

# **Final Exam : Phys 204L**

FALL SEMESTER 05-06

Name: \_\_\_\_\_

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ID No \_\_\_\_\_

**I. Answer the following questions:**

- a- Give two observations that can allow you to distinguish between the interference pattern of two illuminated slits and a diffraction pattern due to one slit.
- b- Draw qualitatively the graph of pressure versus the inverse of the volume in the
- c- Define systematic and random errors. Which type of error can be reduced by repeating your measurements?



## **II. Surface tension:**

You are measuring the surface tension of a liquid by using the equation

$$\gamma = \frac{r \rho g (h + r/3)}{2 \cos \theta}$$

and the following measured values:

$$r = 0.75 \pm 0.01 \text{ mm} ; h = 19.5 \pm 0.08 \text{ mm} ; \theta = 10^\circ ; \rho = 1.00 \text{ g/cm}^3 ; g = 9.81 \text{ m/s}^2.$$

(a) Find the value of  $\gamma$ ?

(b) By using the propagation of error theory, calculate the rms error on  $\gamma$ . (Disregard the uncertainties on  $\theta$ ,  $\rho$  and  $g$ ).

(c) Measuring the angle  $\theta$  is difficult. Is the approximation that  $\cos \theta = 1$  valid considering your calculations? Justify your answer.

### **III. Mechanical equivalent of Heat:**

You are doing the experiment with a calorimeter made of carbon and you obtain the following values for the increase of temperature  $\Delta T$  of the water in the calorimeter: 19.10, 19.50, 19.20, 19.30 and 18.90 K.

- a. Estimate the average value of  $\Delta T$  and its rms error ( $\alpha$ ).
- b. Estimate the specific heat of carbon. (Hint: the mechanical work done is given by  $W = 2\pi nrMg = mc\Delta T$ ) Useful values: Radius of calorimeter  $r = 2.340$  cm; number of turns  $n = 300$ ; Mass attached  $M = 5.00$  kg;  $g = 9.81$  m/s<sup>2</sup>; Mass of calorimeter  $m = 207.1$  g.

#### IV. Geometrical Optics:

You are collecting on a screen the image that a lens, of focal distance  $f$ , is giving of an illuminated object. You obtain the following data for  $o$  and  $i$  that are respectively the distances from the object and the image to the lens.

$o$ (cm)	25.00	30.30	33.00	43.15	46.50
$i$ (cm)	81.90	51.10	44.80	34.30	32.30

- Use linear regression analysis to obtain the equation of a *straight line* that could lead to the value of  $f$ . (You do not need to draw the graph).
- What type of lens are you working with? What is the value of  $f$ ?
- You keep on approaching the object to the lens so that you can no longer collect a clear image of the object on the screen. Give a possible explanation of such an effect.

*Hint:* The relationship between  $o$ ,  $i$  and  $f$  is given by the lens equation:  $\frac{1}{f} = \frac{1}{i} + \frac{1}{o}$ .

## **V. Multiple choice Questions:**

1. A container holds equal amounts of Hydrogen ( $H_2$ ) and Oxygen ( $O_2$ ) gas by weight at  $20^\circ C$ .
  - a) The partial pressures exerted by the two gases are the same.
  - b) There are equal numbers of  $H_2$  and  $O_2$  molecules in the container.
  - c) A hydrogen molecule has the same average speed as an oxygen atom.
  - d) An Oxygen molecule has an average speed 4 times larger than a hydrogen molecule.
  - e) An Oxygen molecule has an average speed 4 times smaller than a hydrogen molecule.
  - f) None of the above statement is correct.
  
2. A ray of light passes from air into water, striking the surface of water with an angle of incidence of  $45^\circ$ . Which of the following four quantities change as light enters the water? [I] wavelength, [II] Frequency, [III] speed of propagation, [IV] direction of propagation.
  - a) I and II only.
  - b) I, III and IV only.
  - c) II, III, and IV only.
  - d) III and IV only.
  - e) I, II, III, and IV.
  
3. In the double slit interference experiment performed using a laser beam, the separation between bright fringes depends on the following parameters:
  - (a) Both order of the fringe and the separation between slits.
  - (b) both separation between slits and distance between slits and screen.
  - (c) distance between slits and screen only.
  - (d) both separation between slits distance between source and slit.
  - (e) Both width and separation of the slits.
  
4. The wavelength region to which the human eye is sensitive falls in the range of:
  - a) 10 to 50 nm.
  - b) 400 to 700 nm.
  - c) 2000 to 4000 nm.
  - d) 20,000 to 50,000 nm.
  - e) None of the above my answer is: \_\_\_\_\_.
  
5. If measurements follow a normal error distribution, what fraction of the  $\sigma$  of the mean?
  - a) 36.8%
  - b) 96.3%
  - c) 99.8%
  - d) 68.3%
  - e) None of the above my answer is: \_\_\_\_\_

**VI.** Indicate whether each of the following statements is True or False: True False

- (a) Measuring the radius of curvature of a symmetric lens, is not enough to deduce its focal length.
- (b) If standing sound waves are set-up in an air column, the amplitude of the signal, detected by a microphone placed at the end of the column that is closed by a piston, is minimum. (N. B. microphone detects pressure variation)
- (c) A Vernier caliper cannot be used to measure the inner diameter of hollow tubes.
- (d) Red light has a longer wavelength than violet light.
- (e) A light wave is a longitudinal wave.
- (f) The image of a real object given by a convex mirror is always virtual.
- (g) The number 55.230 has four significant figures.