PHYS 172 Practice Exam 3 - SOLUTIONS

1) **D** (directly from the definition of c.m. – or just replace the members with equivalent masses at their middle points, and take the c.m. of the resulting two point masses)
2) **C** (in-class clicker q.)
3) **E** (If unsure about D, it does indeed check out. Change in kinetic energy is 900kJ, which is enough to bring ~2.1kg of water from 0C to 100C.)
4) **A** (clearly negative – into the page)
5) **B** (the momentum of the system actually decreases – during the collision the axle acts with a large force on the system so that the ride stays in place. On ice it would slide away.)
6) **C**
7) **B** (need to take the energy difference for all possible pairs of levels. For 4 levels there are (4*3)/2 = 6 pairs in total and all give different energies in this case, precisely those listed in B.)
8) **D** (only this satisfies momentum and energy conservation. For each of the options for final v_2 you can compute final v_1 from momentum conservation, and then check whether kinetic energy would be conserved. Or just solve the 2 equations 2 unknowns as shown in class.)
9) **C** (directly from the definition of angular momentum - standard application of cross product. From right-hand rule the direction is directly into the page.)
10) **B**

The energy of the system in general is

$$E = E_{rest} + K + U_{spring} = E_{rest} + K_{trans} + K_{vib} + U_{spring},$$

and initially $E_{ini} = E_{rest}$ (nothing moves, spring unstretched).

The force does 0.08m * 40 N = 3.2J work on system, so

$$\mathbf{E_{fin} - E_{ini} = K_{trans,fin} + K_{vib,fin} + U_{spring,fin} = 3.2J}.$$

(rest energy does not change, so it drops out). In the point-particle system the work is 0.07m * 40N = 2.8J (center of mass moved 0.07m only), so $\mathbf{K_{trans,fin} = 2.8J}$. This means $K_{vib,fin}+U_{spring,fin} = 3.2 - 2.8 = 0.4$J. At the final position the spring is stretched by 0.02cm, so $\mathbf{U_{fin}}=1/2*(0.02m)^2 * k = \mathbf{0.5J}$, and we then must have $\mathbf{K_{vib,fin}} = 0.4 - 0.5 = \mathbf{-0.1J}$. But that is impossible because kinetic energy cannot be negative (K_{vib} is a sum of " $mv^2/2$ " terms with velocities measured relative to c.m.).

(You can already guess that something strange must be going on if you look at the forces in the final stage – the force due to the spring k*(0.02cm) = 50N is LARGER than F, so the rightmost mass is actually accelerating to the LEFT, and so possibly moving backwards.)

11) **A** (discussed in class – uses cross product formula in terms of angles)