Exam #2: Dynamics, momentum, and energy

Name: /30

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1. A child rides a sled down a hill and onto level ground at the bottom of the hill, eventually coming to a stop when she bumps into a tree. Sketch the kinetic energy, gravitational potential energy, and thermal energy of the system as functions of the child's position. Include the child and the ground in the system, and assume that the coefficient of friction between the sled and the snow is constant. [6 pts]

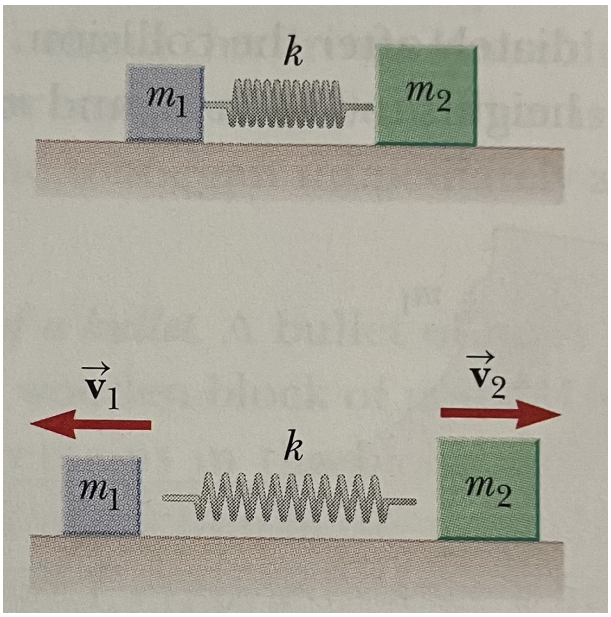
2. A man claims that he can safely hold on to a 10.0 kg child in a head-on collision with a relative speed of 50 m/s (close to 200 km/h or 120 mph). Assume that the collision takes 0.1 s. Find the magnitude of the average force that would be needed to hold onto the child. Is it possible for a person to apply that sort of force (justify your answer)? [6 pts]

3. A railroad car of mass 2.00×10^4 kg moving at 3.00 m/s collides and couples with two coupled railroad cars, each of the same mass as the single car and moving in the same direction at 1.20 m/s.

(a) What is the speed of three coupled cars after the collision? [3 pts]

(b) How much thermal energy was generated during the collision? [3 pts]

4. Two objects of masses $m_1 = 0.5$ kg and $m_2 = 1.0$ kg are placed on a horizontal frictionless surface. A spring with spring constant $k = 300$ N/m placed between them and compressed by 0.1 m. The spring is not attached to either mass. The masses are released and shoot outward, as shown in the diagram below. Ignore the mass of the spring. Determine $\vec{v}_1$ and $\vec{v}_2$. [6 pts]



5. Two objects, with masses m_1 and m_2 , are supported by narrow posts as shown in the figure below. Calculate the normal forces acting on each of the posts. Ignore the width of the posts, and therefore assume that the normal forces are acting on the outside edges of the posts. [6 pts]