Physics 214 Test 3A

Section 1: Dr. Gladden, April 28, 2009

NAME: KEY UM ID#:_____

Conceptual Multiple Choice (*2 points each*): Clearly write the letter corresponding to the BEST possible answer in the space provided. You may also circle the answer to be sure.

1. A The angle of incidence
   A) must equal the angle of reflection.
   B) is always less than the angle of reflection.
   C) is always greater than the angle of reflection.
   D) may be greater than, less than, or equal to the angle of reflection.

2. B An image formed when the light rays do not actually pass through the image location, and would not appear on paper or film placed at that location is referred to as a
   A) real image.
   B) virtual image.
   C) upright image.
   D) inverted image.

3. C Is it possible to see a virtual image?
   A) No, since the rays that seem to emanate from a virtual image do not in fact emanate from the image.
   B) No, since virtual images do not really exist.
   C) Yes, the rays that appear to emanate from a virtual image can be focused on the retina just like those from an illuminated object.
   D) Yes, since almost everything we see is virtual because most things do not themselves give off light, but only reflect light coming from some other source.
   E) Yes, but only indirectly in the sense that if the virtual image is formed on a sheet of photographic film, one could later look at the picture formed.

4. C Light arriving at a concave mirror on a path parallel to the axis is reflected
   A) back parallel to the axis.
   B) back on itself.
   C) through the focal point.
   D) through the center of curvature.

5. A Light travels fastest
   A) in a vacuum.
   B) through water.
   C) through glass.
   D) through diamond.

6. B The critical angle for a beam of light passing from water into air is 48.8. This means that all light rays with an angle of incidence greater than this angle will be
A) absorbed.
B) totally reflected.
C) partially reflected and partially transmitted.
D) totally transmitted.

7. A The principle on which lenses work is
A) refraction.
B) polarization.
C) dispersion.
D) total internal reflection.

8. C A convex lens has focal length f. An object is located at infinity. The image formed is located
A) at 2f.
B) between f and 2f.
C) at f.
D) between the lens and f.

9. C The image of the rare stamp you see through a magnifying glass is
A) always the same orientation as the stamp.
B) always upside-down compared to the stamp.
C) either the same orientation or upside-down, depending on how close the stamp is to the glass.
D) either the same orientation or upside-down, depending on the thickness of the glass used.

10. B When a light wave enters into a medium of different optical density (index of refraction),
A) its speed and frequency change.
B) its speed and wavelength change.
C) its frequency and wavelength change.
D) its speed, frequency, and wavelength change.

11. C What principle is responsible for light spreading as it passes through a narrow slit?
A) refraction
B) polarization
C) diffraction
D) interference

12. D What principle is responsible for alternating light and dark bands when light passes through two or more narrow slits?
A) refraction
B) polarization

C) dispersion
D) interference

13. A At the first maxima on either side of the central bright spot in a double-slit experiment, light from each opening arrives
A) in phase.
B) 90 out of phase.
C) 180 out of phase.
D) none of the given answers

14. D The principle(s) which allows a rainbow to form is (are)
A) refraction.
B) total internal reflection.
C) dispersion.
D) all of the above.

15. C In which of the following ways is a camera different from the human eye?
A) The camera always forms an inverted image, the eye does not.
B) The camera always forms a real image, the eye does not.
C) The camera utilizes a fixed focal length lens, the eye does not.
D) For the camera, the image magnification is greater than one, but for the eye the magnification is less than one.
E) A camera cannot focus on objects at infinity but the eye can.

16. A The closest distance at which an eye can see objects clearly is A) the near point.
B) the far point.
C) nearsightedness.
D) farsightedness.

17. B If a person's eyeball is too long from front to back, the person is likely to suffer from
A) spherical aberration.
B) nearsightedness.
C) farsightedness.
D) astigmatism.

18. C With what color light would you expect to be able to see the greatest detail when using a microscope?
A) red, because of its long wavelength
B) yellow, because of its right wavelength
C) blue, because of its shorter wavelength
D) Color does not matter.

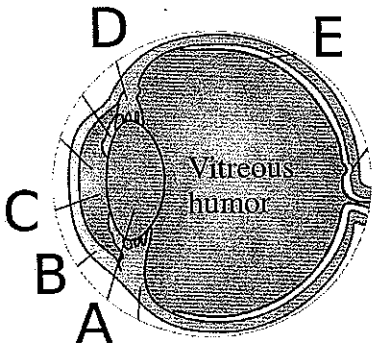
19. A The length of time the shutter is open and the film is exposed in a camera is determined by the
A) shutter speed.
B) f-stop.

C) focusing.
D) none of the given answers

20. B The colors on an oil slick are caused by reflection and
A) diffraction.
B) interference.
C) refraction.
D) polarization.

Problems: Work each of the following problems. Make sure to **show your work** and put a box around your final answer. **Be careful about units!!**

1. (*15 points*) The figure shows a human eye. (10 points) Identify the parts labeled (A-E).



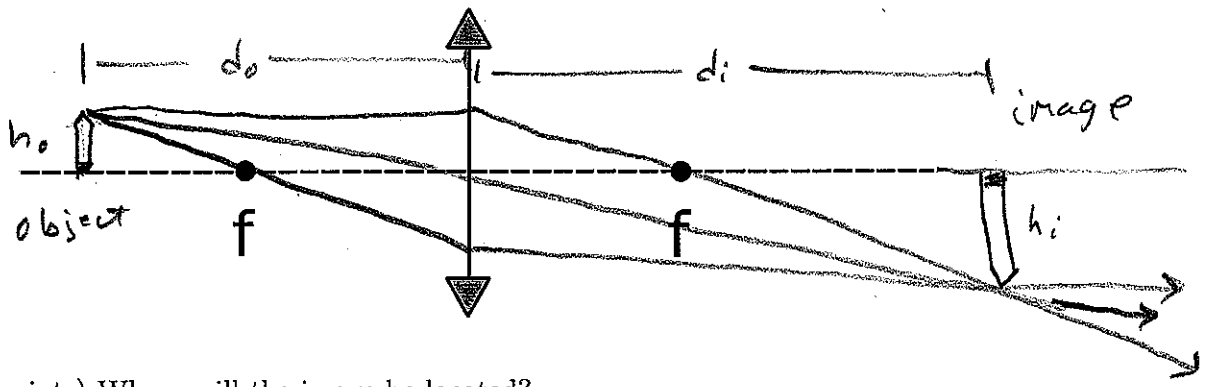
A. Lens
B. Cornea
C. Pupil
D. Ciliary Muscle
E. Retina

(5 points) If a person with a near point of 30.0 cm used a magnifying glass with focal length of 10.0 cm, what will the magnification be of an object if the image is located at the person's near point?

Since the image is at the near point,

$$M = \frac{N}{f} + 1 = \frac{30.0}{10.0} + 1 = \boxed{4}$$

2. (*15 points*) A converging lens is shown below with a focal length of 12 cm. A 4.0 cm tall pencil is placed 18 cm to the left of the lens.



A. (5 points) Where will the image be located?

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

so $$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{1}{12} - \frac{1}{18}$$

$$\Rightarrow d_i = 36 \text{ cm}$$

B. (5 points) What will be the height of the image?

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \Rightarrow h_i = -\frac{d_i}{d_o} h_o$$

$$= -\frac{36}{18}(4.0 \text{ cm})$$

$$= -8.0 \text{ cm}$$

Negative means it is inverted

C. (5 points) Draw the ray diagram above with at least 2 principle rays.

3. (*15 points*) A laser with wavelength of 632 nm is incident on a diffraction grating with 100 ~~1,000~~ grooves per millimeter. The diffraction pattern is projected in a screen 5.0 m away from the grating.

A. (10 points) What will the distance between the central and **second** maxima (bright spot) on the screen be?

$d = 10\,\mu m$

$d \sin\theta_n = n\lambda$, and $\tan\theta_n = \frac{y_n}{L}$

So: $\sin\theta_2 = \frac{2(632\,nm)}{10\,\mu m}$

and $\theta_2 = 7.26°$

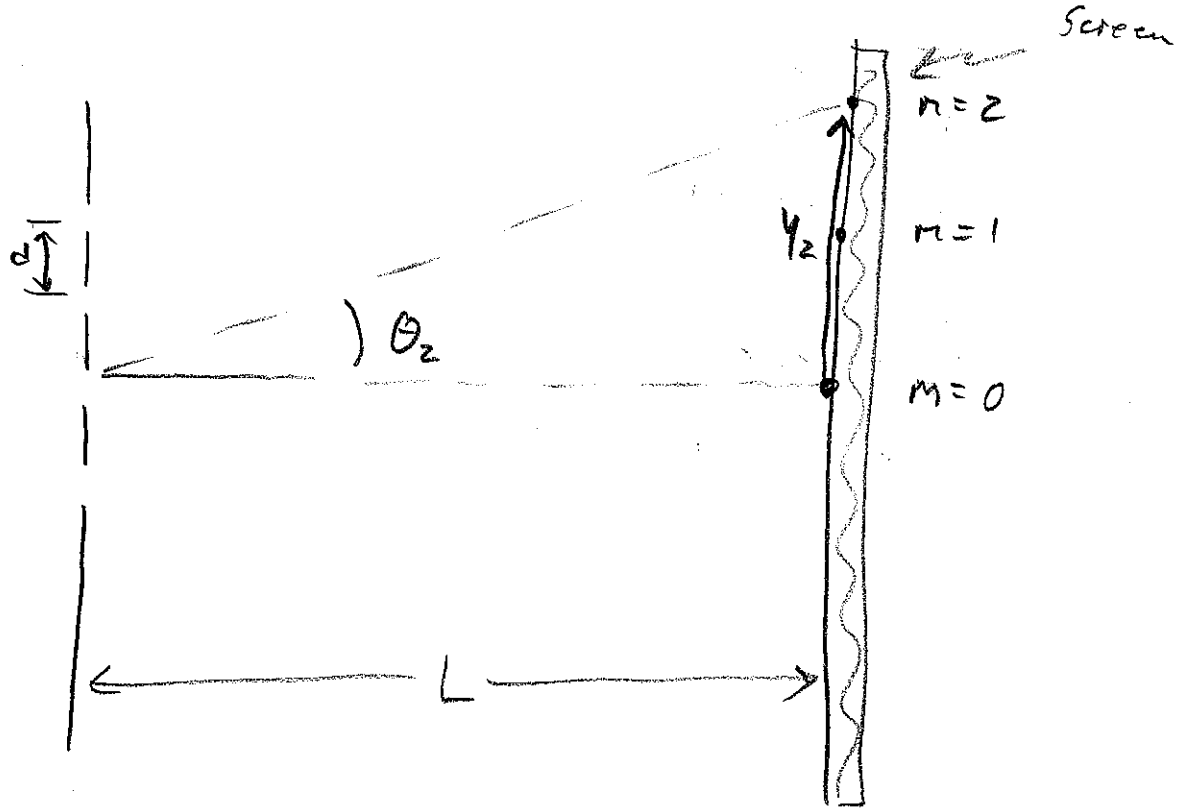
So $y_m = L \tan\theta_m$

$y_2 = 5.0\,m \tan(7.26°)$

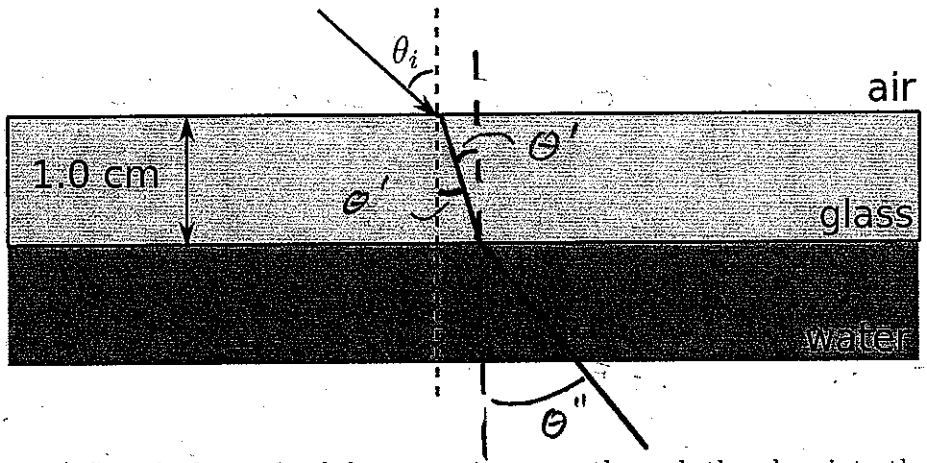
$= 0.637\,m$

$\boxed{y_2 = 63.7\,cm}$

B. (5 points) Sketch a diagram showing the variables in this problem.



4. (*15 points*) The figure shows a beam of light incident on an glass aquarium wall that is 1.0 cm thick. The angle of incidence is $\theta_i = 23°$. The index of refraction for glass is n_g=1.50 and water is n_w=1.33.



A. (5 points) Sketch the path of the ray as it passes through the glass into the water.

B. (10 points) What will be the angle of refraction as it enters the water on the other side.

By Snell's Law

Air - Glass

$n_a \sin\theta_i = n_g \sin\theta'$

so $\sin\theta' = \frac{n_a}{n_g} \sin\theta_i$

Glass - Water

$n_g \sin\theta' = n_w \sin\theta''$

so $\sin\theta'' = \frac{n_g}{n_w} \sin\theta' = \frac{n_g}{n_w} \frac{n_a}{n_g} \sin\theta_i$

$= \frac{n_a}{n_w} \sin\theta'$: like the glass wasn't there!

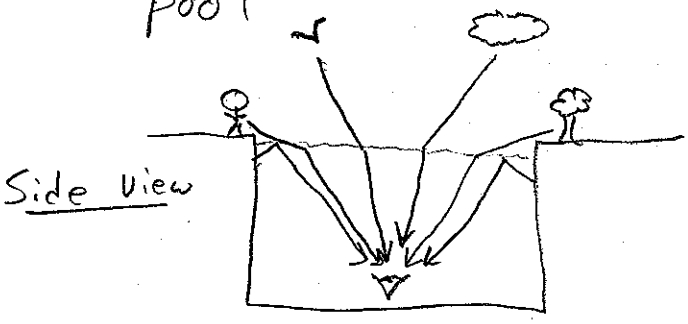
so $\theta'' = \sin^{-1}\left(\frac{1.0}{1.33} \sin 23°\right)$

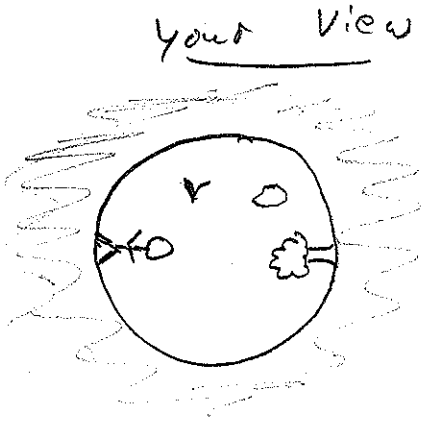
$\boxed{\theta'' = 17.1°}$

Extra Credit(+5 points)

Describe what you would see if you sat at the bottom in the center of a very still pool and looked straight up (hold your nose!). Try this over the summer and send me an email.

You would see a Circle Containing images of all the objects outside of the pool





Constants:
$k = 1/(4\pi\varepsilon_0) = 9 \times 10^9$ Nm^2/C^2
$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/(Nm^2)
Charge of an electron / proton: $e = \pm 1.60 \times 10^{-19}$ C
$\mu_0 = 4\pi \times 10^{-7}$ T m/A
$c = 3.0 \times 10^8$ m/s

Outside the Circle, you would see a reflection of the sides of the pool by total internal reflection