Multiple Choice Section: Answer the following questions and transfer them to the Scantron sheet.

1. A concave mirror forms a real image which is twice the size of the object. If the object is 20 cm from the mirror, the radius of curvature of the mirror must be about:
   A) 13 cm
   B) 20 cm
   C) 27 cm
   D) 40 cm
   E) 80 cm

2. A concave spherical mirror has a focal length of 12 cm. If an object is placed 18 cm in front of it the image position is:
   A) 7.2 cm behind the mirror
   B) 7.2 cm in front of the mirror
   C) 36 cm behind the mirror
   D) 36 cm in front of the mirror
   E) at infinity

3. A convex spherical mirror has a focal length of 12 cm. If an object is placed 6 cm in front of it the image position is:
   A) 4 cm behind the mirror
   B) 4 cm in front of the mirror
   C) 12 cm behind the mirror
   D) 12 cm in front of the mirror
   E) at infinity

4. The image produced by a convex mirror of an erect object in front of the mirror is always:
   A) virtual, erect, and larger than the object
   B) virtual, erect, and smaller than the object
   C) real, erect, and larger than the object
   D) real, erect, and smaller than the object
   E) none of the above
5. The light waves represented by the three rays shown in the diagram all have the same frequency. 4.7 wavelengths fit into layer 1, 3.2 wavelengths fit into layer 2, and 5.3 wavelengths fit into layer 3. Rank the layers according to the speeds of the waves, least to greatest.

A) 1, 2, 3
B) 2, 1, 3
C) 3, 1, 2
D) 3, 2, 1
E) 1, 3, 2

6. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by a multiple of:
A) $\pi/4$
B) $\pi/2$
C) $\pi$
D) $3\pi/4$
E) $2\pi$

7. Light from a small region of an ordinary incandescent bulb is passed through a yellow filter and then serves as the source for a Young's double-slit experiment. Which of the following changes would cause the interference pattern to be more closely spaced?
A) Use slits that are closer together
B) Use a light source of lower intensity
C) Use a light source of higher intensity
D) Use a blue filter instead of a yellow filter
E) Move the light source further away from the slits
8. Light from a point source X contains only blue and red components. After passing through a mysterious box, the light falls on a screen. Red and blue hands are observed as shown. The box must contain:

A) a lens
B) a mirror
C) a prism
D) a double slit
E) a blue and red filter

9. A glass \((n = 1.6)\) lens is coated with a thin film \((n = 1.3)\) to reduce reflection of certain incident light. If \(\lambda\) is the wavelength of the light in the film, the least film thickness is:

A) less than \(\lambda/4\)
B) \(\lambda/4\)
C) \(\lambda/2\)
D) \(\lambda\)
E) more than \(\lambda\)

10. No fringes are seen in a single-slit diffraction pattern if:

A) the screen is far away
B) the wavelength is less than the slit width
C) the wavelength is greater than the slit width
D) the wavelength is less than the distance to the screen
E) the distance to the screen is greater than the slit width
11. Monochromatic plane waves of light are incident normally on a single slit. Which one of the five figures below correctly shows the diffraction pattern observed on a distant screen?

A) I
B) II
C) III
D) IV
E) V

12. Sound differs from light in that sound:
A) is not subject to diffraction
B) is a torsional wave rather than a longitudinal wave
C) does not require energy for its origin
D) is a longitudinal wave rather than a transverse wave
E) is always monochromatic

13. The diagram shows a single slit with the direction to a point P on a distant screen shown. At P, the pattern has its second minimum (from its central maximum). If X and Y are the edges of the slit, what is the path length difference (PX) – (PY)?

A) $\lambda/2$
B) $\lambda$
C) $3\lambda/2$
D) $2\lambda$
E) $5\lambda/2$
14. Two nearly equal wavelengths of light are incident on an $N$ slit grating. The two wavelengths are not resolvable. When $N$ is increased they become resolvable. This is because:

A) more light gets through the grating  
B) the lines get more intense  
C) the entire pattern spreads out  
D) there are more orders present  
E) the lines become more narrow

15. Light of wavelength $\lambda$ is normally incident on some plane optical device. The intensity pattern shown is observed on a distant screen ($\theta$ is the angle measured to the normal of the device). The device could be:

A) a single slit of width $W$  
B) a single slit of width $2W$  
C) two narrow slits with separation $W$  
D) two narrow slits with separation $2W$  
E) a diffraction grating with slit separation $W$
Answer Key

1. C
2. D
3. A
4. B
5. D
6. C
7. D
8. D
9. B
10. C
11. B
12. D
13. D
14. E
15. A
PHYSICS 204-EXAM # 2-SPRING 2009

FREE RESPONSE SECTION: Answer the following problems. Show your work!

1. A concave spherical mirror has a focal length of 12 cm. If an object is placed 6 cm in front of it, determine the image position graphically and analytically.

Answer: 12 cm behind the mirror

2. An object is 30 cm in front of a converging lens of focal length 10 cm. Determine the image position graphically and analytically.

Answer: real and smaller than the object
3. In a Young’s double-slit experiment, light of wavelength 500 nm illuminates two slits that are separated by 1mm. What is the separation between adjacent bright fringes on a screen 5m from the slits?

Answer: 0.25 cm

4. A soap film is illuminated by white light normal to its surface. The index of refraction of the film is 1.50. Wavelengths of 480 nm and 800 nm and no wavelengths between are be intensified in the reflected beam. What is the thickness of the film?

Answer: $4.0 \times 10^{-5}$ cm
5. A plane wave with a wavelength of 500 nm is incident normally on a single slit with a width of $5.0 \times 10^{-6}$ m. Consider waves that reach a point on a far-away screen such that rays from the slit make an angle of $1.0^\circ$ with the normal. What is the difference in phase for waves from the top and bottom?

Answer: 1.1 rad.

6. Monochromatic light is normally incident on a diffraction grating that is 1 cm wide and has 10,000 slits. The first order line is deviated at a $30^\circ$ angle. What is the wavelength, in nm, of the incident light?

Answer: 500 nm