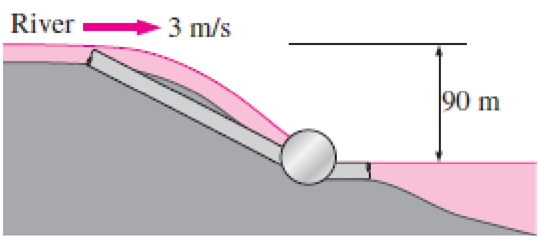
SHEET (2)

1. Answer the following questions:
   a. Consider the process of heating water on top of an electric range. What are the forms of energy involved during this process? What are the energy transformations that take place?
   b. What is the difference between the macroscopic and microscopic forms of energy?
   c. What is total energy? Identify the different forms of energy that constitute the total energy.
   d. How are heat, internal energy, and thermal energy related to each other?
   e. What is mechanical energy? How does it differ from thermal energy? What are the forms of mechanical energy of a fluid stream?
   f. In what forms can energy cross the boundaries of a closed system?
   g. When is the energy crossing the boundaries of a closed system heat and when is it work?
   h. A room is heated by an iron that is left plugged in. Is this a heat or work interaction? Take the entire room, including the iron, as the system.
   i. An insulated room is heated by burning candles. Is this a heat or work interaction? Take the entire room, including the candles, as the system.
   j. What are point and path functions? Give some examples.
   k. A car is accelerated from rest to 85 km/h in 10 s. Would the energy transferred to the car be different if it were accelerated to the same speed in 5 s?
   l. For a cycle, is the net work necessarily zero? For what kind of systems will this be the case?
   m. What are the different mechanisms for transferring energy to or from a control volume?
   n. Can the combined turbine-generator efficiency be greater than either the turbine efficiency or the generator efficiency? Explain.
   o. How is the combined pump–motor efficiency of a pump and motor system defined? Can the combined pump–motor efficiency be greater than either the pump or the motor efficiency?

2. Consider a river flowing toward a lake at an average velocity of 3 m/s at a rate of 500 m^3/s at a location 90 m above the lake surface. Determine the total mechanical energy of the river water per unit mass and the power generation potential of the entire river at that location.



3. Two sites are being considered for wind power generation. In the first site, the wind blows steadily at 7 m/s for 3000 hours per year, whereas in the second site the wind blows at 10 m/s for 2000 hours per year. Assuming the wind velocity is negligible at other times for simplicity, determine which is a better site for wind power generation. *Hint:* Note that the mass flow rate of air is proportional to wind velocity.

4. A person gets into an elevator at the lobby level of a hotel together with his 30-kg suitcase, and gets out at the 10th floor 35 m above. Determine the amount of energy consumed by the motor of the elevator that is now stored in the suitcase.

5. Determine the energy required to accelerate a 1300 kg car from 10 to 60 km/h on an uphill road with a vertical rise of 40 m.

6. Determine the torque applied to the shaft of a car that transmits 450 hp and rotates at a rate of 3000 rpm.

7. Determine the work required to deflect a linear spring with a spring constant of 70 kN/m by 20 cm from its rest position.

8. The engine of a 1500-kg automobile has a power rating of 75 kW. Determine the time required to accelerate this car from rest to a speed of 100 km/h at full power on a level road. Is your answer realistic?

9. A classroom that normally contains 40 people is to be air-conditioned with window air-conditioning units of 5 kW cooling capacity. A person at rest may be assumed to dissipate heat at a rate of about 360 kJ/h. There are 10 lightbulbs in the room, each with a rating of 100 W. The rate of heat transfer to the classroom through the walls and the windows is estimated to be 15,000 kJ/h. If the room air is to be maintained at a constant temperature of 21°C, determine the number of window air-conditioning units required.

10. A university campus has 200 classrooms and 400 faculty offices. The classrooms are equipped with 12 fluorescent tubes, each consuming 110 W, including the electricity used by the ballasts. The faculty offices, on average, have half as many tubes. The campus is open 240 days a year. The classrooms and faculty offices are not occupied an average of 4 h a day, but the lights are kept on. If the unit cost of electricity is 0.18 EGP/kWh, determine how much the campus will save a year if the lights in the classrooms and faculty offices are turned off during unoccupied periods.

11. Consider a room that is initially at the outdoor temperature of 20°C. The room contains a 100-W lightbulb, a 110-W TV set, a 200-W refrigerator, and a 1000-W iron. Assuming no heat transfer through the walls, determine the rate of increase of the energy content of the room when all of these electric devices are on.

12. A water pump that consumes 2 kW of electric power when operating is claimed to take in water from a lake and pump it to a pool whose free surface is 30 m above the free surface of the lake at a rate of 50 L/s. Determine if this claim is reasonable.

13. An escalator in a shopping center is designed to move 30 people, 75 kg each, at a constant speed of 0.8 m/s at 45° slope. Determine the minimum power input needed to drive this escalator. What would your answer be if the escalator velocity were to be doubled?

14. A wind turbine is rotating at 15 rpm under steady winds flowing through the turbine at a rate of 42,000 kg/s. The tip velocity of the turbine blade is measured to be 250 km/h. If 180 kW power is produced by the turbine, determine (*a*) the average velocity of the air and (*b*) the conversion efficiency of the turbine. Take the density of air to be 1.31kg/m^3.

15. An oil pump is drawing 35 kW of electric power while pumping oil with ρ = 860 kg/m^3 at a rate of 0.1 m^3/s. The inlet and outlet diameters of the pipe are 8 cm and 12 cm, respectively. If the pressure rise of oil in the pump is measured to be 400 kPa and the motor efficiency is 90 percent, determine the mechanical efficiency of the pump.