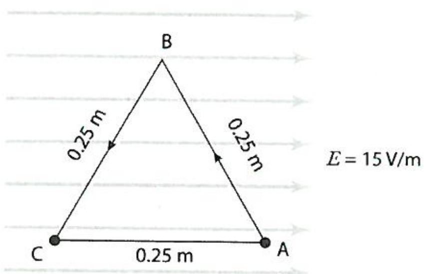
Student 8
Average 40.8 /100
Best 82.0 /100

12^{th}G Physics (2018– 19)

3^{rd} Q Exam

(March 21, 2019)

Class	No.	Name Solutions



In a calculation problem, describe equations clearly and systematically enough to show how to solve the problem. <u>If not enough, you won't get any points.</u>

5point/question x 21questions=105points
Max 100 points

Exam	／[Total 100 点]

Lab Reports	Homework

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Atmospheric Pressure	$1.00\ atm = 1.013 \times 10^5\ Pa$
Avogadro's Number	$N_A = 6.022 \times 10^{23}$ molecule / mol
Universal Gas Constant	$R = 8.31\ J/(mol \cdot K)$
Boltzmann Constant	$k = 1.38 \times 10^{-23}\ J/K$
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	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N \cdot m^2)$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Avogadro's Number	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Magnetic Permeability of Free Space	$\mu_0 = 4\pi \times 10^{-7}\ T \cdot m/A$

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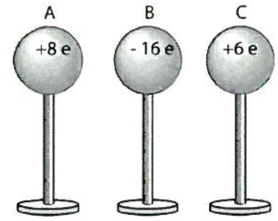
(1) The diagram shows the initial charges and positions of three metal spheres, A, B and C on insulating stands. A is brought into contact with B and then removed. Then B is brought into contact with C and removed. What is the charge on C?



(Equations)

$$\frac{+8-16}{2} = \frac{-8}{2} = -4$$

$$\frac{-4+6}{2} = \frac{2}{2} = 1$$

(1) Answer

$+1e$

36 %

(2) Find the total electric charge of 1.5 kg of protons.

(Equations)

$$1.5\ \text{kg} \times \frac{1\ \text{proton}}{1.673\times10^{-27}\ \text{kg}} \times \frac{1.60\times10^{-19}\ C}{1\ \text{proton}}$$

$$= 1.435\times10^{8}\ (C)$$

$$\rightarrow 1.4\times10^{8}\ C$$

(2) Answer

$1.4\times10^{8}\ C$

63 %

(3) The attractive electrostatic force between the point charges +8.44 x 10^{-6} C and Q has a magnitude of 0.975 N when the separation between the charges is 1.31m. Find the sign and magnitude of the charge Q.

(Equations)

$$F = k\frac{|q||Q|}{r^2}$$

$$|Q| = \frac{F r^2}{k q}$$

$$= \frac{0.975 \times 1.31^2}{8.99 \times 10^9 \times 8.44 \times 10^{-6}}$$

$$= 0.022052 \times 10^{-3}$$

$$\rightarrow 2.21 \times 10^{-5}\ C$$

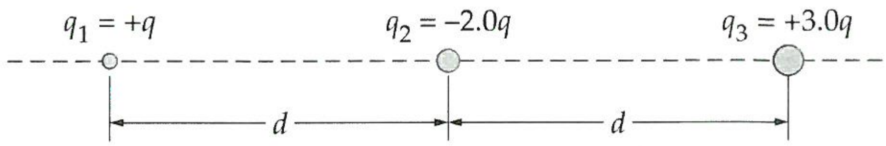
(3) Answer

-2.21×10^{-5} C

64 %

(4) Given that q = +12.1 μ C and d = 16 cm, find the direction and magnitude of the net electrostatic force exerted on the point charge q1 in the figure.

(Equations)



$F_3 \longleftarrow \circ \longrightarrow F_2$

$$F = F_2 - F_3$$

$$= k\frac{|8||28|}{d^2} - k\frac{8 \cdot 38}{(2d)^2} = \frac{2k8^2}{d^2} - \frac{3k8^2}{4d^2}$$

$$= \frac{k8^2}{d^2}\left(2 - \frac{3}{4}\right)$$

$$= \frac{8.99\times10^9 \times 12.1^2 \times 10^{-12} \times \frac{5}{4}}{0.16^2}$$

$$= 64269 \times 10^{-3}$$

$$= 6.4269 \times 10^1 \longrightarrow 64\ N$$

(4) Answer

64 N

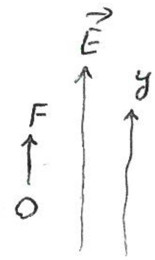
49%

3/21/2019 By Tohei Moritani

(5) A +5.0-μ C charge experiences a 0.44-N force in the positive y direction. If this charge is replaced with a −2.7- μ C charge, what force will it experience?

(Equations)

$$E = \frac{F}{q} = \frac{0.44}{5\times10^{-6}} \; [N/C] \quad +5.0\mu C$$



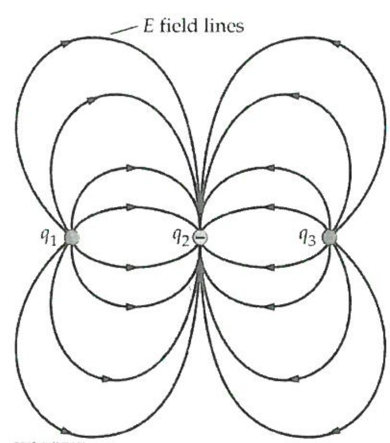
$$F' = q'E$$

$$= -2.7\times10^{-6} \times \frac{0.44}{5\times10^{-6}}$$

$$= -0.238 \longrightarrow -0.24 \; [N]$$

(5) Answer
−0.24 N
negative y

73%



(6) Referring to the figure, suppose q_2 is not known. Instead, it is given that $q_1 + q_2 = -2.5$ μ C. Find q_1, q_2, and q_3.

(Equations)

$$q = q_1 = q_3$$

$$q_2 = -2q$$

$$q_1 + q_2 = -2.5 \rightarrow q - 2q = -2.5$$

$$\rightarrow q = 2.5$$

$$q_2 = -2\times2.5 = -5.0$$

q_1 +2.5 μC

q_2 −5.0 μC

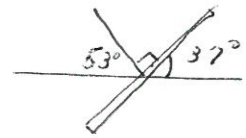
q_3 +2.5 μC

24%

(7) A uniform electric field of magnitude 25,000 N/C makes an angle of 37° with a plane surface of area 0.0153 m², What is the electric flux through this surface?

(Equations)

$\Phi = EA\cos\theta$



$\Phi = 25000 \times 0.0153 \cos 53°$

$= 230.2$

(7) Answer

230 $N \cdot m^2/C$

64%

(8) When an ion accelerates through a potential difference of 2140 V, its electric potential energy decreases by 1.37 x 10^{-15} J. What is the valence of the ion?

(Equations) $U = qV$

$q = \frac{U}{V} = \frac{1.37 \times 10^{-15}}{2140}$

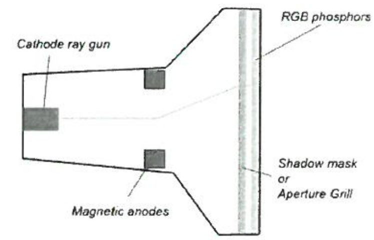
$\frac{q}{e} = \frac{1.37 \times 10^{-15}}{2140 \times 1.60 \times 10^{-19}} = 4.00$

(8) Answer

± 4

40%

(9) The electrons in a TV picture tube are accelerated from rest through a potential difference of 25 kV. What is the speed of the electrons after they have been accelerated by this potential difference?



(Equations)

$$eV = \frac{1}{2} m v^2$$

$$v = \sqrt{\frac{2eV}{m}}$$

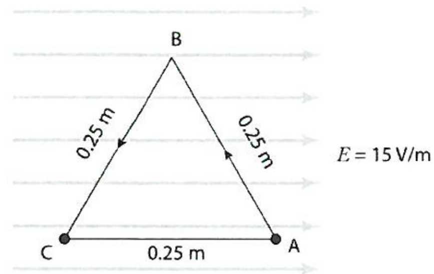
$$= \sqrt{\frac{1.60\times 25\times 2 \times 10^{-16}}{9.11\times 10^{-31}}} = \sqrt{8.78\times 10^{15}} = \sqrt{87.8}\times 10^{7}$$

$$= 9.37\times 10^{7} \longrightarrow 9.4\times 10^{7}\ \text{m/s}$$

(9) Answer
9.4×10^{7} m/s

40%

(10) An electron is moved from point A to point B and then to point C along two legs of an equilateral triangle with sides of length 0.25 m, as shown in the figure. The horizontal electric field is 15 V/m.



(10-a) What is the magnitude of the work required?

(10-b) What is the potential difference between points A and C?

(10-c) Which point is at a higher potential?

(Equations)

$E = 15$ V/m

(a) $V = Ed = 15 \times 0.25$ [V]

$W = qV = -1.60 \times 10^{-19} \times 15 \times 0.25$

$= -6.00 \times 10^{-19}$ [J]

(b)

$V = 15 \times 0.25 = 3.75 \longrightarrow 3.8$ [V]

(c)

(10-a) Answer
-6.0×10^{-19} J
(10-b) Answer
3.8 V
(10-c) Answer
C

48 %

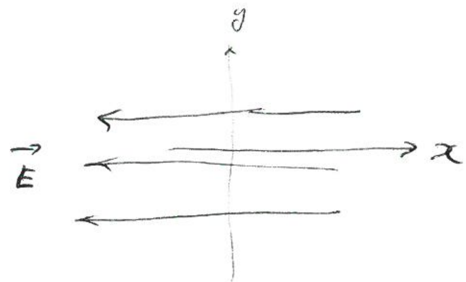
(11) Consider a region in space where a uniform electric field E = 6500 N/C in the negative x direction.

(11-a) What is the orientation of the equipotential surfaces? Choose one from the followings: parallel to the yz plane; parallel to the xz plane; parallel to the xy palane.

(11-b) If you move in the positive x direction, does the electric potential increase or decrease?

(11-c) What is the distance between the +14-V and the +16-V equipotentials?

(Equations)



(a)

(b)

(c) $\frac{16-14}{x} = 6500\ V/m$

$x = \frac{2}{6500} = 3.08 \times 10^{-4} \rightarrow 3 \times 10^{-4}\ (m)$

(11-a) Answer parallel to yz plane
(11-b) Answer decreases
(11-c) Answer 3×10^{-4} m

54 %

(12) A parallel-plate capacitor is constructed with circular plates of radius 0.056 m. The plates are separated by 0.25 mm, and the space between the plates is filled with a dielectric with dielectric constant ε_r. When the charge on the capacitor is 1.2 μC the potential difference between the plates is 750 V. Find the value of the dielectric constant ε_r.

(Equations)

$r = 0.056\ m$

$V = 750\ V$

$$C = \varepsilon_r \varepsilon_0 \frac{A}{d}, \quad Q = CV$$

$$\frac{Q}{V} = \varepsilon_r \varepsilon_0 \frac{A}{d}$$

$$\varepsilon_r = \frac{Q d}{V \varepsilon_0 A}$$

$$= \frac{1.2 \times 10^{-6} \times 0.25 \times 10^{-3}}{750 \times 8.85 \times 10^{-12} \times \pi \times 0.056^2}$$

$$= 0.004590 \times 10^{-9+12}$$

$$= 4.590 \longrightarrow 4.6$$

(12) Answer

4.6

35%

(13) A 0.22-μF capacitor is charged by a 1.5-V battery. After being charged, the capacitor is connected to a small electric motor. Assume 100% efficiency.

(13-a) To what height can the motor lift a 5.0-g mass?

(13-b) What initial voltage must the capacitor have if it is to lift a 5.0-g mass through a height of 1.0 cm?

(Equations)

(a) $U = \frac{1}{2}CV^2$, $U = mgh$) $mgh = \frac{1}{2}CV^2$

$h = \frac{CV^2}{2mg} = \frac{0.22\times10^{-6}\times1.5^2}{2\times5\times10^{-3}\times9.80}$

$= 5.0505\times10^{-6} \rightarrow 5.1\times10^{-6}\,m$

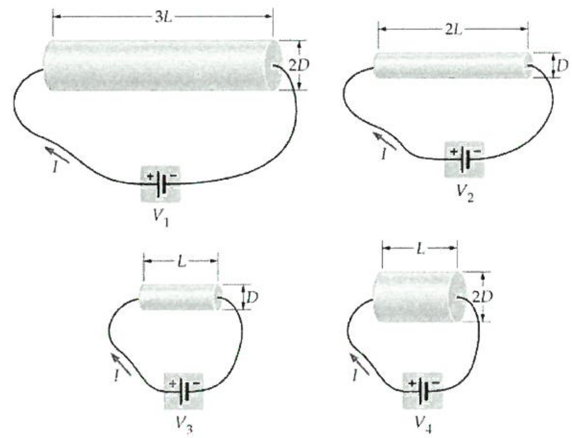
(b) $V = \sqrt{\frac{2mgh}{C}} = \sqrt{\frac{2\times5\times10^{-3}\times9.80\times10^{-2}}{0.22\times10^{-6}}}$

$= \sqrt{4450} = 66.7 \rightarrow 67$

(13-a) Answer
5.1 μm
(13-b) Answer
67 V

21%

(14) The four conducting cylinders shown in the figure are all made of the same material, though they differ in length and/or diameter. They are connected to four different batteries, which supply the necessary voltages to give the circuits the same current, I. Rank the four voltages, V1, V2, V3, and V4, in order of increasing value. Indicate ties using the sign of >.



(Equations)

$R_1 = \rho \frac{3L}{\pi D^2} = \frac{\rho L}{\pi D^2} \cdot 4$

$R_2 = \rho \frac{2L}{\pi(\frac{D^2}{4})} = \text{"} \cdot 8$

$R_3 = \rho \frac{L}{\pi(\frac{D^2}{4})} = \text{"} \quad 4$

$R_4 = \rho \frac{L}{\pi D^2} = \text{"} \quad 1$

$R_4 < R_1 < R_3 < R_2$

$V = IR$

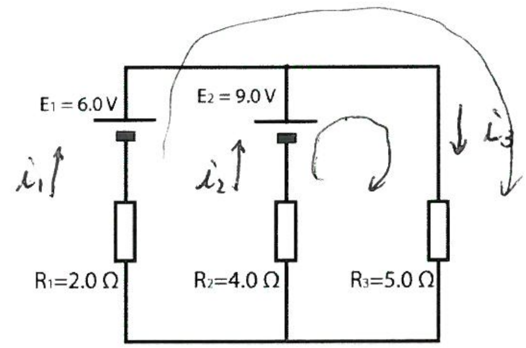
(14) Answer

$V_4 < V_1 < V_3 < V_2$

38%

(15) Two batteries and three resistors are connected as shown in the figure. How much current flows through each battery?

(Equations)



$i_3 = i_1 + i_2$ — ①

$6 = 2i_1 + 5i_3$ — ②

$9 = 4i_2 + 5i_3$ — ③

$6 = 2i_1 + 5i_1 + 5i_2 = 7i_1 + 5i_2$ — ②'

$9 = 4i_2 + 5i_1 + 5i_2 = 5i_1 + 9i_2$ — ③'

$54 = 63i_1 + 45i_2$

$-)\ 45 = 25i_1 + 45i_2$

$9.0 = 38i_1$ $\quad i_1 = 0.237$

② ' → $i_2 = \frac{6 - 7i_1}{5}$

$= \frac{6 - 7 \times 0.237}{5} = 0.868$

$i_3 = i_1 + i_2 = 1.105$

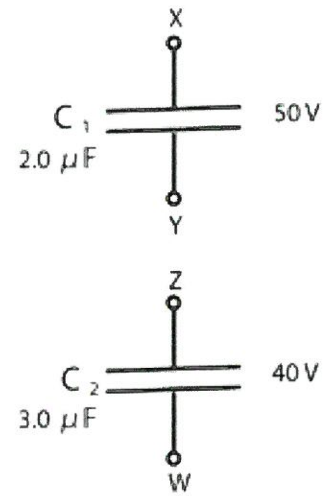
(15) Answer	
E1	0.24 A
E2	0.87 A

40%

(16, 17) Two capacitors, C1 and C2, with capacitances of 2.0 μ F and 3.0 μ F, respectively are charged with 50 V and 40 V, respectively. X and Z are positive electrodes while Y and W are negative ones. Find the electric potential between the plates and the charge on C1 in the following two cases:

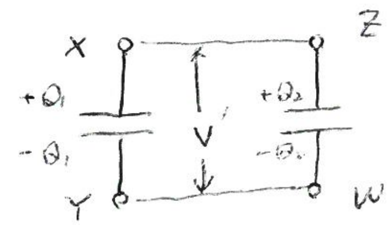
(16) In the case where X is connected with Z, and Y is connected with W.

(17) In the case where X is connected with W, and Y is connected with Z.



(Equations)

(a)



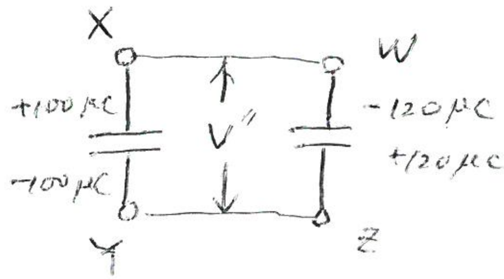
$Q_1 = C_1 V_1 = 2.0\mu \times 50 = 100\mu C$

$Q_2 = C_2 V_2 = 3.0\mu \times 40 = 120\mu C$

$C_1 V' + C_2 V' = 220\mu$ $\quad V' = \frac{220\mu}{2.0\mu + 3.0\mu} = 44.0 (V)$

$Q_1' = C_1 V' = 2.0\mu \times 44.0 = 88\mu (C)$

(b)



$C_1 V'' + C_2 V'' = 100\mu - 120\mu$

$V'' = \frac{-20\mu}{2.0\mu + 3.0\mu} = -4.0 V$

potential $= 4.0 V$

$Q_1'' = C_1 V'' = 2.0\mu \times 4.0 = 8.0\mu (C)$

(16) Answer

44 V

88 μC

13 %

(17) Answer

4.0 V

8.0 μC

13 %

(18) An electron accelerated from rest through a voltage of 550 V enters a region of constant magnetic field. If the electron follows a circular path with a radius of 17 cm, what is the magnitude of the magnetic field?

(Equations)

$$eV = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2eV}{m}}$$

$$qvB = m\frac{v^2}{r}$$

$$B = \frac{mv}{er} = \frac{m}{er}\sqrt{\frac{2eV}{m}} = \frac{1}{r}\sqrt{\frac{2mV}{e}}$$

$$= \frac{1}{0.17}\sqrt{\frac{2 \times 9.11 \times 10^{-31} \times 550}{1.60 \times 10^{-19}}}$$

$$= \frac{1}{0.17}\sqrt{6263 \times 10^{-12}}$$

$$= \frac{79.14}{0.17} \times 10^{-6}$$

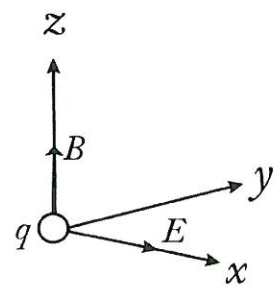
$$= 466 \times 10^{-6} \longrightarrow 4.7 \times 10^{-4} \text{ (T)}$$

(18) Answer

4.7×10^{-4} T

16%

(19) A 6.60 μ C particle moves through a region of space where an electric field of magnitude 1250 N/C points in the positive x direction, and a magnetic field of magnitude 1.02 T points in the positive z direction. If the net force acting on the particle is 6.23 x 10^{-3} N in the positive x direction, find the magnitude and direction of the particle's velocity.



(Equations)

+ charge to positive y

$F_E = qE$

$F_B = qvB$

$F = F_E + F_B = qE + qvB$

$$v = \frac{F - qE}{qB}$$

$$= \frac{6.23\times10^{-3} - 6.60\times10^{-6}\times1250}{6.60\times10^{-6}\times1.02}$$

$$= \frac{(6.23 - 8.25)\times10^{-3}}{6.732\times10^{-6}}$$

$$= -0.3001\times10^{3}$$

$\rightarrow -300$ [m/s]

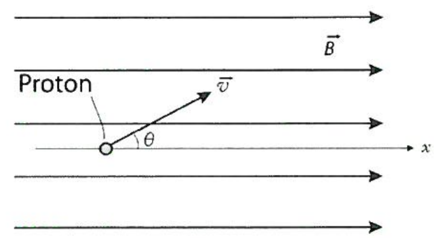
(19) Answer

300 m/s

to negative y

26%

(20-21) A proton is sent with a speed of 1.05 x 105 m/s into a uniform magnetic field of 0.750 T at an angle $\theta = 30.0^\circ$ as shown in the figure.



(20) Find the period of the spiral movement of the proton.

(21) Find the distance the particle travels in the direction of the magnetic field during one cycle.

(Equations)

$$v_x = v\cos\theta = 1.05\times10^5\cos30^\circ$$

$$v_y = v\sin\theta = 1.05\times10^5\sin30^\circ$$

$$q v_y B = m\frac{v_y^2}{r} \rightarrow \frac{r}{v_y} = \frac{m}{qB} \quad -①$$

$$T = \frac{2\pi r}{v_y} \quad -② \qquad ①,② \rightarrow T = \frac{2\pi m}{qB}$$

$$①,② \quad T = \frac{2\pi m}{qB} = \frac{2\pi\times1.673\times10^{-27}}{1.60\times10^{-19}\times0.750} = 8.761\times10^{-27+19}$$

$$\rightarrow 8.76\times10^{-8}\ \text{s}$$

$$x = v_x t = 1.05\times10^5\cos30^\circ\times8.761\times10^{-8}$$

$$= 7.967\times10^{-3}\ [\text{m}]$$

(20) Answer

8.76×10^{-8} s

43%

(21) Answer

7.97×10^{-3} m

19%

Your opinions

The solution will be shown on the Website of Physic Class tomorrow night.