F 15nm

$F = 1pN$. $A = 15nm$

$1p = 10^{-12}$
$1n = 10^{-9}$
$k = ?$
if $f = 70Hz$, $m = ?$

87. Organize and Plan The peak force exerted by a spring on a mass in a SHO is attained when the displacement from equilibrium is at its maximum:

$$F_m = -kA$$

If we know the peak force and the amplitude of the oscillation we can deduce the spring constant in a straight-forward manner $|k| = \frac{F_m}{A}$

Given a known oscillation frequency we can deduce the effective mass as follows:

$$2\pi f = \omega = \sqrt{\frac{k}{m}} \to 4\pi^2 f^2 = \frac{k}{m}$$

Isolating for mass: $m = \frac{k}{4\pi^2 f^2}$

The wrinkle in this problem is the units. The unit pN = 10^{-12} N while the unit *nm* = 10^{-9} m.

Solve Plugging in numbers with mks units:

The inferred spring constant is $k = \dfrac{10^{-12}\text{ N}}{15\times10^{-9}\text{ m}} = 6.7 \times 10^{-5}$ N/m

The effective mass is

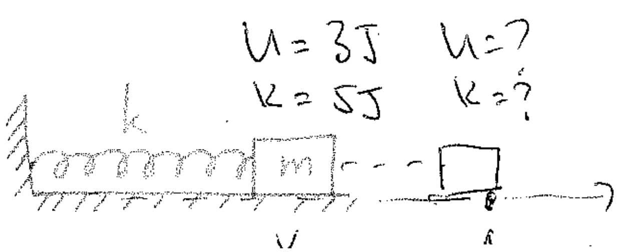
$$m = \frac{6.7\times10^{-5}\text{ N/m}}{4\pi^2(70\text{ Hz})^2} = 3.4\times10^{-10}\text{ kg}$$

$$m = \frac{k}{4\pi^2 f^2}$$

Reflect The mass of a single hydrogen atom is roughly 2×10^{-27} kg so the effective mass is well beyond the single atom limit. The effective mass is equivalent to approximately 10^{17} hydrogen atoms.

33. A particle is in simple harmonic motion along the x axis. The amplitude of the motion is A . At one point in its motion its kinetic energy is K = 5J and its potential energy is U = 3J. When it is at x = A the kinetic and potential energies are:

1) K = 5J and U = 3J
2) K = 5J and U = –3J
3) K = 8J and U = 0
4) K = 0 and U = 8J
5) K = 0 and U = –8J



Ans : 4

$E = K + U = 5J + 3J = 8J = \text{const}$

at $x = x_m$, $V = 0 \Rightarrow K = 0J$

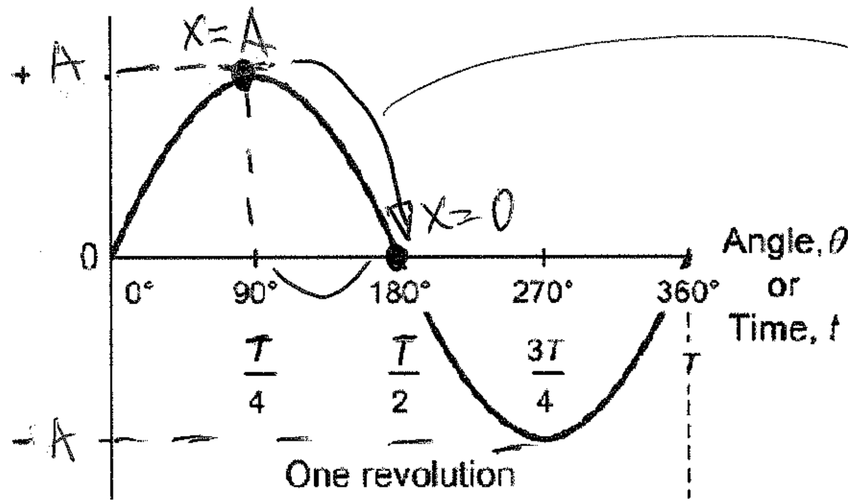
so at $x = x_m$, $U = 8J$

Quiz 2 Name:

The position, x, of a simple harmonic oscillator with period $T = 12$ sec is

$$x = \mathrm{A}\cos(w.t) = \mathrm{A}\cos(\frac{2\pi}{T}.t)$$

Find the time it takes the oscillator to go from $x = \mathrm{A}$ to $x = 0$.



The time it takes an oscillator to go from the maximum displacement $x = \mathrm{A}$ back to the same position at $x = \mathrm{A}$ is one period T. The time it takes to go from

$$x = \mathrm{A} \rightarrow -\mathrm{A} \text{ is } t_{1/2} = \frac{T}{2}$$

Because the motion about the $x = 0$ position is symmetrical in time, the time point of the zero displacement lies halfway between the maximum positive displacement and the maximum negative displacement which is

$$t = \frac{T}{4}$$

So if $T = 12$ sec then $t = 3$ sec