Name: Key

PHY2054.002, Fall 2010
Exam #3

PID:

Part I (50%) Version B

1. Which one of the following statements concerning the image formed by a concave spherical mirror is true?

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ if $d_o > f \Rightarrow d_i < 0$

(A) When the object distance is less than the focal length, the image is virtual. B) When the object distance is larger than the focal length, the image is virtual. C) When the object is at the center of curvature, the image is formed at infinity. D) When the object distance is less than the focal length, the image is inverted relative to the object. E) When the object distance is larger than the focal length, the image is upright relative to the object.

2. The bending of light as it moves from one medium to another with differing indices of refraction is due to a change in what property of the light?

A) amplitude, B) period, C) frequency, (D) speed, E) color

3. An electromagnetic wave has an electric field with a peak value of 250 N/C. What is the average intensity of the wave?

A) 0.66 W/m^2 , B) 0.89 W/m^2 , (C) 83 W/m^2, D) 120 W/m^2, E) 170 W/m^2

$E_{rms} = \frac{E_{peak}}{\sqrt{2}}$

$S = c\epsilon_0 E_{rms}^2$

4. A ray of light propagates in water (n = 1.333) and strikes a sheet of crown glass (n = 1.523). If the angle of refraction in the glass is 35.2°, determine the angle of incidence.

A) 30.3°, B) 32.8°, C) 35.2°, (D) 41.2°, E) 45.0°

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.333 \cdot \sin\theta_1 = 1.523 \cdot \sin(35.2°)$

$\theta = \sin^{-1}\left[\frac{1.523}{1.333} \cdot \sin 35.2°\right]$

5. Which one of the following will *not* generate electromagnetic waves or pulses?

(A) a steady direct current, B) an accelerating electron, C) a proton in simple harmonic motion, D) an alternating current, E) charged particles traveling in a circular path in a mass spectrometer

6. An object is placed at the focal point of a converging lens of focal length f. What is the image distance?

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$, if $d_o = f \Rightarrow d_i = \infty$

A) f, B) $2f$, C) $1/f$, D) $2/f$, (E) at an infinite distance

7. A convex mirror in an amusement park has a radius of curvature of 3.00 m. A man stands in front of the mirror so that his image is half as tall as his actual height. At what distance must the man focus his eyes in order to see his image?

(A) 2.25 m, B) 3.00 m, C) 4.50 m, D) 5.00 m, E) 6.75 m

$r = 3.00\text{m}$.

$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} = \frac{1}{2} \Rightarrow d_o = -2d_i$.

$|f| = \frac{r}{2} = 1.50\text{m}$.

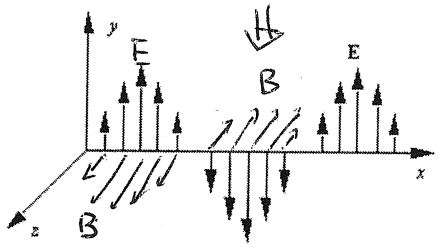
because it is a convex mirror

$f = -1.50\text{m}$

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{-2d_i} + \frac{1}{d_i} = \frac{1}{2d_i}$

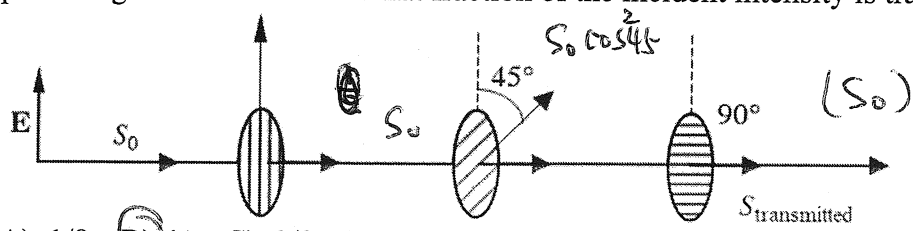
$d_i = -0.75\text{m}$, $d_o = -2d_i = 1.5\text{m}$, $d_o + |d_i| = 2.25\text{m}$

8. The electric field **E** of an electromagnetic wave traveling the positive x direction is illustrated in the figure. This is the wave of the radiation field of an antenna. What are the direction and the phase relative to the electric field of the magnetic field at a point where the electric field is in the negative y direction?
Note: The wave is shown in a region of space that is a large distance from its source.



A) $+y$ direction, in phase, B) $-z$ direction, 90° out of phase, C) $+z$ direction, 90° out of phase
D) $-z$ direction, in phase, E) $+z$ direction, in phase

9. A linearly polarized beam of light is incident upon a group of three polarizing sheets which are arranged so that the transmission axis of each sheet is rotated by 45° with respect to the preceding sheet as shown. What fraction of the incident intensity is transmitted?



$\frac{1}{2}$ $\frac{1}{2}$
$(S_0)(\cos^2 45^\circ)(\cos^2 45^\circ)$
$= \frac{1}{4} S_0$

A) 1/8, B) ¼, C) 3/8, D) ½, E) 3/4

10. An object is placed 1 m in front of a plane mirror. An observer stands 3 m behind the object. For what distance must the observer focus his eyes in order to see the image of the object?

A) 1 m, B) 2 m, C) 3 m, D) 4 m, E) 5 m

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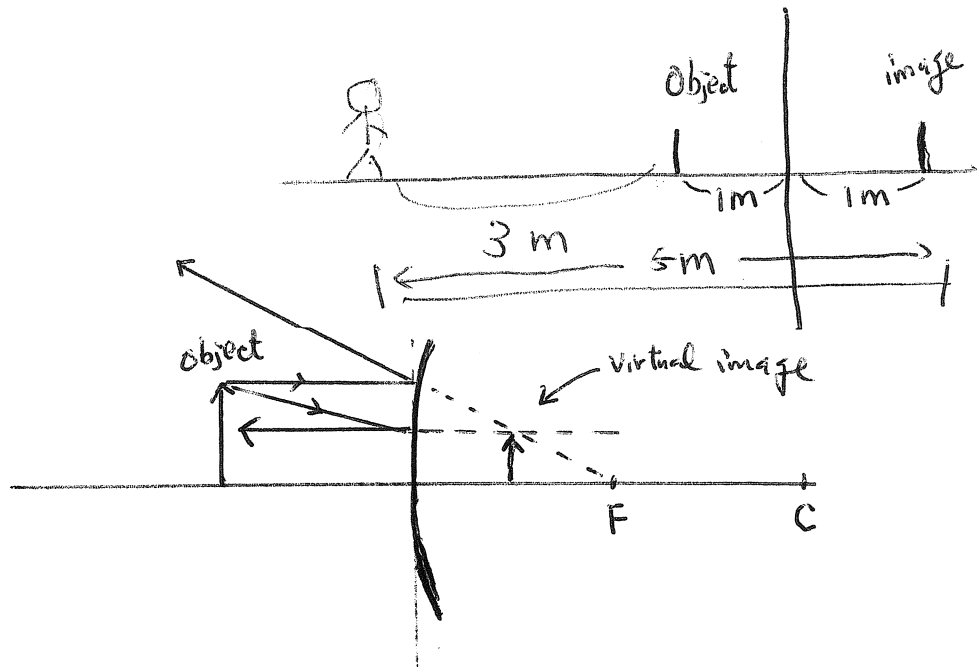


Part II (50%)

1. In a laboratory, the oxygen emits at a wavelength of 513 nm. However, the same emission from oxygen at a distance galaxy NGC 7319 is measured on earth to be 525 nm. (a) what is the relative speed of NGC7319 relative to earth? (10%) (b) Decide whether this galaxy is approaching or receding from earth. (5%).

(a) $\lambda_s = 513\ nm \quad \lambda_o = 525\ nm$

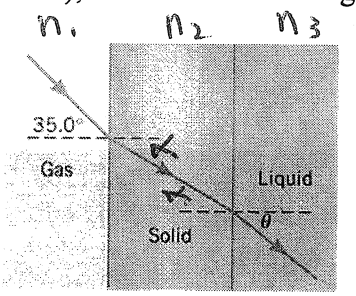
$$f_o = f_s\left(1 - \frac{V_{rel}}{c}\right) \Rightarrow \frac{1}{\lambda_o} = \frac{1}{\lambda_s}\left(1 - \frac{V_{rel}}{c}\right)$$

$$\Rightarrow \frac{1}{525} = \frac{1}{513}\left(1 - \frac{V_{rel}}{c}\right) \Rightarrow \frac{V_{rel}}{c} = 0.02286$$

$$\boxed{V_{rel} = 6.86 \times 10^6\ m/s}$$

(b) The galaxy is receding because the wavelength becomes longer and frequency becomes shorter.

2. The drawing show a light ray traveling through a gas(air, n=1.00), a solid(crown glass, n=1.52) and a liquid (water, n=1.33). (a) At what angle θ does the light enter the liquid? (10%). (b) Now if we change the liquid to chlorobenzene (n=1.52), what will be the angle θ that the light enters the liquid? (5%).



$n_1 = 1.00, \quad n_2 = 1.52, \quad n_3 = 1.33$

(a) $n_1 \sin 35^\circ = n_2 \sin\alpha$

$(1.0)(0.5736) = (1.52)\sin\alpha$

$\alpha = 22.2^\circ$

$(1.52)\sin 22.2^\circ = (1.33)\sin\theta$

$\sin\theta = 0.43, \quad \boxed{\theta = 25.5^\circ}$

(b) if $n_3 = 1.52 \Rightarrow \boxed{\theta = 22.2^\circ}$

$n_2 \sin\alpha = n_3 \sin\theta \quad$ if $n_3 = n_2 \quad \theta = \alpha = 22.2^\circ$

3. An object is placed 8.0 cm in front of a convex mirror. The virtual image is located 4.5 cm away from the mirror. (1) Find the focal length of the mirror (10%), (2) What is the magnification ? (5%), (3) Draw a ray tracing diagram. (5%).

(a) Convex mirror. so f is negative.

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$. $d_o = 8.0\ cm$, $d_i = -4.5\ cm$.

$\Rightarrow \frac{1}{8.0} + \frac{1}{-4.5} = \frac{1}{f}$. $\Rightarrow f = \frac{1}{\frac{1}{8.0} + \frac{1}{-4.5}}$

$\boxed{f = -10.28\ cm}$

(b) $m = -\frac{d_i}{d_o} = -\frac{-4.5}{8.0} = 0.56$

So the image is smaller and upright.

(c)