+40 for multiple choice +60 for problems = 100 total pts

Physics 212, Spring 2009

Quiz 1, Form: A

Name: Key

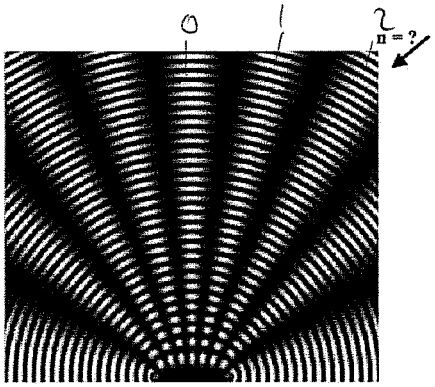
Date: _____

Use $g = 9.8$ m/s^2 for the magnitude of the acceleration of an object in free-fall.

+40 for multiple choice

Section 1. Multiple Choice

1. What is the value of n for the line of total constructive interference indicated by the arrow?



(a) 0
(b) 1
(c) 2
(d) 3
(e) 4

2. Diffraction grating A has a slit spacing d. Diffraction grating B has slits twice as far apart, $2d$. For which grating will the distance from the central maximum to the first bright fringe be the greatest?

$\sin\theta = \frac{n\lambda}{d}$ $\sin\theta \propto \frac{1}{d}$

(a) Grating A
(b) Grating B
(c) Neither; the distance from the central maximum to the first bright fringe is independent of the slit spacing d

$\theta\uparrow$ $d\downarrow$

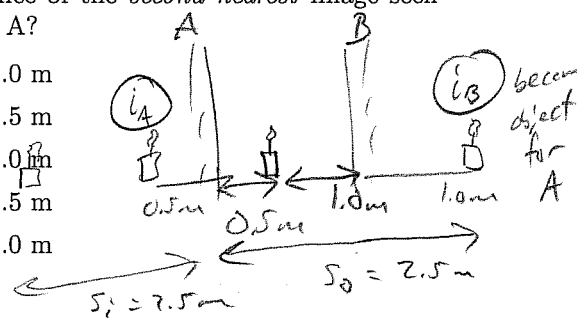
3. A diffraction grating has 1200 slits per centimeter. How far apart are the slits, in cm?

(a) 0.12 cm
(b) 0.012 cm
(c) 0.0012 cm
(d) 1200 cm
(e) 8.3×10^{-4} cm

$\frac{1\text{ cm}}{1200\text{ slits}} =$

4. You stand in an elevator, 0.5 m from mirror A and 1.0 m from mirror B. What is the image distance of the *second nearest* image seen in mirror A?

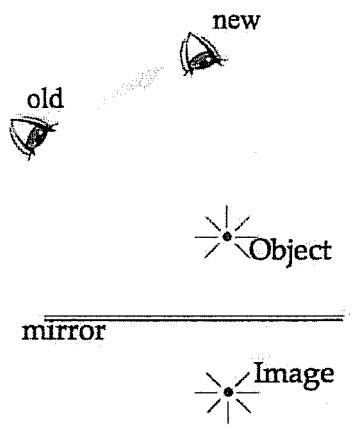
(a) 1.0 m
(b) 1.5 m
(c) 2.0 m
(d) 2.5 m
(e) 3.0 m



5. For the previous question, the image height is

(a) equal to the object height.
(b) less than the object height.
(c) greater than the object height.

.. If the observing eye is moved to the new position shown, the image it sees will appear



(a) closer to the mirrored surface.
(b) further from the mirrored surface.
(c) in the same place as before.
(d) further to the left.
(e) further to the right.

7. A concave makeup mirror is designed so that a person 0.30 m in front of it sees an upright image magnified by a factor of 4. What is the image distance?

$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$

$M = 4 = -\frac{s_i}{s_o}$

$s_i = -4 s_o = -1.2\ m$

(a) -0.60 m
(b) -0.30
(c) -1.20 m
(d) -0.075 m
(e) -0.34 m

8. For the mirror in the previous question, what is its focal length?

$\frac{1}{0.3} + \frac{1}{-1.2} = \frac{1}{f}$

$f = 0.4\ m$

(a) 2.5 m
(b) 0.30 m
(c) 0.075 m
(d) 0.24 m
(e) 0.40 m

9. For total destructive interference, the path difference between two waves must be

(a) $(n - \frac{1}{2})\lambda$ where n = 1, 2, ...
(b) $n\lambda$ where n = 0, 1, 2, ...

10. Two sources of water waves oscillate in phase with a wavelength of 0.080 m and are spaced 0.5 m apart. What is the maximum value of n for which total constructive interference will occur?

$\sin\theta = \frac{n\lambda}{d}$

$n = \frac{d \sin\theta}{\lambda}$, $\theta = 90°$

$n = \frac{0.5}{0.08} = 6.25$

(a) 2
(b) 3
(c) 4
(d) 5
(e) 6

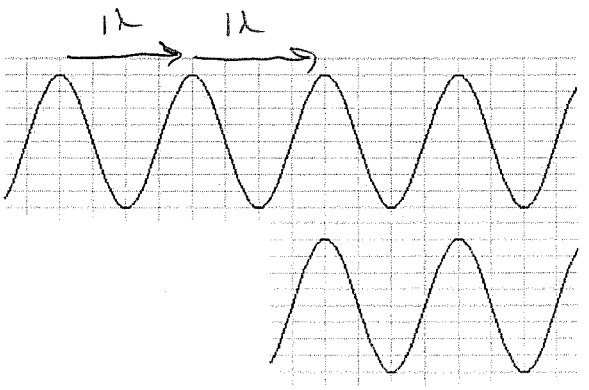
11. Red light has a longer wavelength than blue light. In Young's double slit experiment, which color light will have bright fringes that are *more spread out* (i.e. greater diffraction angle)?

(a) neither, because they will spread out the same amount (i.e. bright fringes will be at the same angles)
(b) red light
(c) blue light

12. Which type of mirror has a negative focal length?

(a) concave mirror
(b) convex mirror
(c) plane mirror

13. What is the path difference between the waves shown?



(a) $\frac{3\lambda}{2}$
(b) $\frac{5\lambda}{2}$
(c) λ
(d) 2λ
(e) 3λ

14. When the two waves in the previous question interfere, the result will be

(a) total constructive interference
(b) total destructive interference
(c) something in between total constructive and total destructive interference, with an amplitude between 0 and twice the amplitude of a single wave

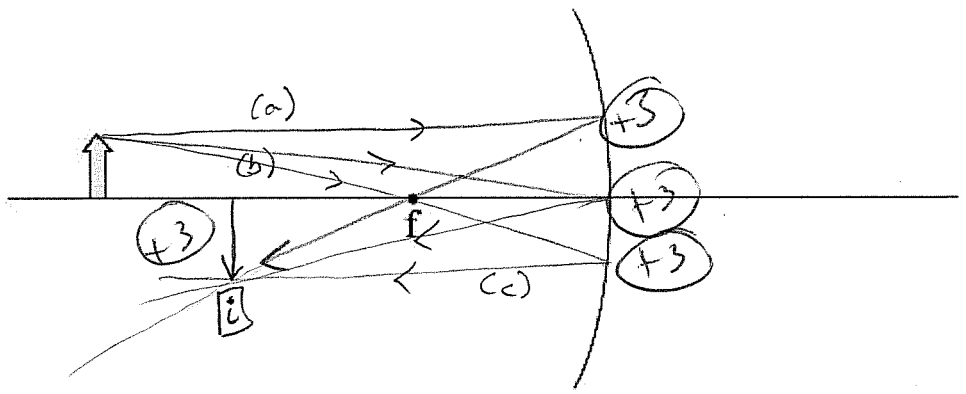
15. The image in a convex mirror is always

(a) real.
(b) the same size as the object.
(c) larger than the object.
(d) smaller than the object.
(e) inverted

+20

Section 2. Problem Solving

16. A concave mirror of radius 50 cm is shown below. The object is 70 cm from the vertex of the mirror.



(a) Sketch a ray emanating from the top of the object that is parallel to the optic axis. Show both the incident and reflected rays. Your sketch should be neat and clear.

(b) Sketch a ray emanating from the top of the object that is incident on the vertex of the mirror. Show both the incident and reflected rays. Your sketch should be neat and clear.

(c) Sketch a ray emanating from the top of the object that passes through the focal point before reflecting from the mirror. Sketch both the incident and reflected rays. Your sketch should be neat and clear.

(d) Sketch the image of the object.

(e) Calculate the image distance.

$R = 50\text{ cm}$

$f = 25\text{ cm}$

$s_o = 70\text{ cm}$

+4

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$$

$$\frac{1}{70} + \frac{1}{s_i} = \frac{1}{25}$$

$$\frac{1}{s_i} = \frac{1}{25} - \frac{1}{70}$$

$$\frac{1}{s_i} = 0.0257$$

so $s_i = \frac{1}{0.0257} \approx$ 39 cm or 0.39 m

(f) Is the image real or virtual (circle one); is it inverted or upright (circle one), reduced or enlarged (circle one). Explain each of your answers.

real. - rays converge at the image, on the mirrored side of the mirror (i.e. in front of the mirror).

- also, s_i is positive.

inverted - see image above; also $M = \frac{-s_i}{s_o} = \frac{-39}{70} = -0.56 = \frac{h_i}{h_o}$

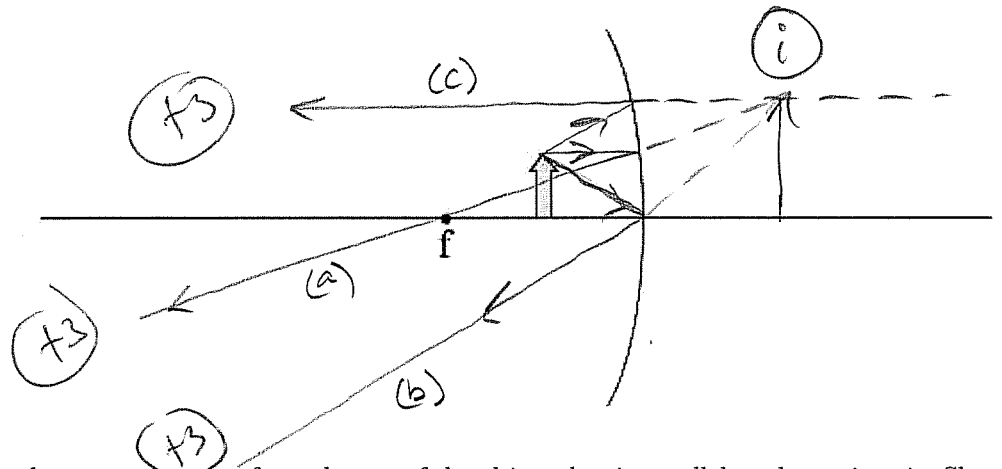
h_i is negative since M is negative.

reduced - $|M| < 1$

+4

12 cm

17. A concave mirror of radius 50 cm is shown below. The object is ~~25~~ cm from the vertex of the mirror.



(a) Sketch a ray emanating from the top of the object that is parallel to the optic axis. Show both the incident and reflected rays. Your sketch should be neat and clear.

(b) Sketch a ray emanating from the top of the object that is incident on the vertex of the mirror. Show both the incident and reflected rays. Your sketch should be neat and clear.

(c) Sketch a ray emanating from the top of the object that reflects from the mirror and subsequently travels parallel to the optic axis. Sketch both the incident and reflected rays. Your sketch should be neat and clear.

(d) Sketch the image of the object.

(e) Calculate the image distance.

$$\frac{1}{s_o} + \frac{1}{s_i} = \frac{1}{f}$$

$s_o = 12$ cm

$f = 25$ cm

$s_i = ?$

$$\frac{1}{s_i} = \frac{1}{25} - \frac{1}{12} = \frac{-13}{300}$$

+4

$$s_i = \frac{-300}{13} = \boxed{-23\text{ cm}}$$

(f) Is the image real or virtual (circle one); is it inverted or upright (circle one), reduced or enlarged (circle one). Explain each of your answers.

virtual : formed behind the mirror; reflected rays diverge, thus they converge behind the mirror at the image point.

upright : see picture; $M = \frac{-s_i}{s_o} = \frac{-(-23)}{12} = +1.9 = \frac{h_i}{h_o}$ +4

M is positive, so h_i is positive.

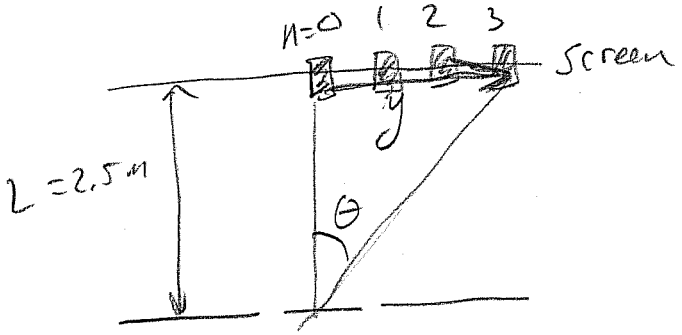
enlarged : $|M| > 1$; image is 1.9 times taller than object.

+20

18. A double-slit arrangement is used to determine the wavelength of light from a monochromatic (single-wavelength) source. The pattern of fringes is viewed on a screen 2.50 m from the slits. The slits are 6.0×10^{-5} m apart. The distance from the center fringe to the third bright fringe away from the center is 0.050 m.

+8

(a) What is the wavelength of the light?



$\sin\theta = \frac{n\lambda}{d} = \frac{y}{L}$

$n = 3$
$\lambda = ?$
$d = 6\times10^{-5}\ m$
$y = 0.05\ m$
$L = 2.5\ m$

$\frac{n\lambda}{d} \simeq \frac{y}{L}$

$\lambda \simeq \frac{yd}{nL}$

$= \frac{(0.05)(6\times10^{-5})}{3(2.5)} = \boxed{4.0\times10^{-7}\ m}$

or $\boxed{\lambda = 400\ nm}$ edge of the violet part of visible spectrum.

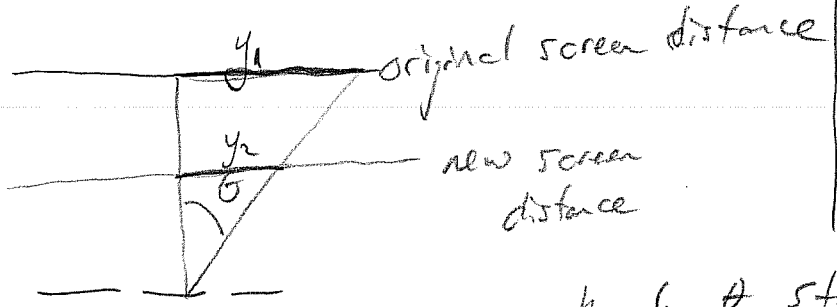
(b) What is the angle between center line and the third bright fringe?

$\sin\theta = \frac{n\lambda}{d} = \frac{3(400\times10^{-9}\ m)}{6\times10^{-5}\ m} = 0.02$

$\theta = \sin^{-1}(0.02) = \boxed{1.1^\circ}$

+6

(c) If the screen is brought closer, will the fringes get closer together or farther apart? Explain your answer using a picture or an equation if possible.



$\sin\theta \simeq \frac{y}{L}$

+6

$y = L\sin\theta$

↑ stays same

If L decreases, y decreases

$y_2 < y_1$ though θ stays the same.