PHY 102 Quiz #1 Name _____

Score _____

Instructions:
1. Do all of your work on this sheet.
2. **Show all of your steps** in problems for full credit.
3. **Be clear and neat** in your work. Any illegible work, or scribbling in the margins, will not be graded.
4. Place your **answers in a box**.
5. If you need more space, you may use the back of the page and write **On back** in the problem space.

1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

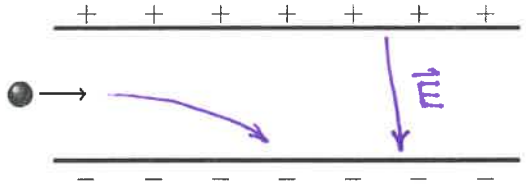
a. A test charge is
a) positive; b) negative; c) electrically neutral: a

b. An proton placed in an electric field will move
a) along the field lines opposite to the field. b) along the field lines in the field direction. c) perpendicular to the field lines. d) It is not unaffected by the field. b

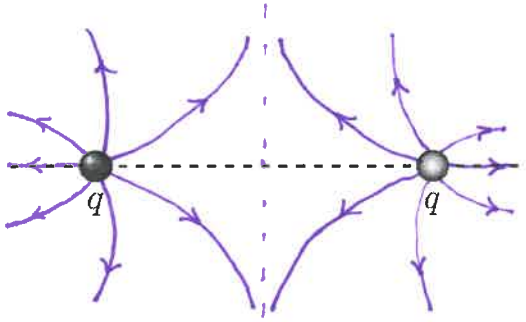
c. Two charges are separated by distance *r*. If one of the charges is replaced by another having twice the charge and the separation distance is doubled, then the force is
a) twice as much; b) half as much; c) four times as much; d) a quarter as much; e) the same as before. b

2. **Definition/Principle (4 pts)**

a. A positive charge enters the region between two parallel plates.
i. Draw an arrow indicating the direction of the E-field between the plates.
ii. Draw the path of the charge



b. Sketch the electric field lines around the charges.

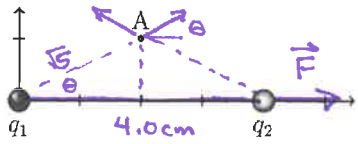


Bonus: Name two methods for charging a body.

contact , induction

Constants: $\varepsilon_0 = 8.85\times10^{-12}$ C²/N-m², $m_e = 9.11\times10^{-31}$ kg, $m_p = 1.67\times10^{-27}$ kg, $m_\alpha = 6.64\times10^{-27}$ kg

3. **Problems (13 pts)** Let $q_1 = q_2 = 3.0\mu C$.



a. What are the magnitude and direction of the force on q_2 if the other charge is 4.0 cm to the left?

$F = k\frac{q_1 q_2}{r^2}$
$= 9\times10^9 \frac{(3\times10^{-6})^2}{(4\times10^{-2})^2}$
$= \boxed{50.6\,N}$

Direction to right

b. What is the magnitude and direction of the electric field at point A due to the two charges?

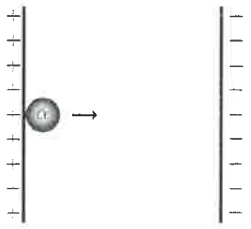
$E_T = 2E_{1,y}$
$= 2k\frac{q}{r^2}\sin\theta$
$= 2(9\times10^9)\frac{3\times10^{-6}}{(4\times10^{-2})^2}\frac{1}{\sqrt{5}}$
$= \boxed{1.5\times10^7\ N/C}$

Direction up

c. How many electrons are in - 4.5 C?

$\#e^- = -4.5C\left(\frac{1}{-1.6\times10^{-19}}\right) = \boxed{2.8\times10^{19}}$

d. An alpha particle with charge *2e* is released from rest at the positive plate in a uniform field, E=1.5×10³ N/C.



i. What is the acceleration of the alpha particle?

$a = \frac{F}{m} = \frac{2(1.6\times10^{-19})(1.5\times10^3)}{6.64\times10^{-27}}$
$= \boxed{7.23\times10^{+10}\ m/s^2}$

ii. How fast is the particle moving 2.0 cm from the start?

$V^2 = V_0^2 + 2ax$
$= 2(7.23\times10^{10})(.02)$
$= 2.89\times10^{10}$
$V = \boxed{5.4\times10^4\ m/s}$

PHY 102 Quiz #2 Name _____

Score _____

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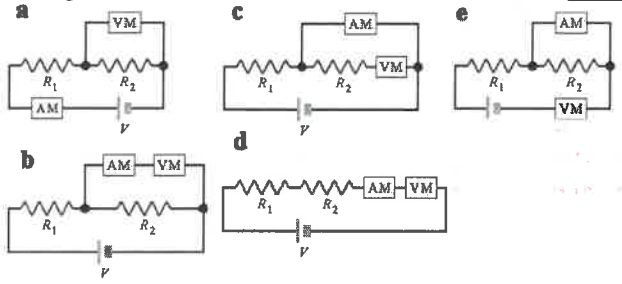
1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

a. Equipotential lines are lines of
a) force; b) equal charge; c) constant electric potential; d) equal electric fields; e) none of these. c

b. Which of the below configurations is the correct way to place the voltmeter and ammeter for measuring the voltage and current across R_2? a



c. A copper wire has twice the length and twice the cross-sectional area of another copper wire. How do the resistances compare?
a) The longer wire has twice the resistance.
b) Both wires have the same resistance.
c) The longer wire has four times the resistance.
d) None of the above. b

2. **Definition/Principle (3 pts)**

a. For the AC voltage $V = 17.0\sin 157t$ find (with units)

i. The rms-voltage $\frac{17}{\sqrt{2}} = 12\text{V}$

ii. The frequency 25 Hz

b. Give the *exact expression* for the capacitance for a capacitor with a dielectric constant κ, separation d, and area A.

$$C = \frac{\kappa\varepsilon_0 A}{d}$$

Constants: $\varepsilon_0 = 8.85\times10^{-12}\ \text{C}^2/\text{N-m}^2$ $m_e = 9.11\times10^{-31}\ \text{kg}$

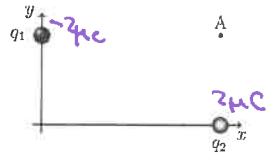
Bonus: How much work is done moving a 7.5×10^{-6} C charge from a point at a potential of +150.0 V to a point at a potential of -50.0 V?

$W = -q_0\Delta V = -7.5\times10^{-6}(-200) = 1.5\times10^{-3}\ \text{J}$

3. **Problems (14 pts)**

a. A $+2.0\mu$ C charge is placed at *(4.0* cm, *0* cm) and a -2.0μ charge is placed at the point *(0* cm, *2.0* cm). Find the total electric potential at point A.

$V = K\frac{q_1}{r_1} + K\frac{q_2}{r_2}$
$= 9\times10^9\frac{2\times10^{-6}}{.08} - 9\times10^9\frac{2\times10^{-6}}{.04}$
$= 4.5\times10^5\ \text{V}$



b. The temperature of a 250.0 Ω resistor is increased 125 °C. If the thermal coefficient of resistivity is 0.0035 $(°C)^{-1}$, what is the new resistance?

$R = R_0(1+\alpha\Delta T)$
$= 250(1+.0035(125)) = 359\ \Omega$

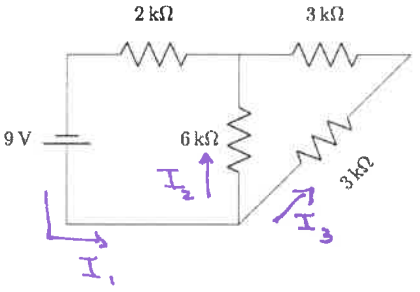
c. An electron is released from the negative plate of a parallel plate capacitor. Find the electron's speed at the positive plate if the potential difference across the plates is 12.0 V.

$\frac{1}{2}mv^2 = e\Delta V$
$v^2 = \frac{2e\Delta V}{m} = \frac{2(1.6\times10^{-19})12}{9.4\times10^{-31}} = 4.2\times10^{12}$
$v = 2.0\times10^6\ \text{m/s}$

d. A 12.0 V battery is connected to a 350 Ω resistor. What is the power loss across the resistor?

$P = V^2/R = .41\ \text{W}$
or $I = \frac{12}{350} = .0343 \rightarrow IV = .411$

e. For the below circuit
i. Find the equivalent resistance of the network.



$\frac{1}{R_p} = \frac{1}{6}+\frac{1}{6} = \frac{1}{3}$
$R_p = 3$
$R_s = 2+3 = 5\ \text{k}\Omega$

ii. Find the currents across the 2 kΩ and 6 kΩ resistors.

$I_1 = \frac{V}{R_s} = \frac{9}{5} = 1.8\ \text{V}$
$I_2 = I_3 = 0.9\ \text{V}$

PHY 102 Quiz #3 Name _____

Score _____

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1. Multiple Guess (3 pts) Find the answer which best fits the question and write it in the space provided.

a. The Earth's magnetic field is parallel to the Earth's surface
a) at the equator; b) at the North Pole; c) at the South Pole; d) at Wilmington, NC; e) None of these. a

b. A current carrying wire is perpendicular to your paper with the current going into the paper from above. The magnetic field produced looks like
a) a uniform field directed from left to right.
b) a uniform field directed from right to left.
c) clockwise concentric circles in the plane of the paper.
d) counterclockwise circles in the plane of the paper.
e) None of these. c

c. If the magnetic field points out of your paper and a negative charge moves from left to right in this field, then the force is directed
a) towards the bottom; b) out of the paper; c) into the paper; d) towards the top; e) none of these. d

2. Definition/Principle (4 pts) In the following closed loops, indicate the direction of the induced current by the direction of flow between points a and b.

Fig. 1

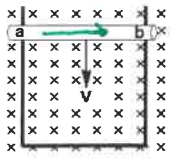


Fig. 2

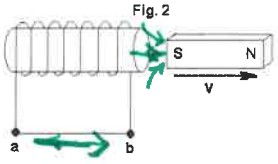


Fig. 3

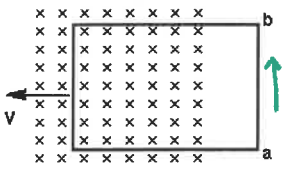
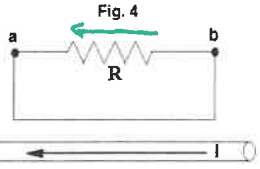
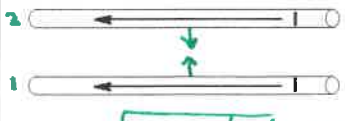


Fig. 4



(Increasing I)

Bonus: a. Two 30.0 cm long wires separated by 5.0 cm each carry 2.0 A in the same direction. What is the magnitude and direction of the force on the lower wire due to these currents?



$= 4.8\times10^{-6}$ N up

$F = \frac{\mu_0 I^2 L}{2\pi r} = \frac{4\pi\times10^{-7}(2)^2(.3)}{2\pi(.05)}$

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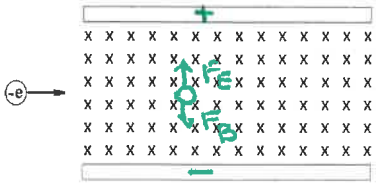
3. Problems (13 pts)

a. A beam of electrons enters a velocity selector with a 0.35 T magnetic field and a 50.0 V/m electric field.
i. Draw the proper charges on the plates.
ii. What is the speed of the undeflected electrons?

$qE = qvB$

$v = E/B = \frac{50}{.35} = 143$ m/s



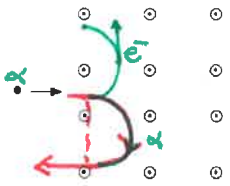
b. An alpha particle (6.64×10^{-27} kg, $q = 2e$) enters a 0.5 T magnetic field and follows a circular path whose radius is 15.0 cm. How fast is the particle moving?

$r = \frac{mv}{qB}$

$v = \frac{qBr}{m} = \frac{2(1.6\times10^{-19})(.5)(.15)}{6.64\times10^{-27}} = 3.6\times10^{6}$ m/s

c. Draw the ~~electron~~ α path ~~and indicated the velocity vector~~.

down
Semicircle



d. What is the current in a long, straight wire if the magnetic field 25.0 mm from the wire is 7.80×10^{-5} T?

$B = \frac{\mu_0 I}{2\pi r} \Rightarrow I = \frac{2\pi r B}{\mu_0} = \frac{2\pi(.025)(7.8\times10^{-5})}{4\pi\times10^{-7}}$

$= 9.8$ A

e. A wire one meter long is directed at a 60° angle to a 4.8 mT magnetic field. What is the magnitude of the force on the wire, if it carries a current of 1.5A?

$F = ILB\sin\theta$

$= 1.5(1)4.8\times10^{-3}\sin60$

$= 6.2\times10^{-3}$ N

f. A 18.0 cm long conducting rod is moving perpendicular to a 1.5 T magnetic field. How fast must the rod move in order to produce an emf of 2.5 mV across the rods' ends?

$\mathcal{E} = vBL$

$v = \frac{\mathcal{E}}{BL} = \frac{2.5\times10^{-3}}{1.5(.18)} = 9.3\times10^{-3}$ m/s

PHY 102 Quiz #4 Name _____

Score _____

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1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

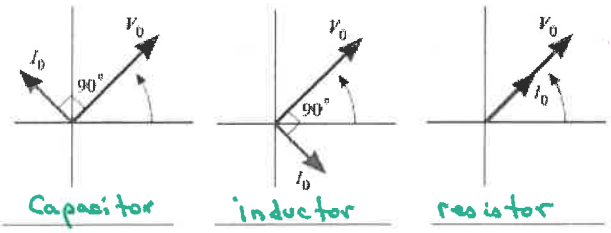
a. In an RL circuit the voltage _____ the current.
a) leads; b) is in phase with; c) lags. a

b. The capacitive reactance has units of
a) farads; b) hertz; c) ohms; d) henries e) none of these c

c. In a transformer the ~~voltage~~ #turns in the secondary coil is ~~greater~~ less than that in the primary coil. This is
a) a step-up transformer; b) a step-down transformer;
c) an efficient transformer e) none of these. b

2. **Definition/Principle (5 pts) - Phasors**

a. Indicate which phasor diagrams below are for a resistor, a capacitor, and an inductor.



b. What is Faraday's Law?

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$$

c. Give the self inductance of a solenoid in terms of its area, length, and number of turns.

$$L = \mu_0 n^2 \ell A$$

Bonus: An LC circuit has a capacitance of 1.25 μF and an inductance of 2.0 mH. What is the resonant frequency of this circuit?

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{2.5\times10^{-9}}} = \frac{1}{2\pi(.5)}10^4$$

$$= 3.2\times10^3 \text{ Hz}$$

(or 3183)

3. **Problems (12 pts)**

a. On the same bar of iron are wound two coils, one with 40 loops and the other with 25 loops. If a 100.0 V alternating voltage is connected to the 25 loop coil, what will be the voltage in the 40 loop coil?

100 25 40 ε

$$V_s = \frac{N_s}{N_p}V_p = \frac{40}{25}100$$

$$= 160\text{V}$$

b. What measured voltage is needed to provide a measured current of 36.0 mA in a circuit containing only a 250.0 μF capacitor, when the source frequency is 2.5 kHz?

$$X_C = \frac{1}{2\pi f C} = 2.55\times10^{-4-3+6} = .255\,\Omega$$

$$V_{rms} = I_{rms}X_C = .918\text{V}$$

c. A series LRC circuit includes a resistance of 15 Ω, a 5.0 μF capacitor, a 2.0 mH inductor, and a voltage source with a peak voltage of 75 V, operating at 2.0 kHz. Determine the following:

i) Impedance

$$X_L = 2\pi fL = 2\pi(2000)(2\times10^{-3}) = 25\,\Omega$$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi(2000)(5\times10^{-6})} = \frac{1}{6.28}10^2 = 15.9\,\Omega$$

$$Z = \sqrt{15^2+9^2} = 17.5\,\Omega$$

ii) Rms Current

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{75/\sqrt{2}}{17.5} = 3.03\text{A}$$

iii) Phase shift

$$\tan\phi = \frac{X_L - X_C}{R} = \frac{9}{15} \qquad \phi = 31^\circ$$

iv) Does the current lead, or lag, the voltage? lag

PHY 102 Quiz #5 Name _____

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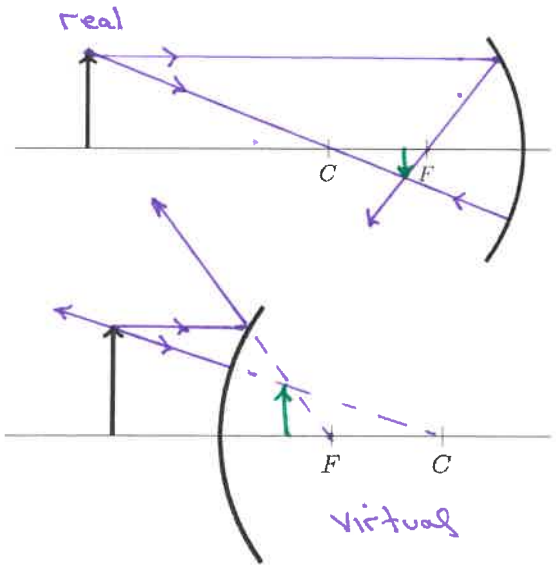
1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

a Which of the following is bent the least as it passes through a prism?
a) red b) green c) blue d) violet. a

b. For a convex mirror the image appears
a) real, inverted, smaller; b) virtual, inverted, larger;
c) real, upright, larger; d) virtual, upright, smaller;
e) none of these. d

c. What electromagnetic wave in the list has the smallest wavelength ?
a) red light; b) violet light; c) microwaves; d) radio waves; b

2. **Definition/Principle (5 pts)** Sketch the ray diagrams for the following mirrors. Clearly show the images and indicate if they are *real/virtual*.



Bonus: A child looks into the back of her shiny soupspoon, which has a 4.0 cm diameter. She sees her image reduced by a factor of one-eighth. How far is the child's face from the spoon?

$m = \frac{1}{8} = -\frac{d_i}{d_o} \Rightarrow \frac{1}{d_i} = -\frac{8}{d_o}$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$\frac{1}{d_o} - \frac{8}{d_o} = \frac{1}{-1} \Rightarrow$ $d_o = 7\text{cm}$

3. **Problems (12 pts)**

a. A truck driver broadcasts at a frequency of 30,000 Hz. What is the wavelength of this electromagnetic wave?

$\lambda = \frac{c}{f} = \frac{3\times10^8}{3\times10^4} =$ 10,000 m

b. The index of refraction for red light in crown glass is $n = 1.52$. What is the angle of refraction for light incident 30° to the surface from the air?

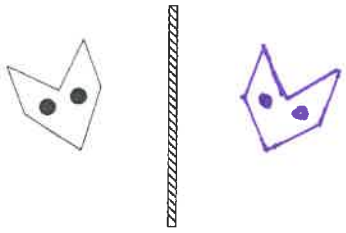
$\sin\theta_2 = \frac{\sin 30}{1.52}$

$\theta_2 =$ 19°

c. An insect is trapped and preserved in amber ($n = 1.546$). It appears to be 2.5 cm beneath the surface. How far below the surface is it actually?

$d_o = \frac{n_1}{n_2} d_i = 2.5\,(1.546) =$ 3.865 cm

d. Clearly draw the image in the mirror to scale and location.



e. The critical angle for a special glass in air is 44 degrees. What is the critical angle if the glass is immersed in water?

$\sin\theta_c = \frac{n_2}{n_1} = 0.6947 \Rightarrow n = 1.44$

$\sin\theta_c' = \frac{1.33}{1.44}$ or $\theta_c' =$ 67.5°

f. The focal length of a concave mirror is 8 cm. A 3.0 cm object is placed 32 cm in front of the mirror. Find the image location and height.

$\frac{1}{8} = \frac{1}{32} + \frac{1}{d_i}$

$\frac{1}{d_i} = \frac{3}{32}$

$d_i = \frac{32}{3} =$ 10.7cm

$m = -\frac{d_i}{d_o} = -\frac{1}{3}$

$h_i =$ −1.0cm