1. A platform is executing simple harmonic motion in a vertical direction with an amplitude of 5 cm and a frequency of $10/\pi$ vibrations per second. A Block is placed on the platform at the lowest point of its path.

   (a) At what point will the block leave the platform?
   (b) How far will the block rise above the highest point reached by the platform?

2. A cylinder of diameter $d$ floats with $l$ of its length submerged. The total height is $L$. Assume no damping. At time $t = 0$ the cylinder is pushed down a distance $B$ and released.

   (a) What is the frequency of oscillation?
   (b) Draw a graph of velocity versus time from $t = 0$ to $t =$ one person. The correct amplitude and phase should be included.
   (c) A uniform rod of length $L$ is nailed to a post so that two thirds of its length is below the nail. What is the period of oscillations of the rod?

3. (a) Find the frequency of vibrations under adiabatic conditions of a column of gas confined to a cylindrical tube, closed at one end, with a well-fitting but freely moving piston of mass $m$
   (b) A steel ball of diameter 2 cm oscillated vertically in a precision-bore glass tube mounted on a 12-liter flask containing air at atmospheric pressure. Verify that the period of oscillation should be about 1 sec. (Assume adiabatic pressure change with $\gamma = 1.4$. Density of steel = 7600 kg/m$^3$.)

4. According to classical electromagnetic theory, an accelerated electric radiate energy at the rate $Ke^2a^2/c^3$, where $K = 6 \times 10^9Nm^2/C^2$, $e =$ electronic charge ($C$), $a =$ instantaneous accelerator ($m/sec^2$), and $c =$ speed of light ($m/sec$).

   (a) If an electron were oscillating along a straight line with frequency $\nu(Hz)$ and amplitude $A$, how much energy would it radiate away
during 1 cycle? (Assume that the motion is described adequately by \(x = A \sin 2\pi \nu t\) during one cycle.

(b) What is the \(Q\) of this oscillator?

(c) How many periods of oscillation would elapse before the energy of the motion was down to half the initial value?

(d) Putting for \(\nu\) a typical optical frequency (i.e., for visible light) estimate numerically the approximate \(Q\) and “half-life” of the radiating system.

5. Imagine a simple seismograph consisting of a mass \(M\) hung from a spring on a rigid framework attached to the earth, (as shown in the book, pg 113, problem 4-6). The spring force and the damping force spring force and the damping force depend on the displacement and velocity relative to the earth’s surface, but the dynamically significant accelerator is the acceleration of \(M\) relative to the fixed stars.

(a) Using \(y\) to denote the displacement of \(M\) relative to the earth and \(\eta\) to denote the displacement of the earth’s surface itself, show that the equation of motion is

\[
\frac{d^2 y}{dt^2} + \gamma \frac{dy}{dt} + \omega^2 y = -\frac{d^2 \eta}{dt^2}
\]

(b) Solve for \(y\) (steady-state vibration), if \(\eta = C \cos \omega t\)

(c) Sketch a graph of the amplitude \(A\) of the displacement \(y\) as a function of \(\omega\) (supposing \(C\) the same for all \(\omega\))

(d) A typical long-period seismometer has a period at about 30 sec and a \(Q\) of about 2. As the result of a violent earthquake, the earth’s surface may oscillate with a period of about 20 min and with an amplitude such that the maximum acceleration is about \(10^{-9} \text{ m/sec}^2\). How small a value of \(A\) must be observable if this is to be detected?