PHY 232C – EXAM 1 Form 1 June 17, 2003

All your answers should appear on the bubble sheets. Please fill in the circles on the sheets using a number 2 pencil. Use the margins or the backs of your exam pages for scratch paper. You may take these exam pages with you when you leave.

Constants in SI units:

The charge on an electron is -1.6×10^{-19} C

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N{\cdot}m^2/C^2}$$

permeability $\mu_0 = 4\pi \times 10^{-7}$ T·m/A

1. An ion consists of 10 protons, 12 neutrons and 12 electrons. What is the charge on the ion?

a. 1.6×10^{-19} C
b. 3.2×10^{-19} C
c. -1.6×10^{-19} C
d. -3.2×10^{-19} C
e. 0 C

$10(+e) + 12(-e)$

$= -2e = -2 \times 1.6 \times 10^{-19} C$

$= \boxed{-3.2 \times 10^{-19} C}$

2. A positive point charge +q is placed to the right of two charges, A and B. The net force on the +q charge is found to be zero. Which statement below, a through d is false; if none are false choose e?

a. B must have the opposite sign of A
b. Changing the medium between the charges to one with a dielectric constant of 2 would have no effect on the net force.
c. Reversing the sign of the charge from +q to –q would have no effect on the net force.
d. The magnitude of charge A must be larger than the magnitude of charge B
e. None of the above statements are false.

3. A metal sphere of radius R = 10 cm carries a total charge Q = +10 μC. What is the electric field just outside the sphere?

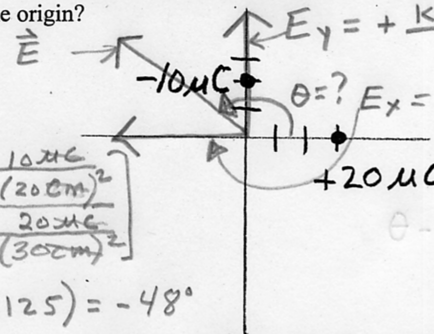
a. 9.0×10^1 N/C toward the center of the sphere
b. 9.0×10^5 N/C toward the center of the sphere
c. 9.0×10^5 N/C away from the center of the sphere
d. 9.0×10^6 N/C toward the center of the sphere
e. 9.0×10^6 N/C away from the center of the sphere

$$|\vec{E}| = \frac{KQ}{r^2} = \frac{(9\times10^9 \frac{N\cdot m^2}{C^2})(10\times10^{-6}C)}{(10\times10^{-2}m)^2} = 9\times10^6\ N/C$$

AWAY FROM SPHERE'S CENTER

4. A -10μC charge is placed on the y-axis at y=20cm and a +20μC charge is placed on the x-axis at x=30cm. What is the direction with respect to the positive x axis of the electric field at the origin?

Q_1 Q_2



$E_y = +\frac{K|Q_1|}{r_1^2}$

$E_x = -\frac{K|Q_2|}{r_2^2}$

$\theta = \tan^{-1}\left(\frac{E_y}{E_x}\right)$

$= \tan^{-1} \frac{KQ_1/r_1^2}{KQ_2/r_2^2}$

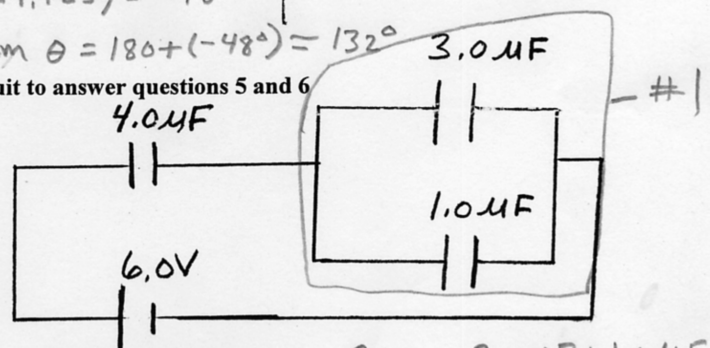
a. 312°
b. 318°
c. 48°
d. 138°
e. 132°

$= \tan^{-1}\left[\frac{\frac{10\mu C}{(20cm)^2}}{-\frac{20\mu C}{(30cm)^2}}\right]$

$= \tan(-1.125) = -48°$

From the diagram $\theta = 180 + (-48°) = 132°$

Use the following circuit to answer questions 5 and 6



5. What is the equivalent capacitance of the circuit.
   a. 0.63μF
   b. 2.00μF
   c. 4.75μF
   d. 8.00μF
   e. None of the above

$C_{eq1} = 3.0\mu F + 1.0\mu F$
$= 4.0\mu F$

$$\frac{1}{C_{eq}} = \frac{1}{4\mu F} + \frac{1}{C_{eq1}} = \frac{1}{4\mu F} + \frac{1}{4\mu F}$$

$C_{eq} = 2.0\mu F$

6. What is the charge on the 4 μF capacitor?

$$Q = CV$$

$$Q_{4\mu F} = (4\mu F)(V_{4\mu F})$$

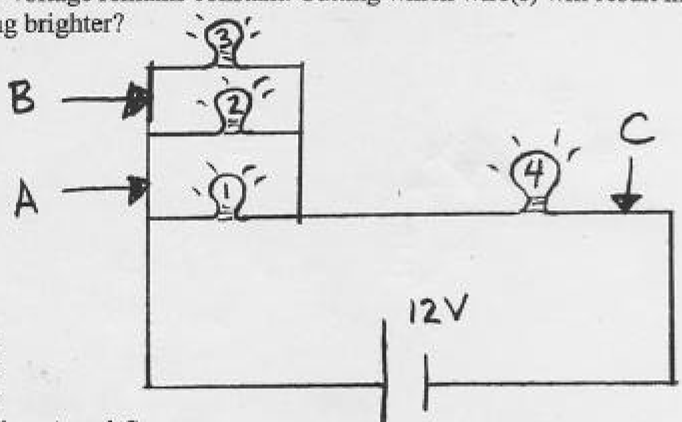
$$= C_{eq} V$$

$$= (2.0\mu F)(6.0V) = 12\ \mu C$$

$$= 1.2 \times 10^{-5} C$$

a. 2.9×10^{-5} C
b. 6.0×10^{-6} C
c. 1.2×10^{-5} C
d. 1.4×10^{-5} C
e. 6.7×10^{-7} C

7. The four light bulbs 1, 2, 3 and 4 do not necessarily have the same resistance. The battery voltage remains constant. Cutting which wire(s) will result in bulb 2 glowing brighter?



a. wire A
b. wire B
c. wire C
d. both wires A and C
e. it is not possible to make the bulb glow brighter by cutting any of the wires

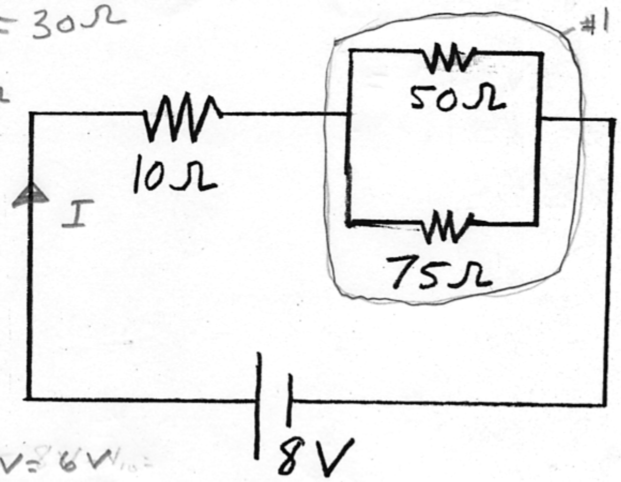
8. What is the current flowing through the 50Ω resistor in the circuit shown below?

$$R_{1eq} = \frac{(50\Omega)(75\Omega)}{50\Omega + 75\Omega} = 30\Omega$$

$$R_{eq} = 10\Omega + 30\Omega = 40\Omega$$

$$I = \frac{V}{R} = \frac{8V}{40\Omega} = 0.20A$$

$$V_{10} = (0.2A)(10\Omega) = 2.0V$$



a. .12A
b. .20A
c. .06A
d. .08A
e. .15A

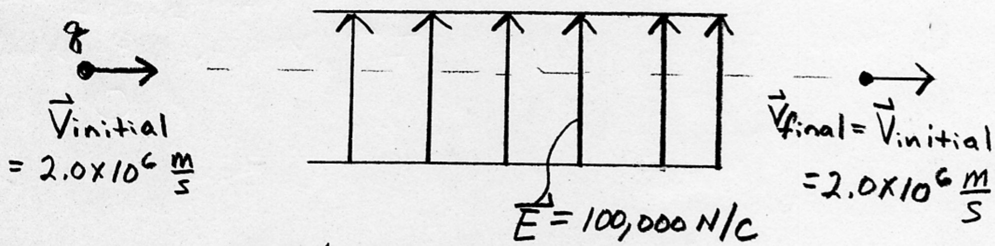
$$V_{50} = 8V - V_{10} = 8V - 2V = 6V$$

$$I_{50} = \frac{6V}{50\Omega} = \boxed{0.12\ A}$$

9. Which of the five statements below is incorrect?

a. If two parallel wires are carrying a current in opposite directions, the magnetic field on a line between them can never be zero.
b. If two parallel wires are carrying a current in opposite directions, they attract one another.
c. If magnetic field lines are perpendicular to the plane of a current loop, there is no torque on the current loop.
d. The Lorenz force on a charged particle moving through a magnetic field cannot be in the same direction as the magnetic field.
e. The magnetic moment of a current loop is perpendicular to the current loop.

10. A velocity selector uses electric and magnetic fields to allow charged particles with only a specific velocity to pass through. Suppose an electric field 100,000N/C is set up using a parallel plate capacitor. Calculate the magnetic field which will allow charged particles with a velocity of 2.0×10^6 m/s to pass through undeflected. The magnetic field is either directly into or directly out of the page.



a. 1.25×10^{-4} T into the page
b. 1.25×10^{-4} T out of the page
c. .05T into the page
d. .05T out of the page
e. Not enough information is given.

$$\Sigma F = 0$$

$$qE - qVB = 0$$

$$E = VB \quad \text{OR} \quad B = \frac{E}{V} = \frac{10^5 \, N/c}{2 \times 10^6 \, m/s} = 0.05T$$

$\vec{E}$ exerts an upward force on a positive charge, downward on a negative charge

Need $\vec{B}$ to exert a downward force on a + charge
upward on a − charge

Using the right handrule;
For a positive charge ⇒ middle finger pointing downward
Thumb pointing in the direction of $\vec{V}$, your index finger points out
$\vec{B}$ is out of the page

The same result is obtained for a negative charge
$\vec{B}$ is out of the page