Physical Constants: Planck's constant = 6.626×10^{-34} J.s, light speed = 3×10^{8} m/s, 1 eV = 1.6×10^{-19} J

1. Consider a system with two photons, one with energy 5MeV and the second one with energy 2 MeV, approaching each other along the x axis. What is the rest energy (in terms of eV) of this system? (10 points)

2. The acceleration voltage of the electron in a typical cathode ray tube TV is 25 keV. What is the minimum wavelength (in terms of nm) x-ray produced when these electrons strike the inner front of the tube? (10 points)

3. Standing in the middle of a 20m-long pier, you notice that at any given instant there are 15 wave crests between the two ends of the pier. Estimate the minimum uncertainty in the wavelength (in terms of m) that could be computed from this information. (10 points)

4. Show the relation between the magnetic moment of an electron and a Bohr orbit of radius. (10 points)

5. The lines of the rotational spectrum of HBr are 5.1×10^{11} Hz apart in frequency. The reduced mass of an HBr molecule can be treated as the ^{1}H mass since the Br atom is 80 times more massive than the proton. Find the internuclear distance in HBr. (10 points)

6. Au has a density of 19.3×10^{3} kg/m^{3}, an atomic mass of 197, a Fermi energy of 5.54 eV, and a resistivity of 2.04×10^{-8} Ωm. Under the assumption that each Au atom contributes one electron to the electron gas, estimate the mean free path in atom spacings between the collisions of the free electrons in Au. (10 points)

7. Please explain the differences between (15 points)
(a) Maxwell-Boltzmann distribution (b) Bose-Einstein distribution (c) Fermi-Dirac distribution

8. For a pn junction excited by a constant-current source supplying a current I in the forward direction (Fig. 1). Please draw the minority carrier distribution in such a forward-biased pn junction along the x-direction. It is assumed that the n region is more heavily doped than the p region; $N_D >> N_A$. (10 points)

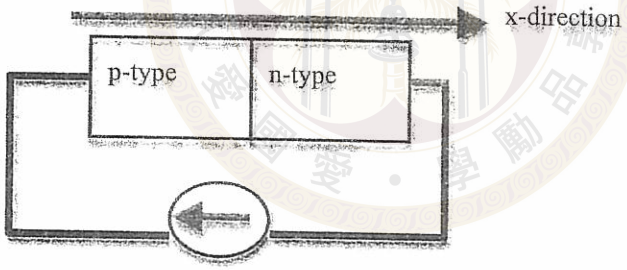

Fig.1

9. Consider the common-emitter amplifier in Fig. 2. (a) Please draw the equivalent circuit using BJT's hybrid π model (5 points) (b) Find input resistance Ri (expressed by the circuit components shown in the figure or in the π model) (5 points) (c) Overall voltage gain from source to load (5 points)

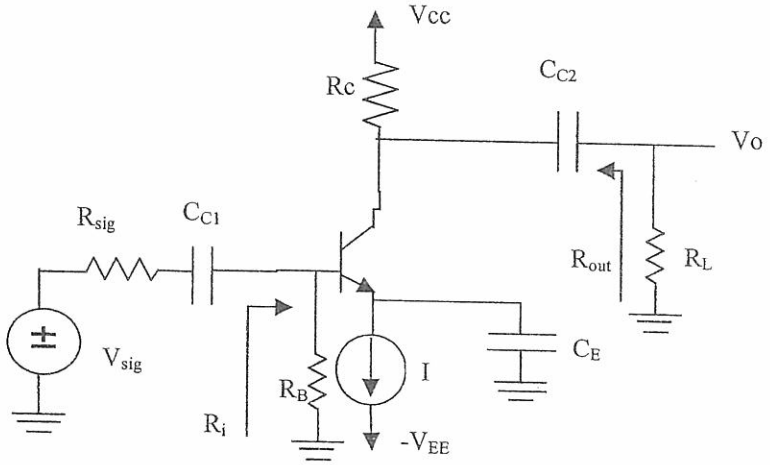

Fig. 2

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