Physics-I Optics/Thermodynamics problems (Final Exam)

(4) Light is incident normally on a diffraction grating and the first order diffraction maximum is seen at 32 degrees. The second order diffraction maximum will be seen at (tick the correct option): [1]

(i) 84 degrees

(ii) 48 degrees

(iii) 64 degrees

(iv) None of these

(5) The energy of a laser pulse coming out of a mode locked pulsed laser is 0.5 Joule. The laser is working at 10 Hz (ten pulses per second). If the width of each pulse is 5 ns,

(i) The peak power of the pulse is \_\_\_\_\_ [2]

(ii) The average power of the laser is \_\_\_\_\_\_ [1]

(6) For questions (a) to (c), tick the correct option: [3]

(a) The difference between a reversible process and a cyclic process is that:

(i) A system need not come to the initial state in a cyclic process

(ii) The surroundings need not come back to the initial state in a cyclic process

(iii) A system need not come back to the initial state in a reversible process

(iv) The surroundings need not come back to the initial state in a reversible process

(b) During an isothermal process:

(i) The temperature remains constant but internal energy changes

(ii) The internal energy remains constant but temperature changes

(iii) The internal energy remains constant but heat flows across the boundary

(iv) The internal energy increases since heat flows across the boundary

(c) The enthalpy of a system remains constant in:

(i) A reversible isochoric (constant volume) process

(ii) An irreversible adiabatic process

(iii) A reversible isobaric (constant pressure) adiabatic process

(iv) A reversible isothermal process

(11) (a) Give 2 reasons why it is important for a diffraction grating to have a large number of slits (of the order of thousands). [2]

(b) Find the number of slits N of a diffraction grating required to resolve the two D-lines of sodium light to the first order. The wavelengths of the two lines are 589.0 nm and 589.6 nm. [1]

(12) For a single slit of width 0.2 mm and a screen placed far away at a distance of 3 m from the slit, calculate the total width of the central maximum (distance between the first 2 minima on both sides of the central maximum) assuming Fraunhofer diffraction with light of wavelength 500 nm. [3]

(13) Fringes of equal thickness are observed when a beam of light of vacuum wavelength 500 nm is incident normally on a wedge-shaped thin film with refractive index 1.5 and air on both sides. What is the angle of wedge alpha if the distance between successive dark fringes is 1/3 cm? [3]

(14) (a) State the mathematical condition for a quantity Z to be called a thermodynamic property of a system. [1]

(b) Deduce whether the following quantity is the differential of a thermodynamic property: dZ = P dv + v dP [1]

(15) (a) Give the expression of the First Law of Thermodynamics for the case of i) a cyclic process, ii) any process. Explain the terms. [2]

(b) For a gas enclosed in a piston-cylinder assembly which is initially at a pressure of 500 Newton m sq and has initial volume 0.2 m3, calculate the work done by the gas (in Joules) if it expands to a final state with pressure 100 Newton/m sq. Assume that the volume of the gas is inversely proportional to pressure. [3]