TEST # 3. PHYS 204. SPRING 2009. 05/04/09

LAST NAME:

FIRST NAME:

1.

An object 0.400 cm tall is placed 18.0 cm to the left of a concave spherical mirror having a radius of curvature of 20.0 cm (a) Draw a ray diagram showing the formation of the image using a proper scale (ruler). (b) Determine (using the mirror equation) the position, size, orientation, and nature (real or virtual) of the image, and compare with (a). (c) Repeat (a) and (b) for the case in which the mirror is convex.

b: $|f| = \frac{r}{2} = 0.1$ cm.

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$\frac{1}{0.18} + \frac{1}{v} = 10$

$v = 0.225$ m

$\frac{0.4}{18} = \frac{h}{22.5}$

$h = 0.5$ Cm

real.

C: $|f| = 0.1$ cm.

$f = -0.1$ cm.

$v = -0.0643$m.

$= -6.43$ cm.

$\frac{h'}{6.43} = \frac{0.4}{18}$

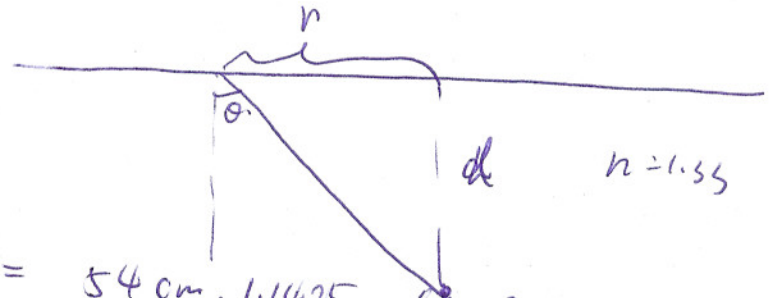
$h' = 0.14$ cm.

2

A point source of light is under water, 54 cm below the surface. Find the diameter of the largest circle at the surface through which light can emerge from the water ($n_{water} = 1.33$).

$n \sin\theta = 1$

$\sin\theta = \frac{1}{n} = 0.75$



$r = d \cdot \tan\theta = d \cdot \frac{0.75}{\sqrt{1-(0.75)^2}} = 54\,\text{cm} \cdot 1.1475 = 61.59\,\text{cm}.$

3.

A screen is placed 1.00 m behind a single slit. The central maximum in the resulting diffraction pattern on the screen is 1.60 cm wide. What is the distance between the two second-order minima?

$$I = I_0 \cdot \frac{\sin^2\theta}{\theta^2}$$

$$\theta = \frac{\pi l}{\lambda D} x.$$

when $\theta = k\pi$ $(k \in \mathbb{Z})$ there is a min

so the distance between second order mins is $1.6 \times 2 = 3.2$ cm.

4

Two twins travel from Earth to Planet X which is 20 light years away in a reference frame in which the two planets are at rest. The twins are 20 years old when they depart from Earth at the same moment. They travel in different rockets. Twin A travels at 0.95c and Twin B travels at 0.75c. Calculate the difference between their ages when they meet again in Planet X at the earliest possible time. Which twin is older?

$$d\tau = \frac{dt}{\gamma}$$

$$\gamma_1 = \frac{1}{\sqrt{1-(0.95)^2}} = 3.2 \qquad \gamma_2 = \frac{1}{\sqrt{1-(0.75)^2}} = 1.52$$

$$dt_1 = \frac{20}{v_1} = \frac{20}{0.95} = 21.05\ y$$

$$\therefore d\tau_1 = \frac{21.05}{3.2} = 6.58\ y.$$

$$dt_2 = \frac{20}{v_2} = \frac{20}{0.75} = 26.67\ y$$

$$d\tau_2 = \frac{dt_2}{\gamma_2} = 17.54.$$

$d\tau_2 > d\tau_1$ so B is older.

TEST # 3. PHYS 208. SPRING 2009. 05/04/09

LAST NAME:

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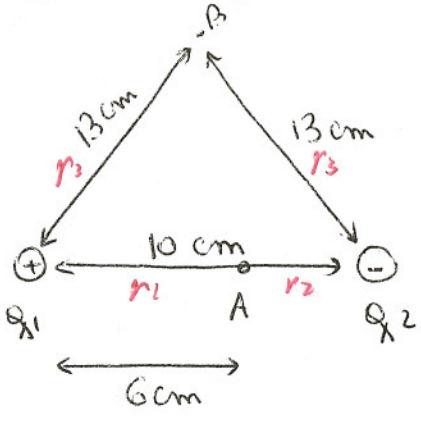
1. Electric Potential.

An electric dipole consists of two charges, $q_1 = +12$ nC and $q_2 = -12$ nC, placed 10 cm apart. Compute the total potential due to both charges at points A and B.



point A: $V = V_1 + V_2 = k\left(\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right)$

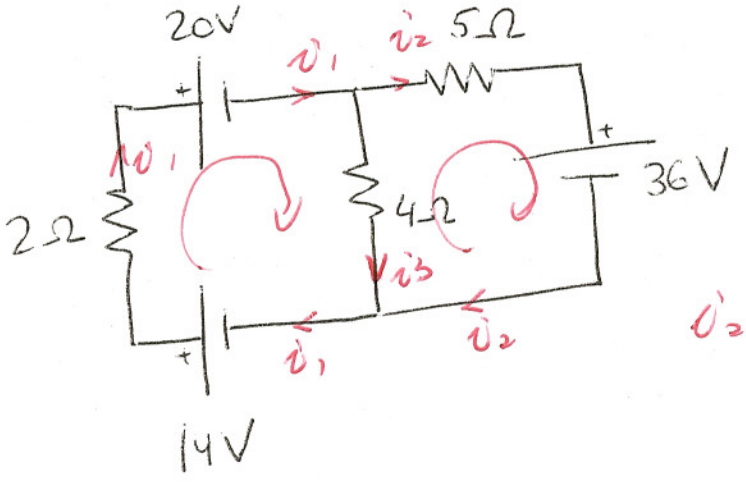
$= 9\times10^9\left(\frac{12\times10^{-9}}{0.06} - \frac{12\times10^{-9}}{0.04}\right)$

$= -900\ V$

B: $V = k\left(\frac{Q_1}{r_3} + \frac{Q_2}{r_3}\right) = 0$

2. DC circuits

Find the current through each of the 3 resistors of the circuit below.



$i_2 + i_3 = i_1$

$$20 + 4i_3 - 14 + 2i_1 = 0$$

$$\begin{cases} 5i_2 + 36 - 4i_3 = 0 \\ i_1 - i_2 - i_3 = 0. \end{cases}$$

$$\Rightarrow \begin{cases} i_1 + 2i_3 + 3 = 0 \\ 5i_2 - 4i_3 + 36 = 0 \\ i_1 - i_2 - i_3 = 0. \end{cases}$$

$$\begin{cases} i_1 = -5.21\ A \\ i_2 = -6.31\ A \\ i_3 = 1.10\ A \end{cases}$$

3 Magnetic field and Magnetic forces

A wire 50 cm long lying along the $x-$axis carries a current of 0.50 A in the positive $x-$direction. A magnetic field is present that is given by $\vec{B} = (0,\ 0.003\ \text{T},\ 0.010\ \text{T})$. Find the components of the force on the wire.

$\vec{l} = (0.5, 0, 0)\ m$

$\vec{B} = (0, 0.003, 0.01)\ T$

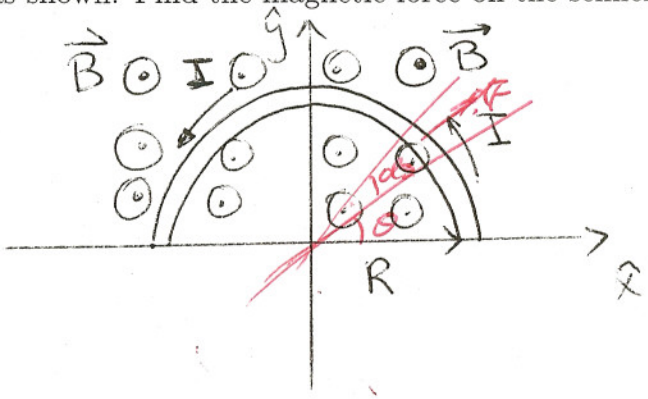
$\vec{F} = I(\vec{l} \times \vec{B})$

$$= 0.5 \cdot \begin{vmatrix} i & j & k \\ 0.5 & 0 & 0 \\ 0 & 0.003 & 0.01 \end{vmatrix}$$

$= (0, -0.0025, 0.00075)\ N$

4.

In the figure below the magnetic field is uniform and perpendicular to the plane of the figure, pointing out. The conductor follows a semicircle with radius R and carries a current I, as shown. Find the magnetic force on the semicircular wire.



$$F_y = \int_0^{\pi} dF \sin\theta$$

$$= \int_0^{\pi} I B R \, d\theta \cdot \sin\theta$$

$$= 2IBR.$$

$$F_x = 0.$$

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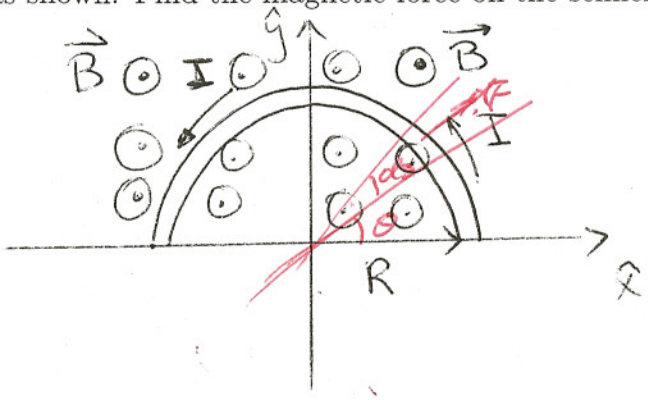

$$F_y = \int_0^{\pi} dF \cdot \sin\theta$$

$$= \int_0^{\pi} I B R \, d\theta \cdot \sin\theta$$

$$= 2IBR.$$

$$F_x = 0.$$