

# SIXTH MIDTERM

1

Name: Lihong Jin

Discussion Instructor (circle): Billeter    Diwekar    Kennedy    Murray    Whitaker

Discussion Section # \_\_\_\_\_

Student ID #: \_\_\_\_\_

**REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!**

Use the conversion constants and data given on the front page.

- (a) Calculate the critical angle for total internal reflection for diamond ( $n = 2.40$ ) in water ( $n = 1.33$ ).

$$\sin \theta_c = \frac{1.33}{2.40} = 0.554 \quad \theta_c = 33.7^\circ$$

- (b) Find the polarizing angle for light incident on a diamond ( $n = 2.40$ ) surface from air.

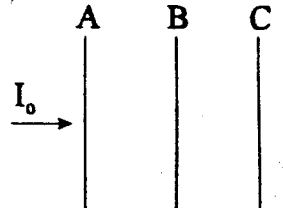
$$\tan \theta_p = \frac{2.40}{1} = 2.40 \quad \theta_p = 67.4^\circ$$

- (c) If microwaves have a wavelength of 1.30 cm, calculate their frequency.

$$\lambda = 1.30 \text{ cm.} \quad v = \lambda f$$

$$f = \frac{v}{\lambda} = \frac{3.0 \times 10^{10} \text{ cm/s}}{1.30 \text{ cm}} = 2.31 \times 10^{10} \text{ Hz. (or s}^{-1}\text{)}$$

- (d) Unpolarized light is incident on three polarizing sheets, such as shown in class. The axis of B is at  $30^\circ$  with respect to A. The axis of C is at  $30^\circ$  with respect to B. If  $I_0$  is the incident intensity, what is the intensity after passing C?



after A:  $\frac{1}{2} I_0$   
 after B:  $\frac{1}{2} I_0 \cos^2 30^\circ$   
 after C:  $\frac{1}{2} I_0 \cos^2 30^\circ \cos^2 30^\circ$

$$I = \frac{1}{2} I_0 \cos^2 30^\circ \cos^2 30^\circ = \frac{1}{2} I_0 \times \frac{3}{4} \times \frac{3}{4}$$

$$= \frac{9}{32} I_0 = 0.281 I_0$$

- (e) Sunlight is incident on a solar collector with an intensity of  $455 \text{ W/m}^2$ . What is the peak value of the magnetic field in the light waves?

$$I = 455 \text{ W/m}^2. \quad I = \frac{E_m B_m}{2 \mu_0} = \frac{c B_m^2}{2 \mu_0}$$

$$B_m = \sqrt{\frac{I \cdot 2 \mu_0}{c}} = \sqrt{\frac{455 \times 2 \times 4\pi \times 10^{-7}}{3 \times 10^8}} = 1.95 \times 10^{-6} \text{ T.}$$