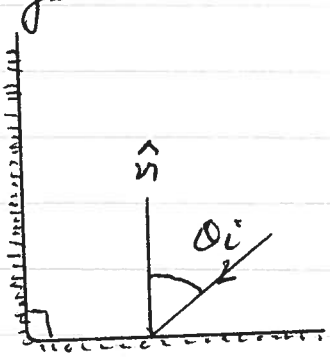
Test Questions (FINAL)

1. The picture shows a corner reflector: Two plane mirrors at right angles to one another. Locate the path of light as it leaves the system.



2. Show that the law of Reflection is a direct consequence of Fermat's principle of least time.

3. Show that with a convergent mirror or lens a real image can never come closer to the mirror (or lens) than its focal point.

4. The lens makers formula

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

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

More Test Questions (for final)

5. Prove that a divergent lens or mirror forms virtual images (q -ive) which can never be further away from the mirror/lens than the focal point (f -ive).

6. What is the depth of a pool of water as perceived by a person standing at the edge and looking straight down. [$n_{water} = 1.33$].

7. Show that when openings and obstacles are large with respect to the wavelength of light, geometrical optics is appropriate.

8. Two slits each of width w are d apart. If $w \ll d$ one observes only an interference pattern. Why?

9. In 2-slit interference the first minimum occurs when $d \sin\theta_1 = \frac{\lambda}{2}$. In single slit diffraction the first minimum is at $w \sin\theta_1 = \lambda$. Why the difference?

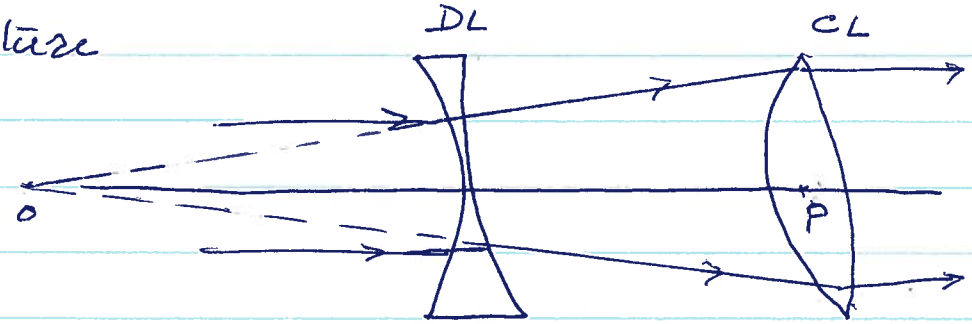
10. Show that for two incoherent sources, the total intensity is just the sum of the two intensities.

11 ~~7~~ 8. Show that a current carrying loop placed in a uniform $\vec{B}$ field behaves exactly like a bar magnet.

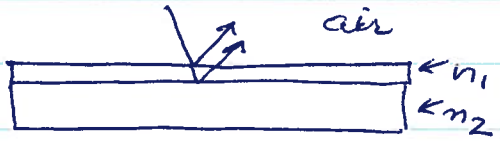
12 ~~8~~. How would you use a convergent lens to produce an enlarged, upright image.

13 ~~9~~. If you use the lens of Prob 8 to produce an enlarged inverted image, where would you locate the object? why?

14 ~~10~~ The picture shows the path of light through a DL-CL combination. Prove that OP = f the focal length of the CL.



15 Light of wavelength 600nm is incident as shown on a plate of refractive index which has a thin covering of refractive index ($n_1 < n_2$). What should be the minimum thickness of the cover so that reflectivity is very low.

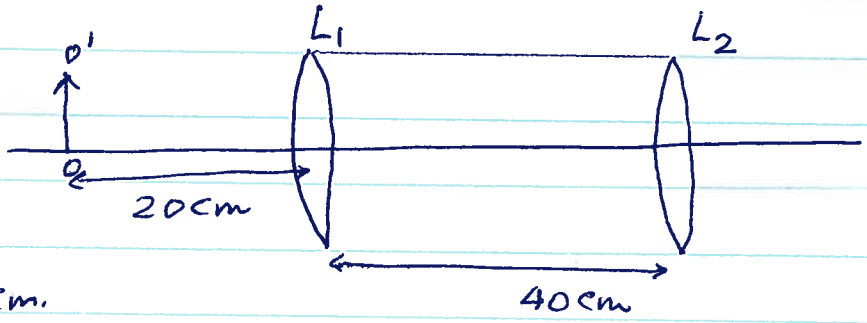


16 Prove that the interference pattern for two slits consists of equally spaced, equal intensity fringes:

$$\text{Spacing } d = \frac{D\lambda}{d}, \quad d = \text{slit separation}, \quad D = \text{slit–screen distance}$$

$$I_{max} \propto 4E_m^2$$

17. In the diagram both lenses have $f = 10\text{cm}$.



Locate the position and size of the final image? Is it upright or inverted?

18 What happens to the frequency of a wave as it goes from one medium into another? Why?

19. Complete the Equation

$$y = \quad \sin(x - vt)$$

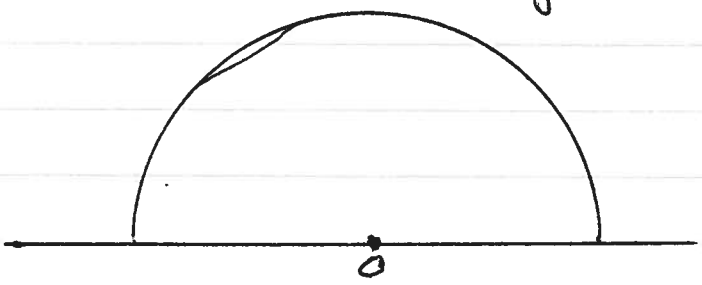
and explain the meaning of the additional parameters.

20 16 What is a Conservative force? Show that the Coulomb force

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

is a conservative force

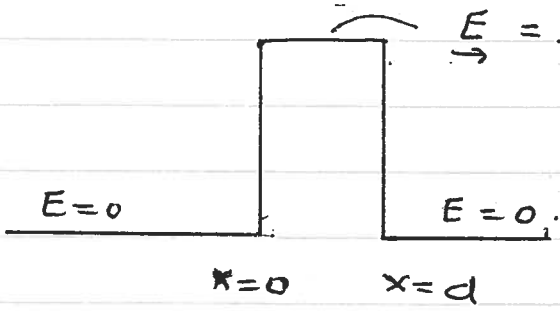
21. A hemispherical piece of glass of radius 10cm is lying on a piece of paper and has a small black dot (O) at its center. Locate the image of O [support your answer with a diagram.



22. Using a convergent lens locate the position and size of images when the object-distance p is i) ∞, ii) 2f (iii) f⁺ (iv) f (v) < f. where f is the focal length.

23. Two coherent sources of sound are separated by a distance of 5λ. If you walk from one to the other how many maxima will you encounter? Why?

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.

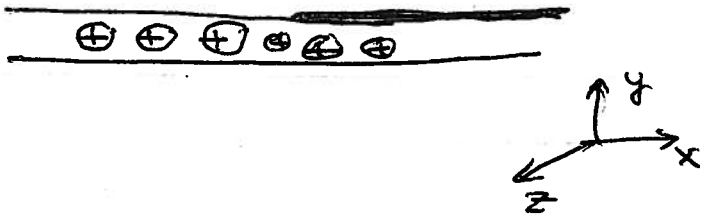
26. Given a charge q and a spring balance how would you discover the presence of an $\underset{\rightarrow}{E}$ - field ii) a $\underset{\rightarrow}{B}$ - field.

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

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

where t is the distance between them.

28 As shown a thin sheet of thickness t carries a uniform current density $\vec{J} = -J\hat{z}$. Show that the $\vec{B}$-field is $\vec{B} = \frac{\mu_0 J t}{2}\hat{x}$ above the sheet and $-\frac{\mu_0 J t}{2}\hat{x}$ below the sheet.



29 What is the difference between a Coulomb $\vec{E}$ field and a non-coulomb $\vec{E}$-field. Which of them has flux equal to zero through any closed surface? Why?

30. The speed of sound in a gas is

$$v_s = \sqrt{\frac{\gamma k_B T}{m}} \quad \text{where} \quad \gamma = \frac{C_p}{C_v}$$

Why is there a γ in this equation.

31. What is total internal reflection. Could you get total internal reflection for a ray of light going from air ($n=1$) to water ($n=1.33$).