Test Questions – EXAM II. (Partial).

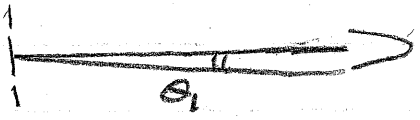
1. Two slits, each of width w are d meters apart. If $w \ll d$ one observes only an interference pattern in a double slit experiment. Why?

2. What is interference?

3. How do you distinguish between interference and diffraction? (conceptually)

4. In 2-slit interference for light of wavelength λ, the first minimum occurs when

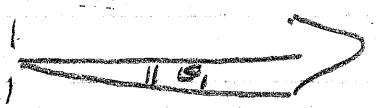
$$\sin\theta_1 = \frac{\lambda}{2d}$$



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 the difference?

5. In single slit diffraction the minima occur at angles

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

why?

6. In single slit diffraction the intensities of the maxima vary as

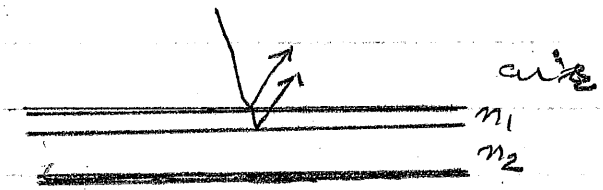
$$1 : \frac{4}{9\pi^2} : \frac{4}{25\pi^2} : \frac{4}{49\pi^2} \cdots$$

Why?

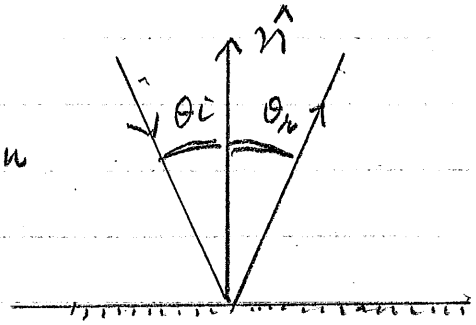
7. Show that when openings and obstacles are large one can talk of geometrical optics

8. Show that the law of reflection is a direct consequence of Fermat's principle of least time for the propagation of light.

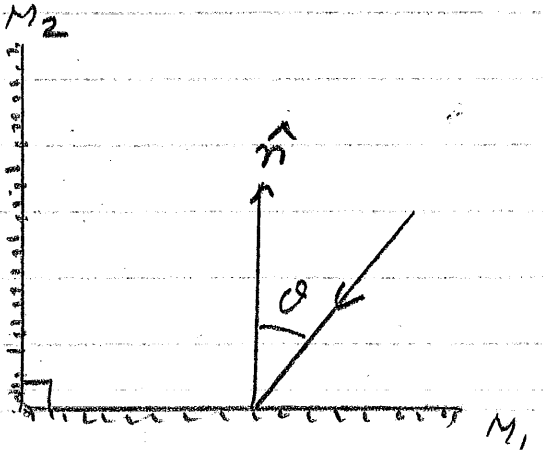
9. Light of wavelength 600 nm is incident as shown on a plate of refractive index $n_2 = 1.5$ which has a thin covering of refractive index $n_1 = 1.3$. What should be the minimum thickness of the cover so that the reflectivity is very low? Why?



10 For the picture shown here if you rotate the mirror by an angle θ, by what angle will the reflected ray rotate? Why?



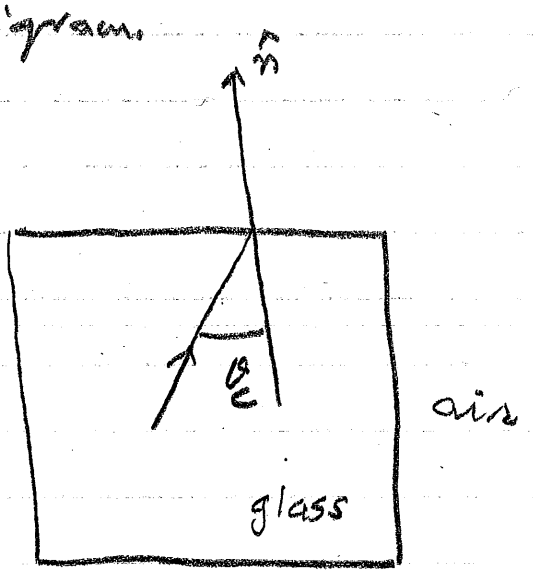
11. Corner Reflector. Two Mirrors M_1, M_2 at right angles to one another. Light is incident on M_1 at angle θ. Locate the path of the reflected ray as it leaves the system.



12 Describe the method to be used to locate the image of a point object formed by a [illegible] optical system.

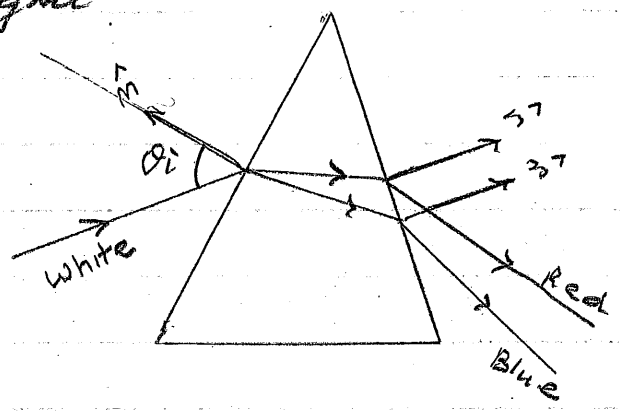
13. What is the difference between a real image and a virtual image? Support your answer with a diagram.

14 As shown, a ray of light is incident at the glass-air interface ($n_{glass} = 1.5$). If the angle of incidence is the critical angle, where would you draw the refracted ray? Why? Calculate θ_c.



15. If in problem 14 the angle of incidence is larger than θ_c what happens to the light when it hits the surface? Why?

16. Newton's Expts. showed that when white light goes through a prism the emerging beam is split into several colors. If he observed something like what is shown in the picture what did he learn about the properties of light? Why?



17. Plane and spherical mirrors form images given by the equations

$$\frac{1}{p} + \frac{1}{q} = \frac{2}{r}, \quad m = -\frac{q}{p}$$

where p = object-mirror distance, q = image-mirror distance, r = radius of the mirror. How do you distinguish among a plane, a concave and a convex mirror? Support your answers with diagrams.

18. Why does the equation for the magnification $m = -\frac{q}{p}$ have a minus sign on the right?

19. How would you experimentally distinguish between a real image and a virtual image?

20. How would you use a convergent mirror to produce an upright, enlarged image? Support your answer with a diagram.

21. For a concave mirror of radius of curvature 1m calculate the position and magnitude of the image if the object is located at 3m, 0.8m, 0.5m. Provide diagrams.

22. The right rear view mirror of your car has the warning "objects are nearer than they appear". What does this tell you about the mirror? Draw a diagram in support of your answer.

23. The lens maker's formula is written as

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

where f is the focal length, n is the refractive index of the lens material (placed in air), R_F, R_B are the radii of the two spherical surfaces. How do you use this equation to distinguish between a convergent lens and a divergent lens.

24. Using a convergent lens locate the images and calculate the magnifications when i) $p = 2f$, ii) $p = f^+$ (iii) $p < f$. where f is the focal length and the relevant Eqs. are

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}, \quad m = -\frac{q}{f}.$$

25 Show that for a Divergent lens all images are Virtual, upright and Reduced. Always provide a diagram.

26 Given a charge q and a spring balance how would you discover the presence of an $\underline{E}$ - field (neglect gravity)? Indeed, Define an $\underline{E}$ - field.

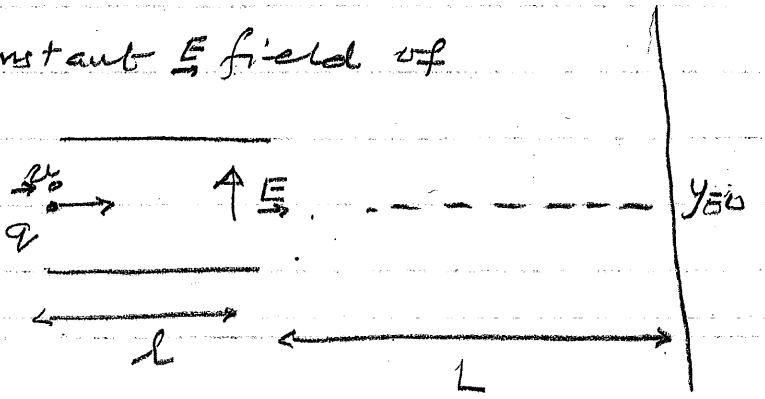
27 Show that Coulomb's law forces between two point charges are consistent with Newton's third law of motion.

28 If two equal charges q are located at $x = -a$ and $x = +a$ the force on a charge q placed at y is

$$\underset{\rightarrow}{F_E} = \frac{2kqqy}{(a^2+y^2)^{3/2}}\,\hat{y}.$$

If you replace q by $-q$ and make y much less than a what motion will $-q$ have? Why?

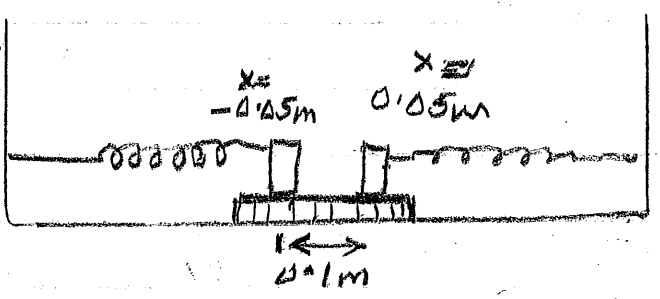
29. As shown, a charge q enters a region of constant $\vec{E}$ field of width ℓ with its initial position $(0,0)$ and initial velocity $v_0\hat{x}$. After passing through $\vec{E}$ it travels toward a screen L meters away. Calculate the point at which it strikes the screen. (neglect gravity)



30. Which $\vec{E}$ field is larger, the one due to a proton at a point 10^{-10} m away from it or one due to an electron at a point 10^{10} away from it?

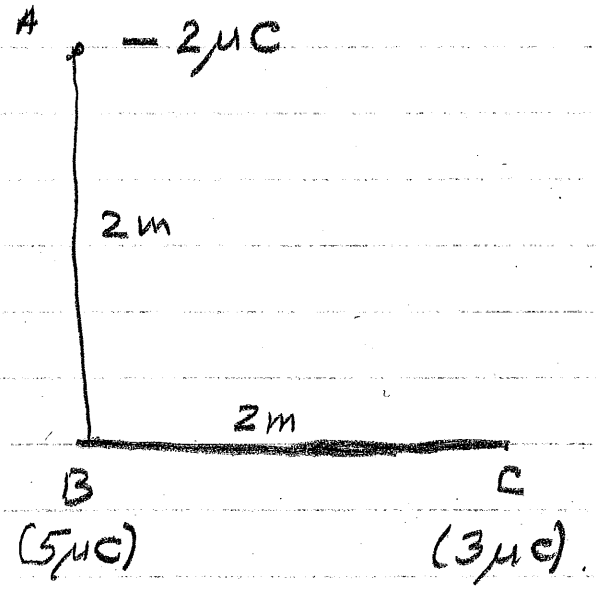
31. A charge of $1\mu C$ is located at $x=0$ and a charge of $25\mu C$ is fixed at $x = 6m$. Where would you place a charge of $-5\mu C$ so that it experiences no force? Why?

32. The picture shows two equal charges (q) attached to two identical springs with spring constant 10^3 N/m. They are in eq when the separation is 0.1m, each spring being squeezed by 0.05m. Calculate q (neglect friction)



33. A charge of $+20\mu C$ is sitting at rest at $r=0$. A particle carrying a $-5\mu C$ is going around it in a circular orbit of radius 3m. What is the speed of the $-5\mu C$ particle if its mass is 0.3kg? Why?

34. In the picture along side what is the total force on the charge located at A? Why?



35. The dipole $\underset{\rightarrow}{p} = q\underset{\rightarrow}{\ell}$ is located in a constant $\underset{\rightarrow}{E} = E\hat{x}$ as shown. a) What is the total force on the dipole? (b) what is the torque on the dipole? why?