1. Determine the kinetic energy of a 10$\underline{0}$0 kg car traveling at a speed of 10.0 m/s. Repeat for speeds of 20.0 m/s and 30.0 m/s. Discuss the significance of the results.

2. A certain banana has 105 Calories. 1 Calorie (dietetic) is equal to 4190 J of energy. At what rate of speed would a 10$\underline{0}$0 kg car have kinetic energy equal to the chemical energy of a banana?

3. A 50$\underline{0}$ g mass is placed on a table that is 91.5 cm high. (a) How much potential energy does the mass have relative to the floor? (b) How much mass on the same table would have as much energy as the chemical potential energy in a 105 Calorie banana?

4. A 5.0 kg object is launched straight upward with initial speed 30.0 m/s. (a) Determine its speed when it is 10.0 m above its launch. (b) Determine the maximum height it will attain.

5. A superball is dropped from a height of 2.00 m. Measure its mass and its rebound height.
(a) With what speed does the ball hit the floor?
(b) With what speed does the ball leave the floor?
(c) How much kinetic energy does the ball lose during the bounce?

6. A ball of mass 300 g is thrown with initial speed 10.0 m/s toward the ceiling. The ball hits the ceiling, which is 1.50 m higher than the point of release. (a) Find the speed of the ball at impact. (b) Find the kinetic energy at impact.

7. A radical parachutist, mass 90.0 kg, jumps with initial speed 2.00 m/s from atop the St. Louis Arch (height 192 m). His chute opens at a point 15.0 m below the top of the arch. (a) Determine the maximum speed that occurs during the stunt. (b) Should the parachute fail to open, what would be the impact speed?

8. Calculate the maximum speed of a pendulum based on measurements of the minimum and maximum heights as it swings back and forth. Measure with a CBR and compare.

9. A string is attached to the ceiling and at the other end a ball is attached. The ball is pulled back to a certain point and released. At the instant the ball reaches its lowest point the string begins to wind around a horizontal rod placed in its path. Make appropriate measurements and calculate: (a) the minimum initial release height that will ensure that the ball completes its first loop around the rod, and (b) the speed of the ball impacting the rod.

10. The engine of a 2500 kg airplane produces thrust 8.50 kN, 180° as the craft accelerates 1500 m, 180° across a level runway. (a) Determine the work done by the thrust. (b) Determine the work done by gravity. (c) Determine the work done by the normal force.

11. The force of friction against a car is 6500 N as the car skids to a stop in 45.0 m. Find the work done by friction.

12. Wind exerts a force of 2.5 kN, 90° (northward) on the sails of a schooner as it moves 2.0 km, 75° through the water. Find the work done by the wind.

13. An object of mass 1.50 kg is pushed 2.00 m along a ramp that is inclined 30.0°. The applied force has magnitude 11.2 N and is directed parallel to the ramp. Friction has magnitude 3.82 N. Determine the work done by each force: the applied force, friction, gravity, and normal force.

14. A curler exerts a force of 29.5 N over a distance of 1.83 m to deliver a stone of mass 18.5 kg. Friction of amount 1.50 N acts on the stone. What speed does the stone attain? How far does the stone slide?

15. A car with mass 1400 kg and initial speed 35 m/s brakes and comes to a complete stop in 150 m. Determine the amount of friction.

16. The engine and transmission of a certain car can do about 16 MJ of work for every gallon of gasoline used. If friction on this car is 600 N when traveling at constant 25 m/s, what is its fuel economy in km/gallon? Repeat for a speed of 35 m/s and friction 1000 N.

17. Calculate and compare the amounts of work done by the engine: (a) to accelerate a 1000 kg car from rest to 20 m/s over a distance of 100 m with average friction 410 N, (b) to move the car 100 m at a constant 20 m/s with friction 380 N.

18. Total friction on a 1993 Ford Festiva can be modeled by three formulas. Rolling resistance: $F_R = (0.024)\,mg$. Air resistance: $F_A = (0.361\ \text{kg/m})\,v^2$. Engine friction: $F_E = (155\ \text{N})\,n$, where n = gear ratio. The total mass, including driver, is right at 10$\underline{0}$0 kg. Assuming the engine is 38% efficient and a gallon of gas has 120.6 MJ of energy, determine the fuel economy in miles per gallon for the following cases: (a) $v = 55$ mph, $n = 0.692$ (5^{th} gear), (b) $v = 75$ mph, $n = 0.692$, (c) $v = 55$ mph, $n = 0.861$ (4^{th} gear), and (d) $v = 55$ mph, $n = 0.692$, and m = 14$\underline{0}$0 kg (includes three passengers).

19. Determine the amount of work required for a hiker of mass 10$\underline{0}$ kg to climb a mountain along a trail with a change in elevation of 10$\underline{0}$0 m.

20. A person tosses a 50$\underline{0}$ g ball into the air. The person exerts an average force of 60.0 N for a distance of 0.500 m "during the throw", after which the ball rises straight upward. Determine the speed of the ball at a point 3.00 m above its release from the person's hand.

21. How much work must the power train do as a 1500 kg car accelerates from 20.0 m/s to 30.0 m/s along a 200 m stretch of road that rises 10.0 m if there is 700 N of friction?

22. A truck with mass 8000 kg descends a mountain on a road that falls 8.0 m for every 100 m of pavement. The truck maintains a constant speed. (a) What amount of friction is there? (b) How much heat is generated each 1.0 km traveled in this manner?

23. A toy dart gun has a spring with constant 50.0 N/m. When loading a dart, the spring is compressed 3.0 cm. Each dart has mass 10.0 g. (a) How much work is required to load a dart? (b) What is the maximum acceleration rate of a dart? (c) Find the "muzzle speed".

24. A car of mass 1300 kg rides on springs with an effective constant 80.0 kN/m. The car encounters a sudden 10.0 cm dip in the road surface. (a) Find the original energy in the springs. (b) By how much will the springs be further compressed as a result of the dip?

25. A sled dog exerts a force of 300 N on its harness as it pulls the sled along. It takes the dog 30.0 minutes to travel a distance of 1.00 km. Find the dog's average power output.

26. A microwave oven is rated at 1.2 kW. How much energy does it use to cook a hot dog for 1.0 minute?

27. A 60 W light bulb is left on for 1.0 hour. How much electric energy does it use in this time? How much time would it take to use 1.0 kWh of energy?

28. A winch is designed for use on a rescue helicopter. What power electric motor would be required to lift 200 kg at a steady speed of 0.50 m/s?

29. A go-cart and rider, mass 275 kg, is powered by a 3.0 hp engine. (a) Ignoring friction, what would be the minimum amount of time required to accelerate from rest to 10.0 m/s? (b) If the actual time required is 12 s, what amount of friction is present?

30. A 2.0-m metal bar is used as a lever to lift one half the weight of a 1200 kg car. The bar pivots about one end and the car touches it 0.20 m from the pivot. What minimum force must be exerted to lift the car 5.00 cm? Using this much force the person moves the other end of the bar 55 cm – what is the efficiency?

31. A wheel and axle system is used to lift a mass of 50.0 kg. The rope lifting the mass wraps around an axle with diameter 2.54 cm and a person exerts a tangential force on a wheel of diameter 50.0 cm. (a) Find the work output for one revolution of the wheel. (b) What amount of force must be exerted by the person?

32. The efficiency of a certain incandescent 60.0 watt bulb is 5.5%. An LED bulb that gives off the same amount of light has efficiency 35%. How many watts is the LED bulb? How much more heat does the incandescent bulb give off every hour?

33. A certain car of mass 1000 kg gets 80.0 km per gallon (50 mpg) when driving at 24.6 m/s (55 mph). Total friction at that speed is 561 N. If gasoline has 120.6 MJ energy per gallon, what is the efficiency of the engine/transmission? How much energy is wasted every 1.6 km driven (1 mile)? If the car were 100% efficient, how many km/gallon would it get?