

## Unit 8. Work, energy and power

Circle the correct answer:

- Which of the following has units of joules (J)?:  
a) kinetic energy      b) potential energy      c) work      d) all of the above
- Which kind of energy is associated with an object due to the object's motion?  
a) kinetic      b) potential      c) mechanical      d) power
- If the speed of an object doubles the kinetic energy of the object  
a) doubles      b) is reduced by half      c) is multiplied by 4      d) does not change
- Which of the following is the correct equation for calculating gravitational potential energy?  
a)  $E_p = \frac{1}{2} mgh$       b)  $E_p = mgh$       c)  $E_p = mv^2$       d)  $E_p = \frac{1}{2} mv^2$
- If a force is applied to an object, but the object doesn't move,  
a) the work done on the object is positive.  
b) the work done on the object is negative.  
c) the work done on the object depends on the magnitude and direction of the force.  
d) no work is done on the object.
- The law of conservation of energy states that  
a) energy always leaks out of a system.  
b) energy never leaks out of a system.  
c) energy cannot be created or destroyed.  
d) mechanical energy is always conserved.
- The rate at which energy is transformed is called  
a) work      b) power      c) mechanical advantage      d) efficiency
- List the six types of simple machines and an example of each.

## Mechanical energy, work and power

1. How much work is done if a force of 12 N moves an object a distance of 5 m?
2. If you use a 40 N force to lift a bag, and do 20 J of work, how far do you lift it?
3. Express the following amounts of energy in joules:  
a) 10 kJ    b) 0.35 kJ    c) 0.2 kJ    d) 876 kJ
4. A child pulls a sled up a snow-covered hill. In the process, the child does 405 J of work on the sled. If she walks a distance of 15 m up the hill, how large a force does she exert on the sled?
5. A car has run out of gas. Fortunately, there is a gas station nearby. You must exert a force of 715 N on the car in order to move it. By the time you reach the gas station, you have done  $2.72 \times 10^4$  J of work on the car. How far have you pushed the car?
6. A cheetah can run briefly with a speed of 31 m/s. Suppose a cheetah with a mass of 47 kg runs at this speed. What is the cheetah's kinetic energy?
7. A table tennis ball has a mass of about 2.45 g. Suppose the ball is hit across the table with a speed of 4 m/s. What is the ball's kinetic energy?
8. A baseball traveling at a speed of 35 m/s has 89 J of kinetic energy. What is the mass of the baseball?
9. A meteoroid entering Earth's atmosphere has a speed of 70 km/s and a kinetic energy of  $2.56 \times 10^{15}$  J. What is the mass of the meteoroid?
10. The kinetic energy of a golf ball is measured to be 143 J. If the golf ball has a mass of 47 g, what is its speed?
11. What is the gravitational potential energy associated with a 75 kg tourist at the top floor of the Sears Tower in Chicago, with respect to the street 436 m below?
12. An Olympic diver weighing 650 N is on a platform 10 m above the water. What is the diver's gravitational potential energy with respect to the water?
13. A bird carries a 25 g oyster to a height of 11 m. What is the gravitational potential energy of the oyster?
14. The bird from the above problem drops the oyster. As it falls, all of the gravitational potential energy is transformed into kinetic energy (ignore air resistance). What is the speed of the oyster when it hits the ground?
15. The world record in pole vaulting is 6.15 m. If the pole vaulter's gravitational potential at this maximum height was 4942 J, what was his mass?

16. An automobile to be transported by ship is raised 7 m above the dock. If its gravitational potential energy is  $6.6 \times 10^4$  J, what is the automobile's mass?
17. An Olympic high-jumper with a mass of 82 kg has a gravitational potential energy of 1970 J at the peak height of the jump. How high is the jump?
18. A 500 kg car has a gravitational potential energy of 200 joules as is lifted by a crane. What is the height of the car with respect to the ground?
19. A 1500 g steel ball is 4 m above the ground. What was the work done in order to place it there? If we let it fall, what will its speed as it reaches the ground? And what is its mechanical energy as it hits the ground?
20. How many  $\text{m}^3$  of pure water is there in a deposit situated at 10 m above the ground if it has a gravitational potential energy of 200 000 J ?
21. Calculate the work done by a crane when it lifts an iron bar of 1.5 tonnes to a height of 3 m above the ground. What is power output of the crane's engine if it took half a minute to lift the bar?
22. Calculate the work done by a car with a mass of half a tonne if it takes 10 s to accelerate from 0 to 90 km/h. We do not take the force of friction with the ground and the air into account.
23. A car engine does  $1.25 \times 10^5$  J of work in 25 s. What is the power output of the engine?
24. A space shuttle is placed in orbit by three engines that do  $6.1 \times 10^9$  J of work in 8.5 min. What is the power output of these engines?
25. A steam turbine is designed to be used as a power generator. The turbine provides enough power to do  $3 \times 10^{10}$  J of work in 1 min. What is the power output of the turbine?
26. Suppose a weightlifter's power output is 356 W during the time he does 3310 J of work on the weights. How long does it take the weightlifter to raise the weights?
27. An icebreaker is a ship designed to break through ice, for example, in Arctic waters. One powerful icebreaker is powered by a nuclear reactor with a power output of 56 MW ( $5.6 \times 10^7$  W). How long does it take for this reactor to do  $5.35 \times 10^{10}$  J of work?