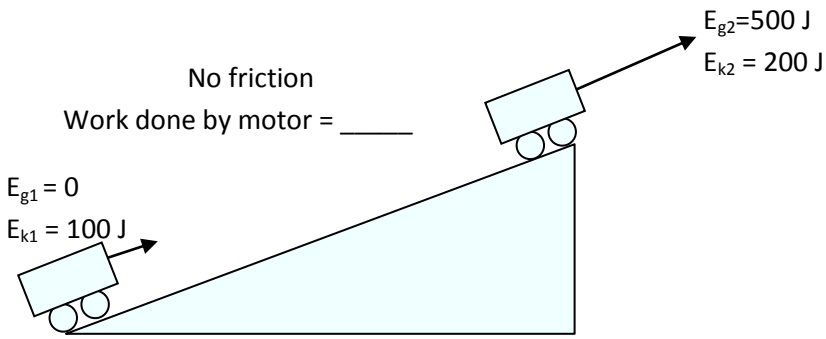
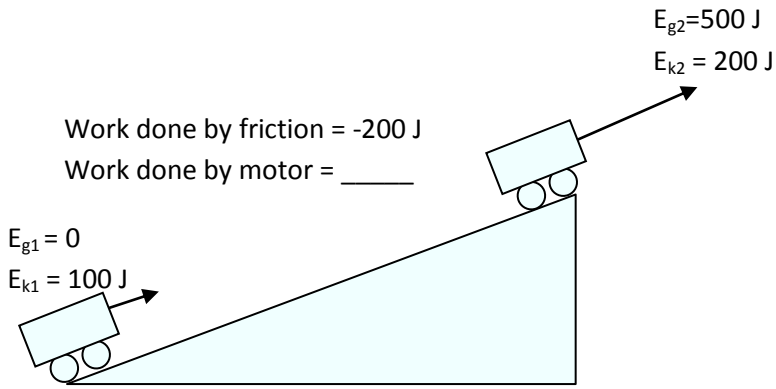
Review: Work and Energy

1. What is the meaning of positive work? Of negative work?
2. Two objects have the same mass, but one has twice the speed. How many times bigger is its kinetic energy?
3. What do we mean when we say that gravitational potential energy is *relative*?
4. Fill in the blanks on the diagrams below.

Work done by friction = -50 J
Work done by motor = +200 J





Why is the work done by the motor in the two situations different?

If it took 12 s for the car to get to the top of the ramp for both of them, what is the power output of the motor for each?

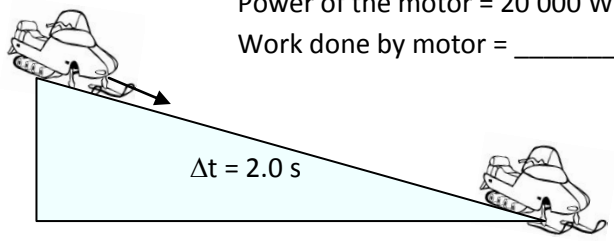
E_{g1} = 10 000 J

E_{k1} = 5000 J

Work done by friction = -5000 J

Power of the motor = 20 000 W

Work done by motor = _____J



E_{g2}=_____J

E_{k2} = _____ J

Water resistance does 5000 J of work

Boat starts at rest

Gas has 12 000 J of energy

Boat's motor is 65% efficient

Energy available to boat: _____

Final kinetic energy of boat: _____

Final speed of boat:_____

5. In the waterfall for a hydroelectric dam, 12 000 kg of water drop a distance of 10.0 m every minute.
   a. How much gravitational energy is lost by the water each minute?
   b. If the turbines are 98% efficient, how much energy is produced each minute?
   c. What is the power output of the dam?

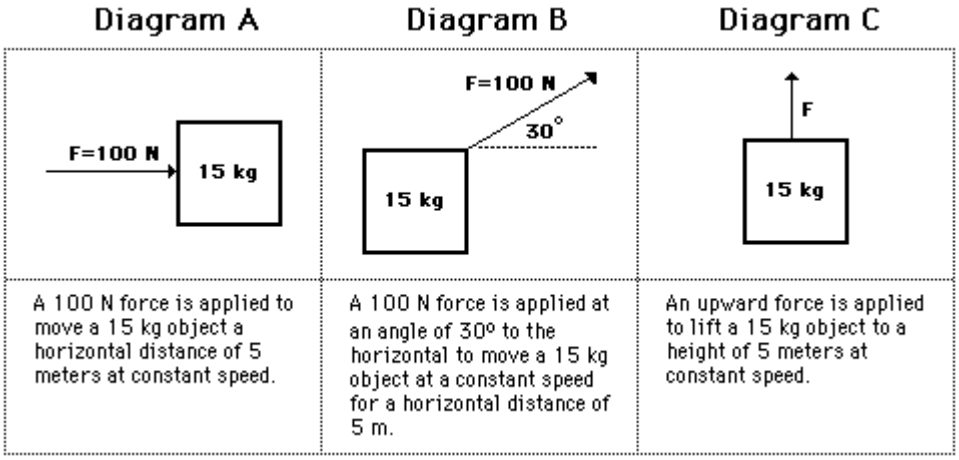
Heat: p310 – 313 Q5,8,9,18,26,28,32,33,34,38,40,44,64,66,67,

Nuclear Energy: p329 #1-2, 333 #3, 4,5, p338#1, 341#1-5

ENERGY AND SOCIETY REVIEW

WORK

1. Apply the work equation to determine the amount of work done by the applied force in each of the three situations described below. (500 J, 433 J, 735 J)

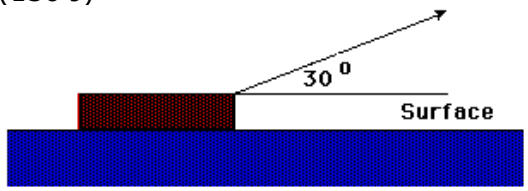


2. Before beginning its initial descent, a roller coaster car is always pulled up the first hill to a high initial height. Work is done on the car (usually by a chain) to achieve this initial height. A coaster designer is considering three different incline angles at which to drag the 2000-kg car train to the top of the 60-m high hill. In each case, the force applied to the car will be applied <u>parallel</u> to the hill. Her critical question is: <u>which angle would require the most work?</u> Analyze the data, determine the work done in each case, and answer this critical question.

Angle (Θ)	Force (N)	Distance (m)	Work (J)
35°	1.12×10^4	105	
45°	1.39×10^4	84.9	
55°	1.61×10^4	73.2	

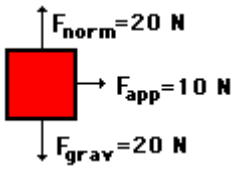
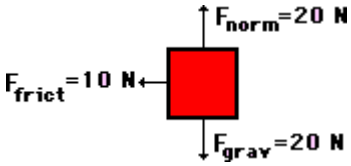
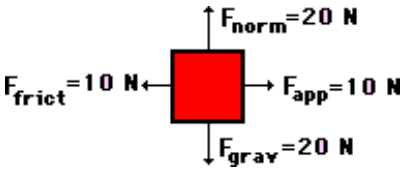
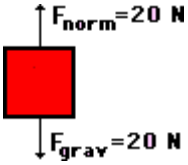
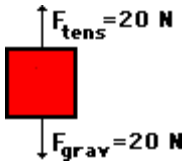
3. Ben Travlun carries a 200-N suitcase up three flights of stairs (a height of 10.0 m) and then pushes it with a horizontal force of 50.0 N at a constant speed of 0.5 m/s for a horizontal distance of 35.0 m. How much work does Ben do on his suitcase during this entire motion? (2000 J, 1750 J, 3750 J)

4. A force of 50 N acts on the block at the angle shown in the diagram. The block moves a horizontal distance of 3.0 m. How much work is done by the applied force? (130 J)

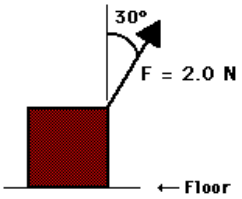


5. How much work is done by an applied force to lift a 15-Newton block 3.0 meters vertically at a constant speed? (45 J)

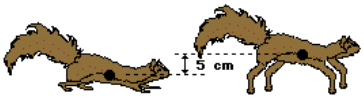
6. On many occasions, there is more than one force acting upon an object. A free-body diagram is a diagram which depicts the type and the direction of all the forces acting upon an object. For each case, indicate which force(s) are doing work upon the object. Then calculate the work done by these forces.

Free-Body Diagram	**Forces Doing Work on the Object**	**Amount of Work Done by Each Force**
A 10-N force is applied to push a block across a friction free surface for a displacement of 5.0 m to the right. 		
A 10-N frictional force slows a moving block to a stop after a displacement of 5.0 m to the right. 		
A 10-N force is applied to push a block across a frictional surface at constant speed for a displacement of 5.0 m to the right. 		
An approximately 2-kg object is sliding at constant speed across a friction free surface for a displacement of 5 m to the right. 		
An approximately 2-kg object is pulled upward at constant speed by a 20-N force for a vertical displacement of 5 m. 		

7. A student with a mass of 80.0 kg runs up three flights of stairs in 12.0 sec. The student has gone a vertical distance of 8.0 m. Determine the amount of work done by the student to elevate his body to this height. Assume that her speed is constant. (6278 J)



8. Calculate the work done by a 2.0-N force (directed at a 30° angle to the vertical) to move a 500 gram box a horizontal distance of 400 cm across a rough floor at a constant speed of 0.5 m/s. (HINT: Be cautious with the units.) (4.0 J)

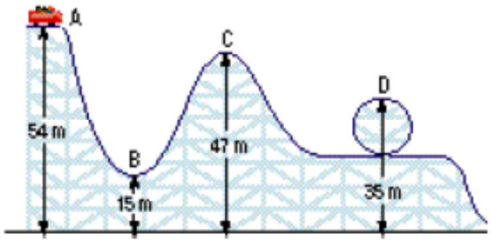


9. A tired squirrel (mass of 1 kg) does push-ups by applying a force to elevate its center-of-mass by 5 cm. Estimate the number of push-ups that a tired squirrel must do in order to do a approximately 5.0 Joules of work. (> 10 pushups)

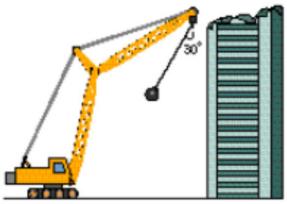
CONSERVATION OF ENERGY

1. A 46.0 kg child cycles up a large hill to a point that is a vertical distance of 5.25 m above the starting position. Find (2369 J)
   a. The change in the child's gravitational potential energy
   b. The amount of work done by the child against gravity

2. A 4.0 x 10^4 kg roller coaster starts from rest at point A. Neglecting friction, calculate its potential energy relative to the ground, its kinetic energy and its speed at points B, C and D in the illustration right.



3. A wrecking ball with a mass of 315 kg hangs from a crane on 10.0 m of cable. The crane swings the wrecking ball so that the angle that the cable makes with the vertical is 30.0°.
   a. What is the potential energy of the wrecking ball in relation to its lowest position? (4141 J)
   b. What will be the kinetic energy of the wrecking ball when it falls back to the vertical position? (4141 J)
   c. What will be the speed of the wrecking ball? (5.13 m/s)



CONSERVATION OF ENERGY WITH NON-CONSERVATIVE FORCES

1. A 68 kg in-line skater starts from rest and accelerates at 0.21 m/s² for 15 m.
   a. Find her final velocity and total kinetic energy after the 15 m of travel (2.5 m/s, 214 J)
   b. After 15 m she exerts a braking frictional force of 280 N, find her stopping distance. (0.77 m)

2. A 2.0 g bullet initially moving with a velocity of 87 m/s [E] passes through a block of wood. On exiting the wood, the bullet's velocity was 12 m/s [E]. How much work did the force of friction

do on the bullet as it passed through the wood? If the wood block was 4.0 cm thick, what was the average force that the wood exerted on the bullet? (7.4 J, 190 N [backwards])

3. Bruce, a 75 kg passenger in a van, is wearing a seat belt when the van moving at 15 m/s collides with a concrete wall. The front end of the van collapses 0.50 m in coming to rest.
   a. What was Bruce's kinetic energy before the crash? (8400 J)
   b. What average force did the seat belt exert on Bruce during the crash? (1.7×10^4 N[backwards])

4. Yossi is pushing his 0.65 kg toy truck along the carpet with a constant speed of 0.40 m/s. He exerts 8.0 N to do this. He then increases his force to 9.0 N for the next 2.5 m. Keeping in mind that friction slows the truck down, how fast will the truck be going after the 2.5 m? (1.4 m/s?)

5. The ram of a pile driver has a mass of 1000 kg. It falls 4.55 m onto a pile and then drives the pile 15.0 cm into the ground. Find the average force the ram exerts on the pile. (3.1×10^5 N [upwards])

POWER AND EFFICIENCY

1. A 60-kg student does 60 push-ups in 40 s. With each push-up, the student must lift an average of 70% of the body mass a height of 40 cm off the floor. Assuming two significant digits, calculate the following:
   a. The work the student does against the force of gravity for each push-up, assuming work is done only when the student pushes up.
   b. The total work done against the force of gravity in 40 s.
   c. The power achieved for this period.

2. A water pump rated at 2.0 kW can raise 55-kg of water per minute at a constant speed from a lake to the top of a storage tank. How high is the tank above the lake? Assume that all the energy from the pump goes into raising the height of the water.

3. Determine how long it would take a hair dryer rated at 1.5×10^3 W to use 5.0 MJ of energy.

4. A portable stereo requires 265 J of energy to operate the CD player, yielding 200 J of sound energy.
   a. How efficiently does the stereo generate sound energy?
   b. Where does the "lost" energy go?

5. A 49.0 kg child sits on the top of a slide that is located 1.80 m above the ground. After her descent, the child reaches a velocity of 3.00 m/s at the bottom of the slide. Calculate how efficiently the potential energy is converted to kinetic energy.

6. A machine requires 580 J of energy to do 110 J of useful work. How efficient is the machine?