Solution 24

1) Given $F = F_0 \sin\frac{x}{L}$
   If conservative, a potential does exist. SO, if we can find the potential, then we know F is conservative
   $$V = -\int_{\frac{\pi}{2}L}^{x} F dx' = F_0 L \left[\cos\frac{x'}{L}\right]_{\frac{\pi}{2}L}^{x} = F_0 L \cos\frac{x}{L}$$

   So, we found a potential and thus F is conservative.

2) The particle is initially at x= 0. At this point the force F = 0. Consequently, the particle will not move. However, the slightest push will have it move away from the point x=0. As soon as the particle is out of x=0 it does experience a non-zero force and will move.

3) The total energy of the particle is constant. This means that
   $$\frac{1}{2}mv^2 + F_0 L \cos\frac{x}{L} = E_0$$
   Initially, v=0 (that is so small that for all practical calculations the initial kinetic energy can be taken as zero). Thus
   $$E_0 = F_0 L \cos 0 = F_0 L$$
   and
   $$v = \sqrt{\frac{2}{m}\left(F_0 L - F_0 L \cos\frac{x}{L}\right)}$$
   This has a maximum when the cos-term has a minimum. This happens at
   $$x = (\pi \pm 2k\pi)L$$
   There
   $$v_{max} = 2\sqrt{\frac{F_0 L}{m}}$$