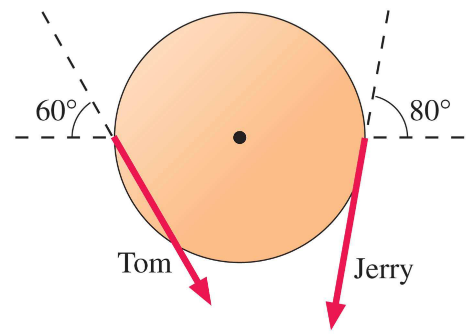
Physics 151
Homework Assignment #7
Due Monday, July 21



#1 Tom and Jerry both push on the 3.00-m-diameter merry-go-round shown in the figure.

(a.) If Tom pushes with a force of $40.0\,N$ and Jerry pushes with a force of $35.2\,N$, what is the net torque on the merry-go-round?

(b.) What is the net torque if Jerry reverses the direction he pushes by 180° without changing the magnitude of this force?

#2 A combination lock has a 1.0-cm-diameter knob that is part of the dial that you turn to unlock the lock. To turn that knob, you grip it between your thumb and forefinger. As you twist your wrist, each finger exerts a normal force of $0.60\,N$ on the lock. Suppose the coefficient of static friction between the knob and your fingers is 0.12. What is the most torque you can exert on the knob without having it slip between your fingers?

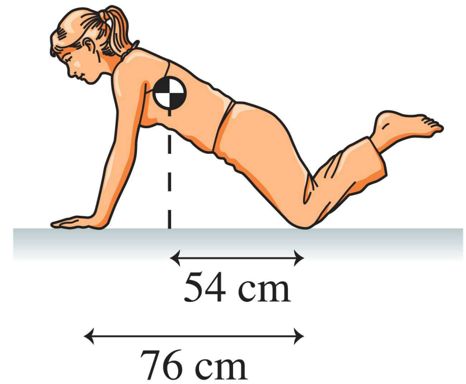
#3 We can, to a good approximation, consider the earth as a solid sphere with radius of $6.38 \times 10^6\,m$ and mass of $5.97 \times 10^{24}\,kg$.

(a.) What is the earth's moment of inertia?

(b.) In reality, the earth's density is uneven. More of the earth's mass is concentrated near its center. Does that mean that earth's moment of inertia is really smaller or larger than the answer you calculated in part (a.)? Explain your answer.

(c.) Using your answer from part (a.), calculate the earth's kinetic energy due to its daily spinning motion.

#4 While doing Pilates, a woman weighing 580 N holds herself stationary on her knees as shown in the figure.



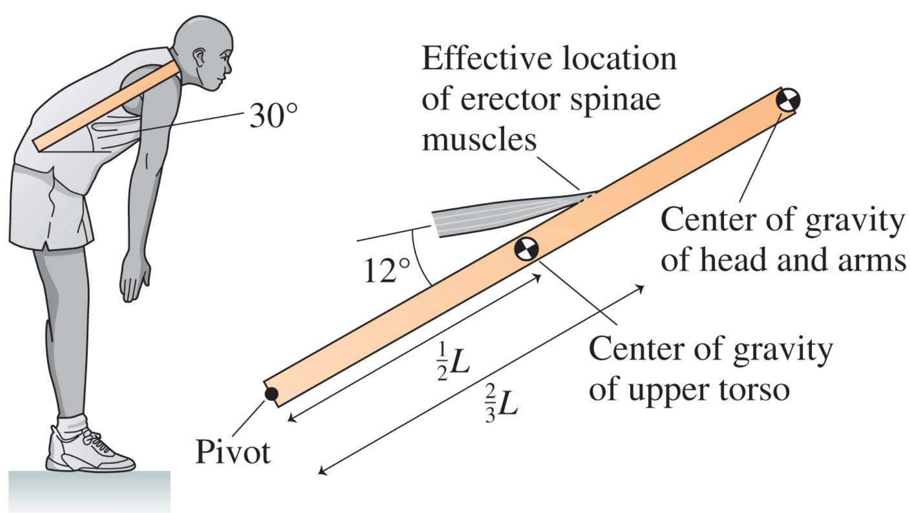
(a.) What normal force does the floor exert *on each hand*?

(b.) What normal force does the floor exert *on each knee*?

#5 When you bend over, a series of large muscles, the erector spinae, pull on your spine to hold you up. The figure shows a simplified model of the spine as a rod of length L that pivots at its lower end. In this model, the center of gravity of the 320 N weight of the upper torso is at the center of the spine. The 160 N weight of the head and arms acts at the top of the spine. The erector spinae muscles are modeled as a single muscle that acts at a 12° angle to the spine. Suppose the person in the figure bends over to an angle of 30° from the horizontal.

a. What is the tension in the erector muscle?

b. A force from the pelvic girdle acts on the base of the spine. What is the component of this force in the direction of the spine? (This large force is the cause of many back injuries) Hint: Put your x-axis to be parallel to the spine.

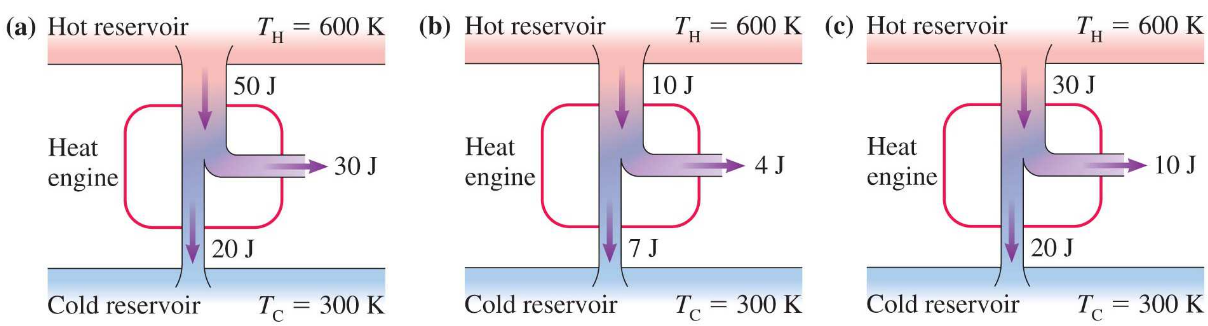


#6 250 students sit in an auditorium listening to a physics lecture. Because they are actively learning with clicker questions, each student is using 125 W of metabolic power, slightly more than they would use at rest. An air conditioner with a COP of 5.0 is being used to keep the room at constant temperature. What minimum electric power must be used to operate the air conditioner?

#7 Which, if any, of the heat engines in the figure below violate:

(a.) The first law of thermodynamics?

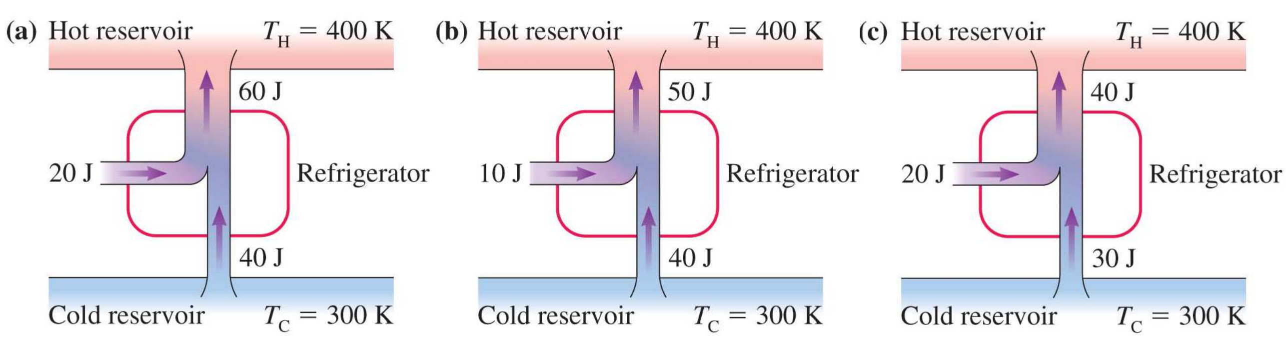
(b.) The second law of thermodynamics? You must *Explain* your answers for full points.



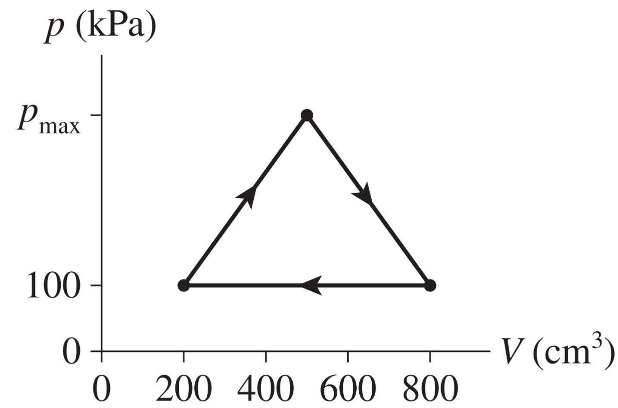
#8 Which, if any, of the refrigerators in the figure below violate:

(a.) The first law of thermodynamics?

(b.) The second law of thermodynamics? You must *Explain* your answers for full points.

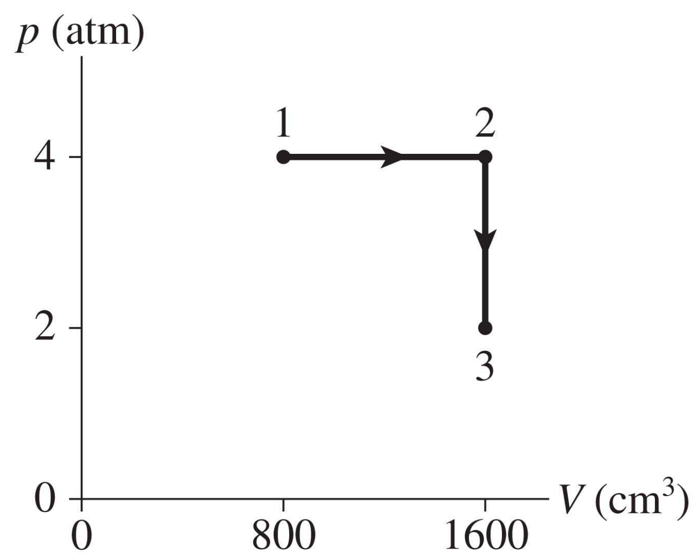


#9 A gas following the pV trajectory in the figure does $60\,J$ of work per cycle. What is p_{max}?



#10 A gas is compressed from $600\,cm^3$ to $200\,cm^3$ at a constant pressure of $400\,kPa$. At the same time, $100\,J$ of heat energy is transferred out of the gas. What is the change in thermal energy of the gas during this process?

#11 $0.10\,mol$ of a monoatomic gas follows the process shown in the figure.



(a.) How much heat energy is transferred to or from the gas during process $1 \to 2$?

(b.) How much heat energy is transferred to or from the gas during process $2 \to 3$?

(c.) What is the total change in thermal energy of the gas?