

1 (15 points) A 3.0 g particle is in a simple harmonic motion in one-dimension and moves according to the equation:

$$x = 0.5 \text{ cm} \cos[(\pi/3 \text{ rad/s})t - \pi/4 \text{ rad}]$$

with t in seconds. (a) At what value of x is the potential energy of the particle equal to half the total energy? (b) How long does the particle take to move to this position x from the equilibrium position?

2. (20 points) A quantity of an ideal monatomic gas consists of n moles initially at temperature T_1 . The pressure and volume are then slowly doubled in such a manner as to trace out a straight line on a p - V diagram. In terms of n , R , T_1 , what are (a) W , (b) ΔE_{int} , and (c) Q for the process? (d) If one were to define a molar specific heat for the gas as it undergoes this process, what would be its value?

3. (20 points) A slab of copper of thickness b is thrust into a parallel-plate capacitor of plate area A , as shown by Fig. 1, it is exactly half-way between the plates. (a) What is the capacitance after the slab is introduced? (b) If a charge q is maintained on the plates, what is the ratio of the stored energy before to that after the slab is inserted? (c) How much work is done on the slab as it is inserted? Is the slab sucked in or must be pushed in?

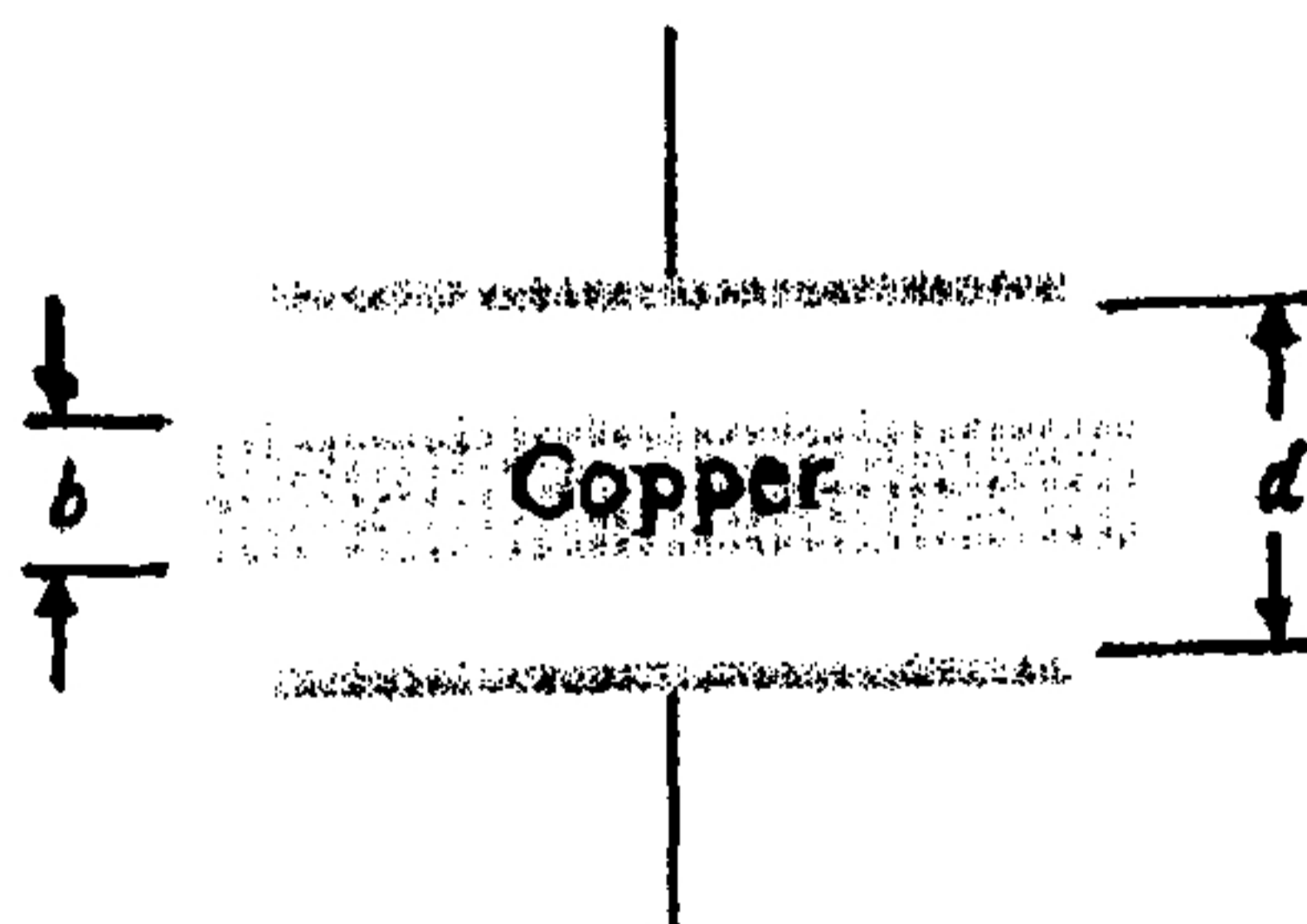


Fig.1

(背面仍有題目,請繼續作答)

4. (15 points) An optical fiber consists of a glass core (index of refraction n_1) surrounded by a coating (index of refraction $n_2 < n_1$). Suppose a beam of light enters one end of the fiber from air at an angle θ with the fiber axis as shown in Fig. 2. (a) Show that the greatest possible value of θ for which a ray can travel down the fiber is $\theta = \sin^{-1} \sqrt{n_1^2 - n_2^2}$. (b) If the indexes of refraction of the glass and coating are 1.58 and 1.53, respectively, what is the greatest possible value of the incident angle θ ?

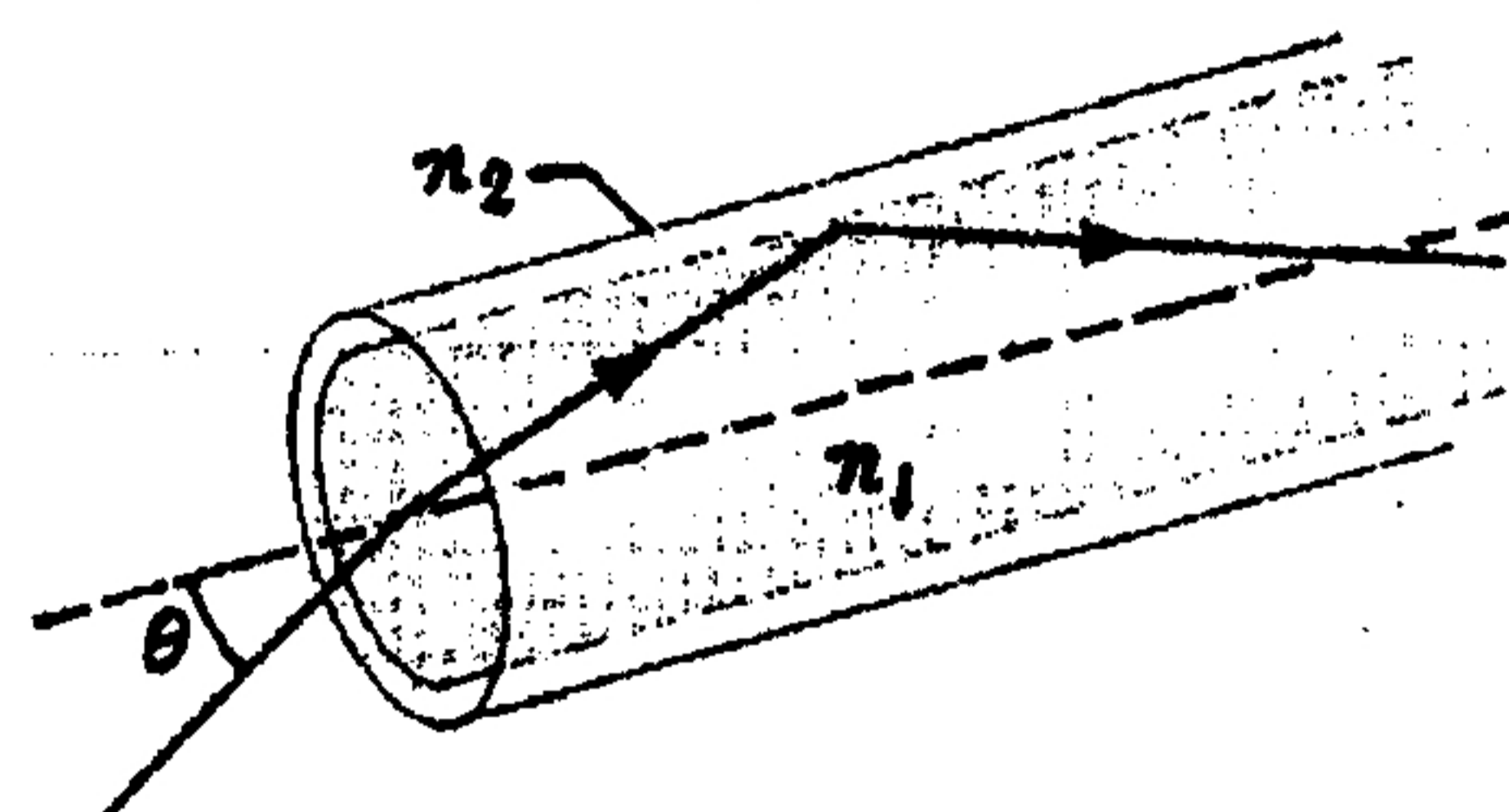


Fig.2

5. (15 points) Monochromatic light (wavelength = 450 nm) is incident perpendicularly on a single slit (width = 0.40 mm). A screen is placed parallel to the slit plane, and on it the distance between the two minima on either side of the central maximum is 1.8 mm. (a) What is the distance from the slit to the screen? (*Hint*: The angle to either minimum is small enough that $\sin\theta \approx \tan\theta$) (b) What is the distance on the screen between the first minimum and the third minimum on the same side of the central maximum?
6. (15 points) An electron is trapped in a one-dimensional infinite well of width 250 pm and is in its ground state. What are the four longest wavelengths of light that can excite the electron from the ground state via a single photon absorption?