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SUMMARY OF TERMS (KNOWLEDGE)

Work The product of the force and the distance moved by the force:

$$W = Fd$$

(More generally, work is the component of force in the direction of motion times the distance moved.)

Power The time rate of work:

$$\text{Power} = \frac{\text{work done}}{\text{time interval}}$$

(More generally, power is the rate at which energy is expended.)

Energy The property of a system that enables it to do work.

Mechanical energy Energy due to the position of something or the movement of something.

Potential energy Energy that something possesses because of its position.

Kinetic energy Energy that something possesses because of its motion, quantified by the relationship

$$\text{Kinetic energy} = \frac{1}{2}mv^2$$

Work–energy theorem The work done on an object equals the change in the kinetic energy of the object:

$$\text{Work} = \Delta\text{KE}$$

(Work can also transfer other forms of energy to a system.)

Law of conservation of energy Energy cannot be created or destroyed; it may be transformed from one form into another, but the total amount of energy never changes.

Machine A device, such as a lever or pulley, that increases (or decreases) a force or simply changes the direction of a force.

Conservation of energy The work output of any machine cannot exceed the work input. In an ideal machine, where no energy is transformed into thermal energy, $\text{work}_{\text{input}} = \text{work}_{\text{output}}$; $(Fd)_{\text{input}} = (Fd)_{\text{output}}$.

Lever A simple machine consisting of a rigid rod pivoted at a fixed point called the fulcrum.

Efficiency The percentage of the work put into a machine that is converted into useful work output. (More generally, useful energy output divided by total energy input.)

READING CHECK QUESTIONS (COMPREHENSION)

7.1 Work

1. When is energy most evident?
2. A force sets an object in motion. When the force is multiplied by the time of its application, we call the quantity *impulse*, and an impulse changes the *momentum* of that object. What do we call the quantity force multiplied by distance?
3. Cite an example in which a force is exerted on an object without doing work on the object.
4. Which requires more work: lifting a 50-kg sack a vertical distance of 2 m or lifting a 25-kg sack a vertical distance of 4 m?
5. Exactly what is it that enables an object to do work?
6. If both sacks in the preceding question are lifted their respective distances in the same time, how does the power required for each compare? How about for the case in which the lighter sack is moved its distance in half the time?

7.2 Potential Energy

7. A car is raised a certain distance in a service-station lift and therefore has potential energy relative to the floor. If it were raised twice as high, how much more potential energy would it have?
8. Two cars are raised to the same elevation on service-station lifts. If one car is twice as massive as the other, compare their gains of potential energy.
9. When is the potential energy of something significant?

7.3 Kinetic Energy

10. When the speed of a moving car is doubled, how much more kinetic energy does it have?

7.4 Work–Energy Theorem

11. Compared with a car moving at some original speed, how much work must the brakes of a car supply to stop a car that is moving twice as fast? How will the stopping distances compare?
12. If you push a crate horizontally with 100 N across a 10-m factory floor and the friction between the crate and the floor is a steady 70 N, how much kinetic energy does the crate gain?
13. How does speed affect the friction between a road and a skidding tire?

7.5 Conservation of Energy

14. What will be the kinetic energy of a pile driver ram that starts from rest and undergoes a 10-kJ decrease in potential energy?
15. An apple hanging from a limb has potential energy because of its height. If it falls, what becomes of this energy just before it hits the ground? When it hits the ground?