Physics 271  
Practice Exam 2 Solutions  
Date: Fall 2017

1. Short answer, collision: m moving left with $v/3$ and 2m moving right with $2v/3$.

2. Short answer, impulse: Fully elastic, 20kg dropped from 5m.

3. Short answer, cart leaking sand: Equal to $v$.

4. Short answer, center of mass: $d/10$ to the right of O.

5. Short answer, spring with mass drop: Horizontal momentum conserved.


7. Short answer, mass twirled around stick: Energy conserved in the motion of ball.

8. Short answer, dumbells: First part: both have the same CM velocity.  
   Second Part: Right dumbell (with force on mass rather than on CM) acquires greater kinetic energy from F.

9. Long answer, collision:  
a) $\tan \theta = \frac{1}{2}$, $U = \sqrt{5}v$  
b) $K_i - K_f = -2mv^2$, $Q < 0$ superelastic.

10. Long answer, cube on sphere:  
a) $mgR(1 - \cos \theta)$  
b) $\cos \theta = \frac{2}{3}$

11. Long answer, rocket on table:  
a) $\gamma v_\text{ex} > \mu g M_o$  
b) $V_{\text{MAX}} = v_\text{ex} \ln(2) - \mu g \frac{M_o}{2\gamma}$  
c) $X_{\text{afterfuel}} = V_{\text{MAX}}^2/(2\mu)$  
d) $X_{\text{total}} = [v_\text{ex} M_o/(2\gamma)] [1 - \ln 2] - \frac{1}{8} \mu g \frac{M_o^2}{\gamma^2} + X_{\text{afterfuel}}$
12. Long answer, pendulum with catch:
   a) $\omega = \frac{v}{3d}$
   b) $E_{\text{lost}} = E_i - E_f = \frac{1}{6}Mv^2$
   c) $v = \sqrt{12dg}$

13. Long answer, plank with pivot:
   a) Work done by pivot is 0. Only gravity does work here.
   b) $\dot{\theta} = \sqrt{(3g/d) \sin \theta}$
   c) $\ddot{\theta} = \frac{3}{2}(g/d) \cos \theta$
   d) $F_h = \frac{3}{4}Mg \sin \theta \cos \theta$, $F_v = Mg(\frac{3}{4} \cos^2 \theta - \frac{3}{2} \sin^2 \theta - 1)$

14. Long answer, Atwood machine:
   a) $I = 3MR^2$
   b) $v = \sqrt{gh/3}$
   c) $h_{\text{new}} = h + 2v^2/g = \frac{5}{3}h$

15. Long answer, rolling down inclined plane:
   a) Smallest $c$ wins (sphere).
   b) $\Delta t = t_{\text{hoop}} - t_{\text{sphere}} = 2\ell \sqrt{\frac{1}{gh}}(1 - \sqrt{\frac{7}{10}})$