

Position: # (your seat #).....

Your Name: Last, First.....

Name of Workshop Instructor: Last, First.....

Total points: 42

$c=3 \times 10^8$  m/s (the speed of light)

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$$f = \frac{1}{T} \quad (\text{SI unit Hz} = \text{s}^{-1}) \quad (5-8)$$

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$$v = \frac{\lambda}{T} = f\lambda \quad (11-6)$$

Wien:  $\lambda T = 2.898 \times 10^{-3}$  Km

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Stefan's law of radiation (blackbody):

$$\mathcal{P} = \sigma AT^4 \quad (14-15)$$

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$$\sigma = 5.670 \times 10^{-8} \text{ W}/(\text{m}^2 \cdot \text{K}^4) \quad (14-16) \quad \text{reflection:}$$

$v=c/n$ ,  $\lambda=\lambda/n$ ,  $n$  refractive index

$$\theta_i = \theta_r$$

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### Snell's Law

$$n_i \sin \theta_i = n_t \sin \theta_t \quad (23-4)$$

refraction

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Critical angle:

$$\theta_c = \sin^{-1} \frac{n_t}{n_i} \quad (23-5a)$$

Total internal reflection

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Mirror equation:

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \quad (23-10)$$

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Magnification equation:

$$m = \frac{h'}{h} = -\frac{q}{p} \quad (23-9)$$

Brewster's angle:

$$\theta_B = \tan^{-1} \frac{n_t}{n_i} \quad (23-6)$$

**Q1.(8pts)** Estimate the energy radiated from a person whose skin is at temperature of 32 C. Assume the total surface area of the person is 2.0 m<sup>2</sup>

At what wavelength is most energy emitted ? What is name given to this type of radiation ? If the room where the person is sitting is at 20 C what is the net energy which must be supplied by the body to maintain this temperature.

**Q2.(3pts)** Calculate the speed of EM radiation in a material whose refractive index is 1.5. If the radiation has a frequency of  $1 \times 10^{14}$  Hz what is the wavelength in the medium ?

**Q3. (2 pts)** A white light source is viewed through a combination of yellow and magenta filters. What color is perceived ? Explain your answer

**Q4. (3 pts)** Explain what is meant by a light ray. What criterion must be satisfied if the propagation of a light wave is to be successfully described in terms of rays ?

**Q5. a) (2pts)** What is the angle of refraction when light passes from air into diamond at an angle of incidence of  $60^\circ$  (assume the refractive index of diamond is 2.42).

**b) (2pts)** A beam of light passing is observed to be refracted on passing from water to air. The angle of incidence is  $30^\circ$  and the angle of the refracted beam is  $41.7^\circ$ . What is the refractive index of water ?

**Q6.(5 pts)** An object is placed at a distance of 40 cm from the center of a thin converging lens. The focal length of the lens is 20 cm. What is the distance of the image from the lens. Is it real or virtual ? What is the ratio of the image size to object size ?

**Q7. (7pts)** An object of height 3cm is placed at distance of 10 cm from a converging mirror whose focal length is 20 cm.

Sketch a ray diagram showing the location of the image. Is the image real or virtual, upright or inverted ? Use the mirror/lens equations to find the location of the image and the size of the image.

**Q8. (3pts)** Calculate the critical angle for total internal reflection for a diamond under water (the refractive indices for water and diamond are 1.33 and 2.42 respectively)

**Q9. (3pts)** Sunlight reflected off a still lake is observed to be perfectly polarized if the angle of incidence is precisely  $53.1^\circ$ . Calculate the refractive index of water. In what direction is the reflected light polarized ?

**Q10. (2pts)** What is the temperature of a blackbody if the peak of the blackbody spectrum corresponds to a wavelength of  $1\text{cm}$  ?