Physics 228 – Spring 2004 – First Common Hour Exam Solutions

1. Apparent depth is reduced by ratio of indices of refraction:

$$d' = \frac{d}{n_{liq}} \Rightarrow n_{liq} = \frac{d}{d'} = \frac{10.}{6.4} = 1.56$$

2. For two slits, bright fringes occur at

$$d\sin\theta = m\lambda$$
$$d = \frac{\lambda}{\sin\theta} \approx \frac{\lambda L}{\Delta y} = 2.25 \text{ mm}$$

3. Using the lens equation

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$
$$q = \left(\frac{1}{f} - \frac{1}{p}\right)^{-1}$$
$$q = -7.78 \text{ cm}$$

for p = 35 cm for example.

4. For θ=40° we have

$$I = I_0 \cos^2\theta$$
$$\frac{I}{I_0} = 0.587$$

16. We can hear around corners because the wavelength of sound is much greater than that of light.

17. The edge of the hole where the "mirror" appears to start is where light begins to be totally internally reflected:,

$$\sin\theta_c = \frac{1}{n} \Rightarrow \theta_c = 48.8^o$$
$$\tan\theta_c = \frac{r}{d} = 1.14 \Rightarrow d = 1.8 \text{ m}$$

18. In order to emerge from side BC, we need ϕ>26.56° from which we find

$$\sin\theta > n\sin\phi$$
$$\Rightarrow \theta > 35.5^o$$

The condition for the ray to totally reflect internally is

$$\sin(90^o - \phi) > \frac{1}{n}$$
$$90^o - \phi > 50.3^o$$
$$\phi < 39.7^0$$
$$\Rightarrow \theta < 56.2^o$$

Therefore the ray will totally internally reflect only if 35.5°≤θ≤56.2°

19. Using the mirror equation,

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$
$$f = \left(\frac{1}{p} + \frac{1}{q}\right)^{-1}$$
$$q = -Mp = -p/4 = -3 \text{ cm}$$
$$\Rightarrow p = 12 \text{ cm}$$
$$\Rightarrow f = -4 \text{ cm}$$

20. Using the lens equation we find

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$$

$$M=-\frac{q}{p}$$

$$\Rightarrow\frac{1}{p}+\frac{1}{-Mp}=\frac{1}{f}$$

$$1-\frac{1}{M}=\frac{p}{f}$$

$$M=\left(1-\frac{p}{f}\right)^{-1}$$

So if $p<f$ then M>1, so the image is upright and enlarged. Since $q<0$, the image is virtual.

21. Starting with the lens equation we see that

$$M=-\frac{q}{p}=-\frac{0.024}{1.6}=-0.015$$

$$q=0.015p$$

$$\frac{1}{p}\left(1+\frac{1}{0.015}\right)=\frac{1}{f}$$

$$p=67.67f=3.4\text{ m}$$

22. The condition for strong reflection is given by

$$2nt=(m+\frac{1}{2})\lambda$$

$$\Rightarrow n=\frac{\lambda}{4t}=1.4$$

for m=0.

23. The condition here for minimum reflection is given by

$$2nt=(m+\frac{1}{2})\lambda$$

$$t_{\min}=\frac{\lambda}{4n}=96\text{ nm}$$

24. From the Bragg diffraction law we find

$$2d\sin\theta=m\lambda$$

$$m=\frac{2d\sin\theta}{\lambda}$$

$$m=2$$

25. The false statement is that f=3.64x10^{14} Hz; the actual frequency is the same as that of the incoming beam, $f=c/\lambda$=5.45x10^{14} Hz

26. For a circular aperture,

27. For a diffraction grating,

$$d\sin\theta=m\lambda$$

$$\lambda_1=\frac{d\sin\theta_1}{1}$$

$$\lambda_1=523.1\text{ nm}$$

$$\lambda_2=524.1\text{ nm}$$

$$\lambda_3=523.5\text{ nm}$$

So the best choice is λ=523 nm.