Show your work to receive credit. Sketch relevant diagram, list known and unknowns and write formula before plugging in numbers. Show algebraic steps systematically with equal signs in proper places. Remember a vector has both magnitude and direction.

1. A block of wood is suspended by a string and it has 2.50 kg mass. A bullet of mass 10.0 g strikes horizontally to the block and gets stuck into the block. After the collision the bullet-block system swings to a maximum height 0.455 m above the initial position. (a) (6 points) Use conservation of momentum for the collision to write bullet’s initial speed in terms of the bullet-block system’s speed right after collision. (b) (6 points) Use conservation of energy during the swing to find the bullet-block speed right after collision. (c) (4 points) Combine equation from part (a) and part (b) to obtain bullet’s initial speed.

2. (10 points) A bicycle has wheels of radius 0.32 m. Each wheel has a rotational inertial of 0.080 kg·m² about its axle. Total mass of the bicycle including rider is 79 kg. When coasting at constant speed of 15 m/s, what is the total kinetic energy of the bicycle including the rider?

3. (10 points) A weight of 1200 N rests on a lever at a point \( l_1 = 0.50 \) m from a support. On the same side of the support, at a distance of \( l_2 = 3.0 \) m from it, an upward force with magnitude \( F \) is applied. If the system is in equilibrium, what is \( F \) ? Ignore the weight of the board.

4. (14 points) Calculate the acceleration about the center of mass of a solid ball of mass 1.5 kg rolling down a slope inclined at an angle \( \theta = 35° \) to the horizontal as shown in Figure? (Hint: Draw free body diagram and use both Newton’s second law for translational and rotational motion along the inclined plane, eliminate friction by using torque equation.)

5. (10 points) What percentage of a floating iceberg’s volume is above water if the density of seawater is 1025 kg/m³ and density of ice is 917 kg/m³?

6. (10 points) In a hurricane, roof may tear away from the house because of the difference in pressure between the air inside and air outside. Suppose that air is blowing across the top of a 186 m² roof at 67 m/s. What is the magnitude of the force on the roof? Assume the thickness of the roof is negligible.

7. (10 points) The upper surface of a cube of gelatin, 5.0 cm on a side, is displaced by 0.64 cm by a tangential force. If the shear modulus of the gelatin is 940 Pa, what is the magnitude of tangential force?

8. A wave on a string has an equation: \( y(x,t) = 4.00 \text{ mm} \sin((600 \text{ rad/s})t - (6.00 \text{ rad/m})x) \). (a) (5 points) What is the wavelength? (b) (5 points) What is the period?

9. (10 points) An ambulance traveling travelling at 44 m/s approaches a car heading in the same direction at a speed of 28 m/s. The ambulance driver has a siren sounding at 550 Hz. At what frequency does the driver of the car hear the siren? Assume air temperature is 20°C and speed of sound at 0°C = 331 m/s. CONSTANTS: \( I = \frac{2}{5}mr^2 \) for solid sphere, \( g = 9.80 \text{ N/kg} = 9.80 \text{ m/s}^2 \), \( \rho_{\text{air}} = 1.20 \text{ kg/m}^3 \), \( \rho_{\text{water}} = 1000 \text{ kg/m}^3 \)