

## PHYSICS 232 – SAMPLE FINAL EXAM

### Problem 1

The proverbial bird on the wire is resting on a high tension line separating two telephone poles very far apart. The bird starts at  $t = 0$  to bounce periodically, first up and then down, exactly 6 times every 10 s with an amplitude of 3.4 cm. If the speed of the wave is 20 m/s, find the vertical position of the point 1.14 m away from the bird at time  $t = 0.42$  s.

### Problem 2

The left-hand end of a glass rod is ground to a spherical surface. The glass has index of refraction  $n = 1.5$ . A small object 4 mm tall is placed in the axis of the rod, 31 cm to the left of the vertex of the spherical surface. The image is formed in the rod, 35 cm to the right of the vertex.

- (a) What is the magnitude of the radius of curvature of the spherical surface at the end of the rod?
- (b) What is the height of the image?

### Problem 3

A diffraction grating is to be used to find the wavelength of the emission spectrum of a gas. The grating spacing is not known, but a light of a known wavelength of 632.8 nm is deflected by  $43.2^\circ$  in the second order by this grating. Light of the wavelength to be measured is deflected by  $53.4^\circ$  in the second order. What is the wavelength of this light?

### Problem 4

- (a) Calculate the energy of an electron that has de Broglie wavelength of  $6.5 \times 10^{-12}$  m.
- (b) What is the energy of a neutron of the same wavelength as the electron?  
( $m_n = 1.675 \times 10^{-27}$  kg)
- (c) What is the energy of a photon of the same wavelength as the electron?

### Problem 5

- (a) The energy of an electron in a hydrogen atom is *negative*. What significance does this have?
- (b) Describe an experiment that would extract information about the angular momentum of the electron in a Hydrogen atom.
- (c) How would you try to prove or disprove Heisenberg's uncertainty principle using a beam of electrons and an aperture?
- (d) Describe the Compton effect. Is it observable with visible light? Explain.

### Problem 6

- (a) What role do quantum numbers and Pauli's exclusion principle play in the structure of atoms?
- (b) Describe the ground-state electron configuration of Sodium (Na,  $Z = 11$ ) and Potassium (K,  $Z = 19$ ). Include all shells and subshells. Why do these two elements (Na and K) have similar chemical properties?
- (c) What are the energy bands and how do they explain the difference between conductors and insulators?
- (d) What is the difference between the two types of semiconductors (p-type vs n-type)?