Physics 212 Test 3A

Dr. Gladden, April 26, 2012
Chapters 32-36

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. 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.

12. 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.

13. 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.

14. 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.

15. C The Poynting vector is oriented
A. parallel to both E and B
B. parallel to E but perpendicular to B
C. in the same direction the EM wave is propagating
D. parallel to B but perpendicular to E

16. B The last piece of the puzzle for the theory of electricity and magnetism and discovered by Maxwell was
A. derivative current
B. displacement current
C. AC current
D DC current

17. B A phasor diagram is a way to
A. graphically represent a circuit
B. graphically represent the voltage across elements in an AC circuit as a rotating vector
C. graphically represent a combination of resistors
D. graphically represent the momentum in a circuit

18. B The effect of an inductor in an AC current is to make the current
A. lead the voltage by a phase of 90°
B. lag behind the voltage by a phase of 90° .
C. make the current in phase with the voltage.
D. increase the amplitude of the voltage.

19. A The RMS value of an AC voltage is used for power because
A. the average is 0
B. the values change all the time
C. the average is negative
D. the average is the same as the amplitude

20. C Of the following, which is not electromagnetic in nature?
A) microwaves
B) gamma rays
C) sound waves
D) radio waves

Test 3 B Key

1. C
2. B
3. B
4. B
5. A
6. C
7. C
8. B
9. A
10. A
11. D
12. B
13. B
14. A
15. C
16. B
17. C
18. A
19. C
20. C

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

1. (*20 points*) A step down transformer is used to charge an smart phone. The turn ratio is $N_2/N_1 = 1/15$. The input voltage (from a standard US wall socket) is 120 V (rms) and the transformer draws 0.089 A from the socket.

   (A) What is the RMS output voltage coming out of the transformer?

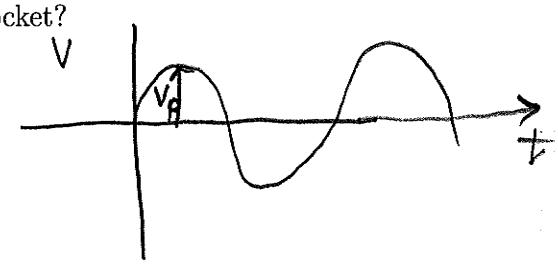
By transformer eqn.

$$V_2 = \frac{N_2}{N_1} V_1 = \left(\frac{1}{15}\right) 120\,V = \boxed{8\ V_{rms}}$$

(B)How much power is delivered to the smart phone?

$$P_{in} = P_{out} = I_{rms} V_{rms} = (0.089\,A)(120\,V) = \boxed{10.7\ \text{Watts}}$$

(C) What is the **PEAK** voltage delivered by the wall socket?



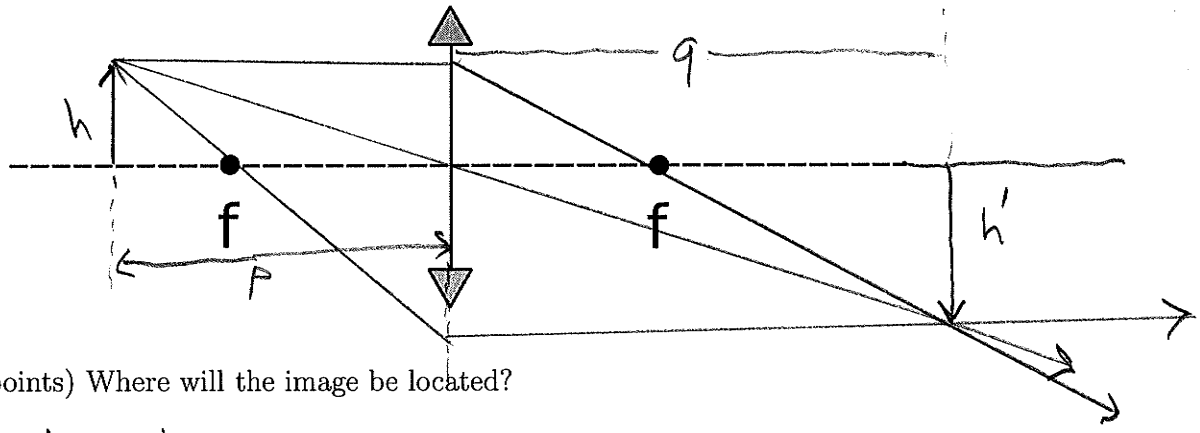
$$V_{rms} = \frac{1}{\sqrt{2}} V_p$$

So $V_p = \sqrt{2}\, V_{rms}$

$= \sqrt{2}\,(120\,V)$

$= \boxed{170\ V}$

2. (*20 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?

By thin lens eqn.

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

so $\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{12} - \frac{1}{18} = 0.0277$

So $q = \frac{1}{0.0277} = \boxed{36\text{ cm}}$

By Sign Conventions, all these are (+) numbers

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

$$M = \frac{h'}{h} = -\frac{q}{p} \Rightarrow h' = -\frac{q}{p} h$$

$$= -\left(\frac{36}{18}\right) 4.0\text{cm} = \boxed{-8.0\text{cm}}$$

(-) Means inverted

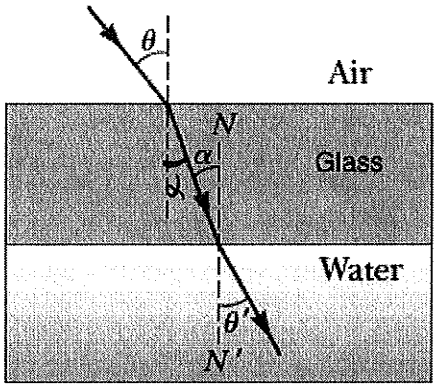
C. (5 points) Draw the ray diagram above with at least 2 principle rays.

See above

D. (5 points) Use three key terms to describe this image.

Real, larger, inverted

3. (*20 points*) The figure shows a light ray passing from air, through a plate of glass, into water (like a fish tank). Use the following for indices of refraction: $n_{air} = 1.0, n_{glass} = 1.5, n_{water} = 1.33$. The angle of incidence (θ) is 23°.



(A) (6 points) Determine the angle of refraction α.

By Snell's Law

$n_{air} \sin\theta = n_g \sin\alpha \Rightarrow$

so $\alpha = \sin^{-1}\left[\frac{n_{air}}{n_g}\sin\theta\right] = \sin^{-1}\left[\frac{1}{1.5}\sin(23)\right] = \boxed{15.1^\circ}$

(B) (6 points) Determine the exit angle into the water (θ').

Again by Snell's

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

so $\theta' = \sin^{-1}\left[\frac{1.5}{1.33}\sin(15.1)\right] = \boxed{17.1^\circ}$

(C) (8 points) For the scenario shown, would a total internal reflection be possible? If so, how and where? If not, why not? (Feel free to consider any value for θ).

Internal reflection can only happen when light transitions from slower to faster medium. Here that would be glass to water. What is max angle though?

if $\theta = 90^\circ$ → $\alpha_{max} = \sin^{-1}\left[\frac{n_{air}}{n_g}(1)\right] = 41.8^\circ$

and Critical angle for glass → water $\Rightarrow \alpha_c = \sin^{-1}\left[\frac{n_w}{n_g}\right] = 62.5^\circ$

Since $\alpha_{max} < \alpha_c$, total internal reflection is <u>Not</u> Possible.

Extra Credit (5 points)
How is a rainbow created? Make sure to mention the 3 physical phenomenon required and draw a detailed sketch.

The 3 phenomena are

1. dispersion
2. refraction
3. total internal reflection