)

$$\sigma = 8.8\times 10^{-6}\ C/m$$

(a) $$\Phi = \frac{\text{Enclosed Charge}}{\varepsilon_0} = \frac{8.8\times 10^{-6}\times 10\times 10^{-2}}{8.85\times 10^{-12}}$$

$$= 0.994\times 10^{1-2-6+12} = 0.994\times 10^{5} \Rightarrow 9.9\times 10^{4}$$

(b) $$\Phi = EA$$

$$= E\cdot 2\pi r\cdot L$$

$$E = \frac{\Phi}{2\pi r L}$$

$$= \frac{0.994\times 10^{5}}{2\pi\times 1.0\times 10^{-2}\times 10\times 10^{-2}}$$

$$= 0.1582\times 10^{5+2+2-1}$$

$$= 0.1582\times 10^{8}$$

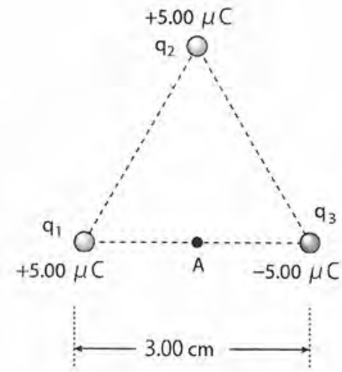
$$\longrightarrow 1.6\times 10^{7}$$

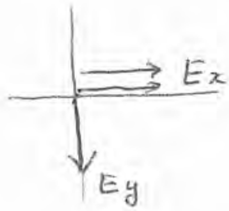
(7-a) Answer 9.9×10^{4} lines

(7-b) Answer 1.6×10^{7} N/C

(8%)

(8) In the figure at the right, three point charges are placed at the vertices of an equilateral triangle. Find the direction and magnitude of the electric field at a point A halfway between q1 and q3.
(Equations)





$$E_x = k\frac{q}{\left(\frac{d}{2}\right)^2} \times 2$$

$$= \frac{8k}{d^2}$$

$$E_y = k\frac{q}{\left(\frac{\sqrt{3}}{2}d\right)^2} = -\frac{4kq}{3d^2}$$

$$E = \sqrt{E_x^2 + E_y^2} = \frac{kq}{d^2}\sqrt{8^2 + \left(\frac{4}{3}\right)^2} = 8.1104 \times \frac{kq}{d^2}$$

$$= 8.1104 \times \frac{8.99 \times 10^9 \times 5 \times 10^{-6}}{3^2 \times 10^{-4}}$$

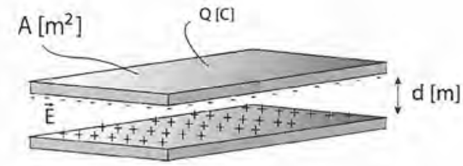
$$= 40.51 \times 10^7 \longrightarrow 4.05 \times 10^8 \ (N/C)$$

$$\theta = \tan^{-1}\left(\frac{E_y}{E_x}\right) = \tan^{-1}\left(\frac{-\frac{4}{3}}{8}\right) = \tan^{-1}\left(\frac{1}{6}\right) = -9.482^\circ \rightarrow -9.46^\circ$$

(8) Answer 4.05×10^8 N/C
-9.46° from positive x axis

(39%)

(9~12) A parallel-plate capacitor has plates with an area of A=0.036 m^2 and a separation of d=0.75 mm. The magnitude of electric field E=2.88 x 10^7 N/C.



(9) Find the charge on the capacitor plates.
(10) Find the potential difference between the plates.
(11) A particle with a mass of 3.8 g and a charge of + 4.56 x 10^{-6} C is released from rest at the positive plate and moves to the negative plate. Find the change in electric potential energy for this charge.
(12) Find the speed of the particle when it reaches the negative plate.
(Equations)

(9) $E = \frac{\sigma}{\varepsilon_0} \rightarrow \sigma = E\varepsilon_0 = 2.88\times10^{7} \times 8.85\times10^{-12}$

$= 25.488 \times 10^{-5}$

$Q = A\sigma = 0.036 \times 25.488\times10^{-5} = 0.918 \times 10^{-5}$

$\rightarrow 9.2\times10^{-6}$ C

(10) $E = \frac{\Delta V}{d} \rightarrow \Delta V = Ed$

$= 2.88\times10^{7} \times 0.75\times10^{-3}$

$= 2.16\times10^{4} \longrightarrow 2.2\times10^{4}$ (V)

(11) $\Delta U = q\Delta V$

$= 4.56 \times10^{-6} \times 2.16\times10^{4}$

$= 9.8496\times10^{-2} \rightarrow 9.8\times10^{-2}$ J

U shold decreases. $\Delta U < 0$

(9) Answer 9.2×10^{-6} C (45%)

(10) Answer 2.2×10^{4} V (39%)

(11) Answer -9.8×10^{-2} J (18%)

(12) Answer 7.2 m/s (17%)

(12) $\frac{1}{2}mv^2 = \Delta U$ (>0)

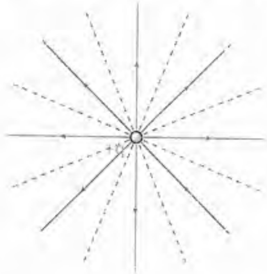
$v = \sqrt{\frac{2\Delta U}{m}}$

$= \sqrt{\frac{2\times9.85\times10^{-2}}{3.8\times10^{-3}}}$

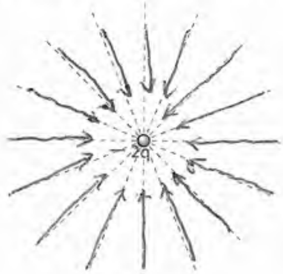
$= 7.20$ (m/s)

$\rightarrow 7.2$ (m/s)

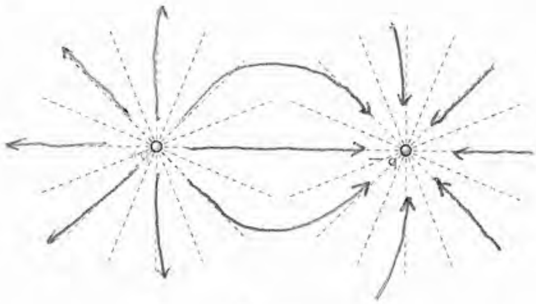
(13) Figure (a) shows electric field lines point away from a positive charge +q1. Based on this, depict electric field lines for Figures (b) ~ (e).



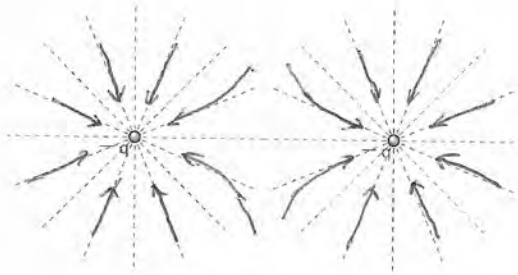
(a)



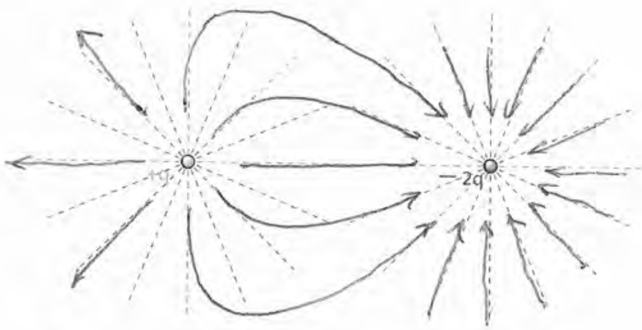
(b)



c)



(d)



(e)

(13) Answer
Depict lines inside figures.

(78%)