Exam 2 Practice Problems

1. (hr05-049) In the figure to the right, a block of mass \( m = 5.00 \, \text{kg} \) is pulled along a horizontal frictionless floor by a cord that exerts a force of magnitude \( F = 12.0 \, \text{N} \) at an angle \( \theta = 25.0^\circ \). (a) What is the magnitude of the block’s acceleration? (b) The force magnitude \( F \) is slowly increased. What is its value just before the block is lifted (completely) off the floor? (c) What is the magnitude of the block’s acceleration just before it is lifted (completely) off the floor?
   Answer (a) 2.18 \, \text{m/s}^2 \) (b) 116 \, \text{N} \) (c) 21.0 \, \text{m/s}^2

2. (hr05-073) In the figure to the right, box 1 (\( m_1 = 1.0 \, \text{kg} \)) on a frictionless inclined surface is connected to box 2 (\( m_2 = 2.0 \, \text{kg} \)). The pulley is massless and frictionless. An applied upward force of magnitude \( F = 6.0 \, \text{N} \) acts on box 2, which has a downward acceleration of 5.5 \, \text{m/s}^2. What are (a) the tension in the connecting cord and (b) angle \( \beta \)?
   Answer: (a) 2.6 \, \text{N} \) (b) 17°

3. (yf04-037) Two adults and a child want to push a wheeled cart in the direction marked \( x \) in the figure to the right. The two adults push with horizontal forces \( \vec{F}_1 \) and \( \vec{F}_2 \) as shown in the figure. (a) Find the magnitude and direction of the smallest force that the child should exert. You can ignore the effects of friction. (b) If the child exerts the minimum force found in part (a), the cart accelerates at 2.0 \, \text{m/s}^2 in the +x-direction. What is the weight of the cart?
   Answer (a) 17 \, \text{N}, at 90° clock-wise from the +x axis \) (b) 840 \, \text{N}

4. (cjex02-03) A block in the figure has mass \( m_1 = 6.10 \, \text{kg} \). The coefficient of static friction between the block and the horizontal desk top is \( \mu_s = 0.40 \). The block is attached by a cord to a cowbell of mass \( m_2 = 1.25 \, \text{kg} \). The cowbell is attached by a second cord to a hook on the wall. The first cord is horizontal, and the second cord at an angle of \( \theta = 40.0^\circ \) from the horizontal.
   (a) The system is in equilibrium as shown. Calculate the tension \( T_2 \).
   (b) Calculate the magnitude of the friction force exerted by the desk on the block.
   (c) How much additional mass can be added to the cowbell (i.e. to \( m_2 \)) and still keep the system in equilibrium?
   Answer (a) \( T_2 = 19.1 \, \text{N} \) \) (b) \( f_s = 14.6 \, \text{N} \) \) (c) 0.80 \, \text{kg}
5. (hr06-059) In the figure to the right, a 1.34 kg ball is connected by means of two massless strings, each of length $L = 1.70$ m, to a vertical, rotating rod. The strings are tied to the rod with separation $d = 1.70$ m and are taut. The tension in the upper string is 35 N. What are the (a) tension in the lower string, (b) magnitude of the net force $\vec{F}_{\text{net}}$ on the ball, and (c) speed of the ball? (d) What is the direction of $\vec{F}_{\text{net}}$?

Answer: (a) 8.74 N  (b) 37.9 N  (c) 6.45 m/s  (d) radially inward

6. (hr06-070) The figure shows a conical pendulum, in which the bob (the small object at the lower end of the cord) moves in a horizontal circle at constant speed. (The cord sweeps out a cone as the bob rotates.) The bob has a mass of 0.040 kg, the string has length $L = 0.90$ m and negligible mass, and the bob follows a circular path of circumference 4.20 m. What are (a) the tension in the string and (b) the period of the motion?

Answer: (a) tension = 0.585 N,  (b) period = 1.56 s

7. (yf05-059) A solid uniform 45.0-kg ball of diameter 32.0 cm is supported against a vertical, frictionless wall using a thin 30.0-cm wire of negligible mass, as shown in Fig. P5.59. (a) (With the help of a free-body diagram) Find the tension in the wire. (b) How hard does the ball push against the wall?

Answer (a) 470 N  (b) 163 N
8. (cjex02-01) A spring of force constant $k = 800 \text{ N/m}$ and a relaxed length $L_0 = 1.10 \text{ m}$ has its upper end fixed/attached to a pivot in the ceiling. Its free end is attached to a block of mass $m=45.0 \text{ kg}$ that sits on a frictionless, horizontal surface. When the block is directly below the pivot, the spring is stretched to a length $h = 1.20 \text{ m}$. The block is then pulled left a horizontal distance $b = 0.90 \text{ m}$ and released from rest. Calculate
(a) the magnitude of the force exerted by the spring on the block, 
(b) the acceleration of block right after being released, and 
(c) the speed of block as it passes directly under the pivot again.
You can assume that the block remains on the surface. 
Answer: (a) $F_S = 320 \text{ N}$, (b) $4.27 \text{ m/s}^2 \hat{i}$, (c) $1.63 \text{ m/s}$

9. (cjex02-02) In the figure, the pulley has negligible mass and is frictionless. Block A has a mass of 2.5 kg, and block B 4.0 kg. The angle of the incline is $\theta = 35^\circ$. The coefficient of kinetic friction between the incline and block A is $\mu_k = 0.30$. The blocks are set in motion from rest with the cord taut. Find
(a) the magnitude of the friction force exerted by the incline on block A. After block B falls a distance of 45 cm, calculate 
(b) the work done by gravity on block A, and 
(c) the total kinetic energy of the two blocks.
You can assume that block A remains on the incline. 
Answer: (a) 6.02 N, (b) $W_{gA} = -6.32 \text{ J}$, (c) 8.61 J

10. (hr07-057) A 230 kg crate hangs from the end of a rope of length $L = 12.0 \text{ m}$. You push horizontally on the crate with a varying force $\vec{F}$ to move it distance $d = 4.00 \text{ m}$ to the side, as shown in the figure to the right. (a) What is the magnitude of $\vec{F}$ when the crate is in this final position? During the crate’s displacement, what are 
(b) the total work done on it, (c) the work done by the gravitational force on the crate, and (d) the work done by the pull on the crate from the rope? (e) Knowing that the crate is at rest at the start and end of its displacement, use the answers to (b), (c), and (d) to find the work your force $\vec{F}$ does on the crate. (f) Why is the work of your force not equal to the product of the horizontal displacement and the answer to (a)?
Answer: (a) 797 N; (b) 0; (c) $-1.55 \text{ kJ}$; (d) 0; (e) $+1.55 \text{ kJ}$; 
(f) (the product would be 3.19 kJ) $\vec{F}$ varies during displacement
11. (hr08-031) A block with mass \( m = 2.00 \, \text{kg} \) is placed against a spring on a frictionless incline with angle \( \theta = 30.0^\circ \) (see attached figure). (The block is not attached to the spring.) The spring, with spring constant \( k = 19.6 \, \text{N/cm} \), is compressed 20.0 cm and then released. (a) What is the elastic potential energy of the compressed spring? (b) What is the change in the gravitational potential energy of the block–Earth system as the block moves from the release point to its highest point on the incline? (c) How far along the incline is the highest point from the release point? 
Answer: (a) 39.2 J; (b) 39.2 J; (c) 4.00 m

12. (yf06-087) Consider the system shown in the figure. The rope and pulley have negligible mass, and the pulley is frictionless. Initially the 6.00-kg block is moving downward and the 8.00-kg block is moving to the right, both with a speed of 0.900 m/s. The blocks come to rest after moving 2.00 m. Use the work–energy theorem to calculate the coefficient of kinetic friction between the 8.00-kg block and the tabletop.
Answer: 0.786

13. (yf07-041) At a construction site, a 65.0-kg bucket of concrete hangs from a light (but strong) cable that passes over a light, friction-free pulley and is connected to an 80.0-kg box on a horizontal roof (see figure). The cable pulls horizontally on the box, and a 50.0-kg bag of gravel rests on top of the box. The coefficients of friction between the box and roof are shown. (a) Find the friction force on the bag of gravel and on the box. (b) Suddenly a worker picks up the bag of gravel. Use the concepts of work, kinetic and potential energy to find the speed of the bucket after it has descended 2.00 m from rest. (You can check your answer by solving this problem using Newton’s laws.)
Answer: (a) zero on the bag of gravel, 637 N on the box  (b) 2.99 m/s