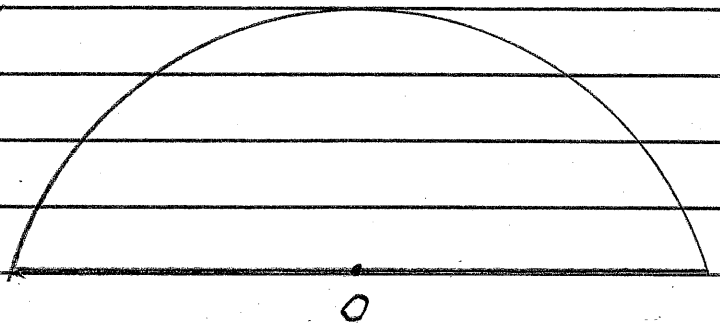
Test Questions – for FINAL

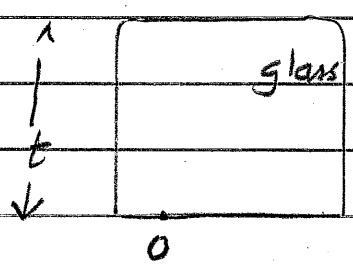
1. A hemispherical piece of glass of radius 10 cm is lying on a piece of paper and has a small black dot (O) at its center. Locate the image of O [support your answer with a diagram.]



2. Show that a divergent lens or mirror can form only virtual images and that the image can never be further away from the lens (or mirror) than its focal point. (Provide ray Diagrams).

3. If you want to form an upright, enlarged image using a convergent lens (or mirror) where would you place the object? Why? (provide ray diagram)

4. Locate the image of the object O placed below a block of glass ($n_g = 1.5$) of thickness t.



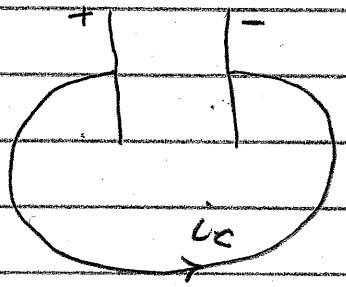
5. Complete the equation

$$D = \sin(x - vt)$$

and precisely define the necessity for the factors that you introduce as well as their physical significance. Here x and t are space and time coordinates

6. Show that $\varepsilon_0 \frac{\Delta \phi_E}{\Delta t}$ where $\Delta \phi_E = \vec{E} \cdot \vec{A}$ has the dimensions of current.

7. The capacitor is fully charged when you connect a wire as shown. Show that the displacement current between the plates is equal to the conduction current in the wire.



8. What is a conservative force? Show that the Coulomb force is a conservative force.

$$\vec{F}_E = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}\,\hat{r}$$

9. Show that when a sheet of charge having charge density σ is crossed the $\underline{E}$-field jumps by $\frac{\sigma}{\epsilon_0}$.

10. Show that when a thin sheet of thickness carrying a current density $\underline{J}$ is crossed the $\underline{B}$-field jumps by $\mu_0 \underline{J} t$.

11. Prove that the energy densities of E and B fields are $\eta_E = \frac{1}{2}\epsilon_0 E^2$ and $\eta_B = \frac{B^2}{2\mu_0}$, respectively.

12. Show that the Intensity of a ~~periodic~~ electromagnetic wave can be written as $I = \frac{1}{2}\epsilon_0 c E_m^2 = \frac{c B_m^2}{2\mu_0}$ where E_m and B_m are the amplitudes

13. Light and Sound are both waves, list 5 notable differences between them. (in gases)

14. The speed of sound in a gas is given by $v_s = \sqrt{\frac{\gamma k_B T}{m}}$. Why is there a γ in this equation.

15. Prove that the intensity of a periodic sound wave is $I = \frac{1}{2} s_m^2 \omega^2 \gamma P_0 / v_s$ where s_m is the amplitude and ω the angular frequency.

16 The lens maker's formula

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_F} - \frac{1}{R_B}\right]$$

calculates the focal length of a thin lens with two spherical surfaces having radii R_F and R_B. How do you use it to distinguish between a double convex lens and a double concave lens.

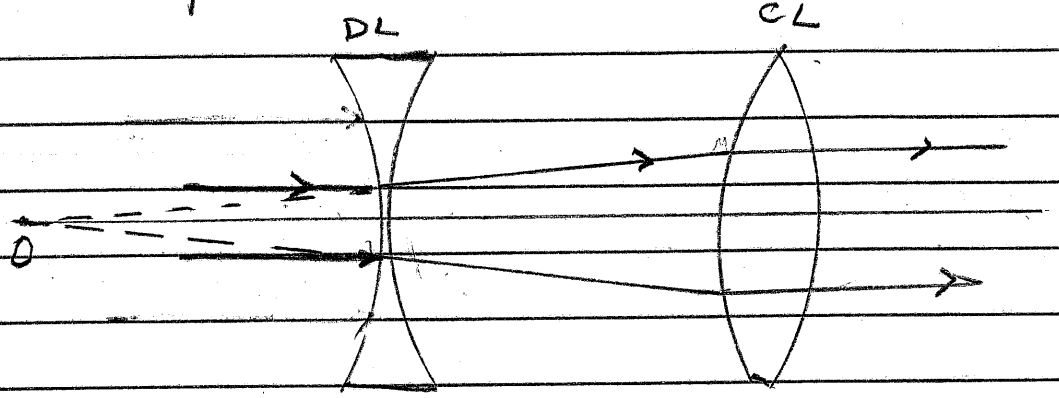
17 Show that $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$ has the dimensions LT^{-1}.

18. Show that a current carrying loop of wire behaves exactly like a Bar magnet when placed in a B field.

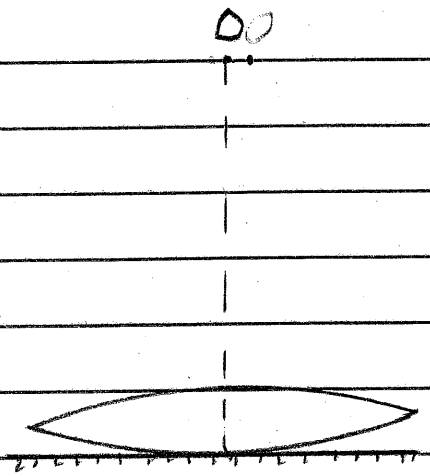
19 How would you use a convergent lens / mirror to produce an enlarged, upright image? Why?

20 If you want to use the lens of prob 19 to produce an enlarged inverted image, where would you locate the object? Why?

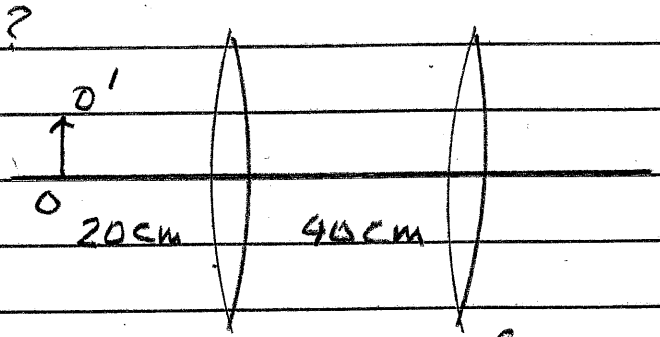
21 The picture shows the path of light for a DL - CL combination. Show that the point O is located at the focal point of either lens.



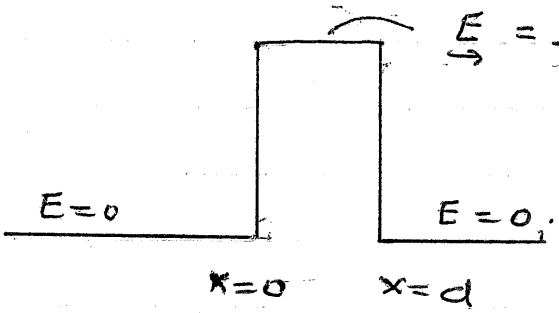
22. The picture shows a plane mirror CL combination. Where would you locate O so that its image is also at O? Why?



23 In the diagram both lenses have $f = 10\,cm$. Locate the position and size of the final image. Is it upright or inverted?



24. In order to create the $\underset{\rightarrow}{E}$ - field shown in the diagram what sheets of charge would you require? Why?



25 A $y_i = A_i \sin(kx - \omega t)$ wave travelling on a string arrives at $x=0$ where velocity changes from V to V' and gives rise to a reflected wave $y_r = A_r \sin(kx + \omega t)$. We are told that $\frac{A_r}{A_i} = \frac{V - V'}{V + V'}$. Show that if $V > V'$ the wave has a phase change of π during reflection.

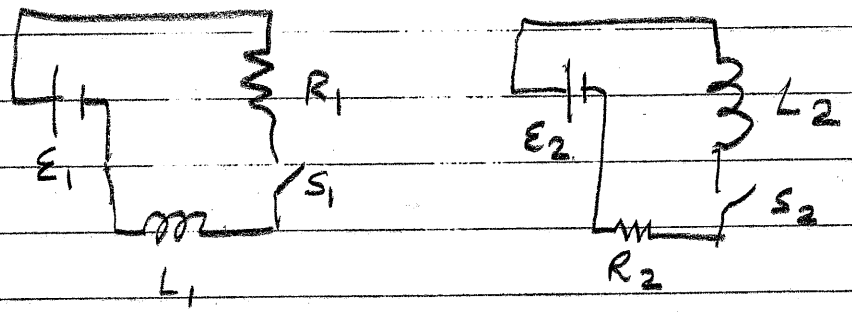
26. Given a charge q and a spring balance how would you discover the presence of an $\underset{\rightarrow}{E}$ - field ii) a $\underset{\rightarrow}{B}$ - field.

27. F Show that for two parallel wires each of length 1m the current - current force is

$$\underset{\rightarrow}{F}_{I_1, I_2} = -\frac{\mu_0 I_1 I_2}{2\pi r}\hat{r}$$

28 What happens to the frequency of a wave when it goes from one medium to another with a different wave velocity? Why?

29



In the two circuits shown which one will reach $i = 1$ mAmps first if both switches are closed at same time?

Case I $\varepsilon_1 = 10V$
$\varepsilon_2 = 20V$
$L_1 = 10mH$, $L_2 = 20mH$
$R_1 = 1k\Omega$ $R_2 = 2k\Omega$

Case II $\varepsilon_1 = 20V$
$\varepsilon_2 = 20V$

30 The right rear view mirror of your car has the warning, "objects are nearer than they appear". What does this tell you about this spherical mirror? Why?

Final

More Test Questions

1. We can hear sound around a corner but no light will go around a corner. Why?

2. What is the difference between interference and diffraction? (Conceptually)

3. Show that when light from two identical incoherent sources arrives at a point, the total intensity is just twice the intensity due to one source.

4. If you want to observe interference effects from the two sources what must be the relationship between their phases? Why?

5. Show that the interference pattern in a double slit experiment consists of equal intensity, equally spaced fringes.

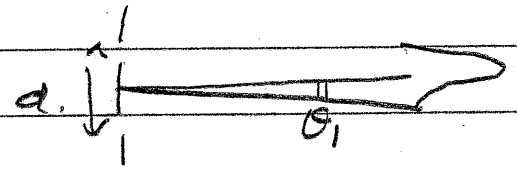
6. In the experiment of problem 5 show that the intensity averaged over the entire pattern is exactly twice the intensity due to light from one slit.

7. You wish to make a non-reflecting slab of glass ($n = 1.5$) by coating it with a transparent material of $n = 1.25$. Choosing $\lambda_0 = 600$ nm to do so what must be the smallest thickness of the coating.

8. Two slits of width w are d meters apart. If $w \ll d$ one observes only an interference pattern in a double slit Experiment. Why?

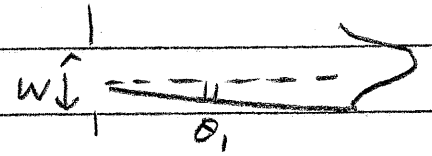
9. In 2-slit interference of light of wavelength λ the first minimum occurs when

$$\sin\theta_1 = \frac{\lambda}{2d}$$



where d is the slit separation. In single slit diffraction the first minimum is at

$$\sin\theta_1 = \frac{\lambda}{w}$$



where w is the slit width. Why this difference?

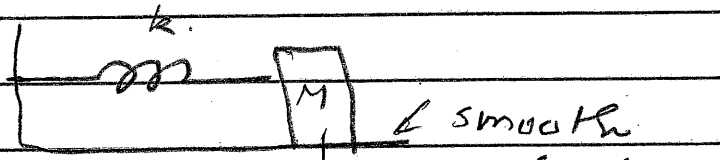
10 In single slit diffraction why do the dark spots occur at angles

$$\sin\theta_m = \frac{m\lambda}{w} \quad m = 1, 2, 3$$

11. Show that the intensity of the maxima in single slit diffraction vary as

$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2} :$$

12. A mass M is attached to a spring as shown.



At $x=0$, the spring is relaxed. If you move M to $x=A$ and release it, why does it oscillate?

13 In the dopplers effect the observed frequency is $f' = f\left[1 \pm \frac{V_{obs}}{V_s}\right]$ if the observer moves and $f' = \frac{f}{1 \pm \frac{V_{source}}{V_s}}$ if the source moves. Why are these two results different [f is the emitted freq, V_s the speed of sound]

14 In a simple pendulum why do you need the amplitude to be small to observe linear harmonic motion?

15. If a tube is closed at both ends the normal modes satisfy the equation

$$\frac{n\lambda_n}{2} = L \qquad n = 1, 2, 3, \ldots$$

If it is open at one end they following

$$\frac{(2n-1)\lambda}{4} = L \qquad n = 1, 2, 3$$

where L is the length of the tube. Why this difference?

16 A current generates a $\vec{B}$ field, a current feels a force in a $\vec{B}$ field. Show that parallel currents attract one another.

17 A point charge Q is located at $r=0$. Show that the flux of $\vec{E}$ through any surface surrounding the origin is $\frac{Q}{\varepsilon_0}$. Hence, derive Gauss' law.