Module 11
Work, Energy, Power and Machines

What this module is about

Energy is an important concept in every day life. It appears as gravitational potential energy of objects raised to a certain height, as elastic potential energy in a stretched rubber band, as kinetic energy of moving objects, or as chemical energy in the food that we eat. Closely associated with energy is the concept of work. Energy is transferred to another system when you do work. Power provides a measure of the energy expended per unit time. Efficiency of machines provides a measure of the energy converted into useful work.

This module is about work, power, and energy. It consists of the following lessons:

- **Lesson 1 - Work**
- **Lesson 2 - Energy**
- **Lesson 3 - Machines and Power**

What you are expected to learn

After going through this module, you are expected to:

1. define work in a scientific sense;
2. calculate the work done by a force that moves an object through a certain displacement;
3. show that doing work on a body increases its energy;
4. distinguish between kinetic and potential energy;
5. calculate the kinetic energy and the potential energy of a free falling object;
6. show that mechanical energy of a free falling body is conserved;
7. identify some sources of energy;
8. show how simple machines like lever and inclined plane help us do work;
9. distinguish between ideal and actual mechanical advantages of machines;
10. calculate the mechanical advantages and efficiency of machines; and
11. compare the power ratings of some electrical appliances.

How to learn from this module

In order to achieve the objectives of this module, here's a simple guide for you:

1. Read and follow instructions carefully.
2. Answer the pretest before going through the lessons.
3. Take note and record points for clarification.
4. Compare your answers against the key to answers found at the end of the module.
5. Do the activities to fully understand each lesson.
6. Answer the self check to monitor what you learned in each lesson.
7. Answer the posttest after you have gone over all the lessons.

What to do before (Pretest)

Direction: Choose the letter of the best answer and write this on your answer sheet.

1) In which of the following situations is work being done from a scientist's perspective?
   a. a person sitting on the chair
   b. a person pushing the wall
   c. a person walking with a load on its head
   d. a person lifting a box

2) Which of these equations gives the amount of work done?
   a. Work = F/d
   b. Work = F_gd
   c. Work = Fd
   d. Work = F/t

3) How much work is done in holding a 1-kg object 2 m above the ground?
   a. zero
   b. 2
   c. 9.8
   d. 19.6

4) How much work was done on an object when a constant force of 20 N pushed it 2 m away?
   a. zero
   b, 10
   c. 20
   d. 40

Refer to this situation in answering questions 5-7.

An object falls freely from a certain height.

5) Which of the following happens to the object? It

a. loses PE and gains KE. c. loses both PE and KE.
b. gain PE and loses KE. d. gains both PE and KE.

6) The PE of the object at the highest point compared to its KE at the lowest point is

a. lesser. c. equal.
b. greater. d. not related.

7) The total mechanical energy of the object at the highest point compared to its total mechanical energy at the lowest point is

a. lesser. c. equal.
b. greater. d. not related.

8) What device expends the greatest amount of energy per second?(Use the data in the table below)

Electrical Device	Power Rating (W)
Flat iron	1000
Electric fan	75
Television set	70
Fluorescent lamp	20

a. flat iron c. television set
b. electric fan d. fluorescent lamp

9) Which device expends the least?

a. flat iron c. television set
b. electric fan d. fluorescent lamp

10) What is the efficiency of a machine with AMA of 2.7 and IMA of 3?

a. 27% c. 90%
b. 30% d. 111%

For questions 11 - 13, refer to the situation:

A box weighing 1500 N is pulled along an inclined plane 4 m long and 1.5 m high. A force of 700 N is exerted in pulling the load.

11) What is the work input in joule?

a. 700 c. 2250
b. 1500 d. 2800

12) What is the work output in joule?

a. 700 c. 2250
b. 1500 d. 2800

13) What is the AMA of the inclined plane?

a. 1.5 c. 2.6
b. 2.2 d. 4

14. The power in watts when a 400 N weight is lifted to a height of 6 m in 2 minutes is

a. 10
b. 20
c. 30
d. 40

15. Which of the following is NOT a unit of power?

a. watt
b. horsepower
c. joule second
d. Newton meter per second

Key to answers on page 40

Familiarity with the following terms will help you get the most from this module:

Terms	**Definition**
1. Work	- The product of a constant force magnitude and the magnitude of the displacement
2. Joule	- The unit of work which is the special name for Newton meter
3. Energy	- The capacity to do work
4. Potential energy	- The energy due to position
5. Kinetic energy	- The energy due to motion
6. Power	- The rate of doing work
7. Watt	- The unit of power which is the special name for Joule per second
8.Machines	- Devices that help us do work

9. Actual Mechanical Advantage	- It determines the number of times a machine multiplies force
10. Ideal Mechanical Advantage	- The ratio of the effort distance to the resistance distance
11. Efficiency	- The ratio of the actual mechanical advantage to the ideal mechanical advantage, or the ratio of the work output to the work input

Lesson 1 Work

Think of the many things you do at home. Do you wash dishes? Do you fetch water, scrub or sweep the floor? What does your father or any member of your family do for a living?

In everyday usage, work is done whenever force is applied. You do work if you exert effort and earn for such effort. In science, however, work has a different meaning. **Work** is done on a body when force is applied causing that body to move. To understand more about work, do the following activity.

What you will do

Activity 1.1 Doing Work

1. Lift a book.
2. Push a table.
3. Answer the following questions
   a. Did you apply force in lifting the book? in pushing a table?
   b. If yes in each case, in what direction did you apply force?
   c. Did the objects move?
   d. If yes, in what direction was the book moved? In what direction was the table moved?

Key to answers on page 40

When you lifted the book, force was applied upward. The force you applied has a magnitude equal to the magnitude of the book's weight. The book also moved upward. In this case, work was done in scientific sense.

When you pushed a table causing it to move along the floor, work was also done. The table moved along the same direction as the force applied.

In science, you do work by exerting force on the object through a distance. The force you exert on the object moves the object from one place to another, that is, the object undergoes a displacement.

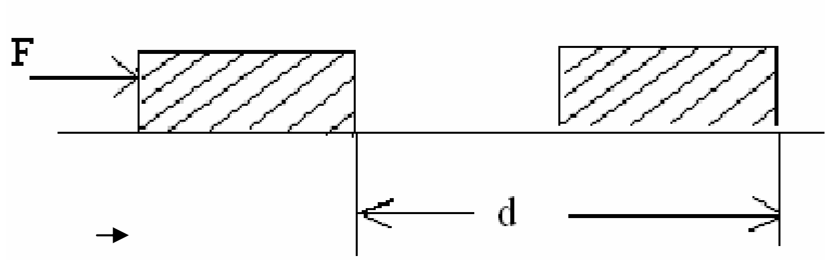


Fig. 1.1. Work is done when a constant force F acts in the same direction as the displacement, d.

Work done, **W**, on a body by a constant force, **F**, acting on the body is defined as the product of the magnitude of the force and the distance through which the object moves, or in equation,

$$\mathbf{W = Fd}$$

From the equation, work done on the body is greater if **F** is greater, or if **d** is greater, or if both **F** and **d** are greater. What is the SI unit of work? Yes, you are right! The SI unit for work is

Unit of work = unit of F x unit of d
= newton x meter (N-m)

The unit N-m is given a special name, Joule, in honor of James Prescott Joule. Therefore

1 joule (J) = 1 newton-meter (N-m)

What is the unit of work if F is in dynes and d is in cm? That's right! The unit of work is dyne-cm, which is given a special name of erg. So,

1 erg = 1 dyne-cm

Now consider the situation that follows. A bag is pulled as shown in Fig. 1.2. Is work done on the bag?

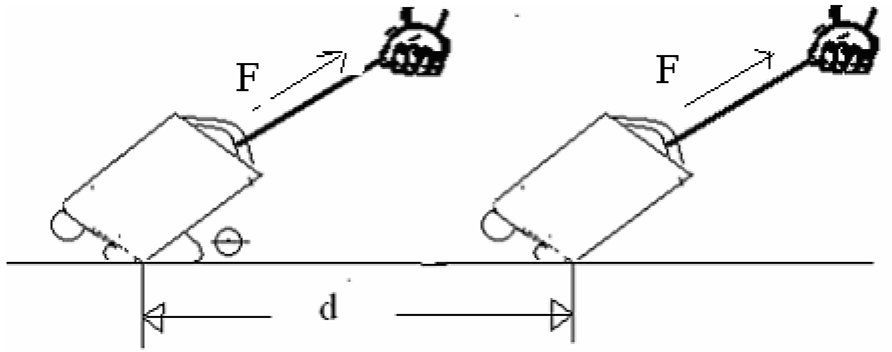


Fig. 1.2 A bag pulled a distance, d

A force F acts along the handle of the bag and makes an angle θ with the surface of the table. A component of this force, Fcosθ, moves the bag along the surface of the table. The work done on the bag is the product of this component of the force and the magnitude of the displacement, **d**, along which the bag moves.

$$W = F\cos\theta\ d$$

where θ is the angle (180º or less) between the direction of **F** and the direction of **d**. The **F** and **d** are the magnitudes of the force and displacement vectors, respectively. They are both scalar quantities. Also, we assume that the force and θ are constant while the object is having a displacement.

Now, going back to the first two examples, wherein the book is lifted and the table is pushed, could the equation

$$W = F\cos\theta\ d$$

be used? Let's analyze.

When the bag is lifted, the direction of the force and the displacement is the same. Therefore, θ is 0, and cos θ = 1.

The equation

$$W = F\cos\theta\ d$$

becomes

$$W = Fd$$

What you will do
Self-Test 1.1

Let's see if you understand the scientific meaning of work. Fill in the table by writing **W** if work is done and **N** if no work is done on the object.

Activity	Work, W or No work, N
1. pushing a jeepney a certain distance	
2. pushing a wall	
3. holding a book	
4. lifting a suitcase	
5. taking a load upstairs	

In pushing a jeepney a certain distance, lifting a suitcase and taking a load upstairs, work is done on the jeepney, on the suitcase and on the load, respectively. In holding a book, although force is exerted, this force does not move the book. It only supports the book, otherwise it will fall. Hence, no work is done on holding a book. In pushing the wall, although force is also applied, there is no displacement, so no work is done on the wall as well.

Remember this:

Work is done only when force applied on the object causes the object to have a displacement in the same direction as the direction of the force, or the component of a force.

Example 1

How much work is done when a force of 500 N is used to slide a heavy cabinet 1 meter across the floor?

Solution: a) Write the given quantities.

The given quantities are:

F = 500 N

D = 1m

b) Write the equation.

The equation for work is

W = Fd

c) Substitute the given quantities into the equation

W = 500 N x 1m

d) Do the mathematical operation required in the problem

Multiply to find the answer: 500 N-m

e) Answer: W = 500 N-m or 500 joules

Example 2

How much work is done in lifting a 2 kg book onto a shelf 1.5 m high?

Solution: a) Write the given quantities.

The given quantities are:

m = 2 kg

d = 1.5 m

b) Write the equation.

The equation for work is

$$\mathbf{W = Fd}$$

But the magnitude of F = magnitude of the weight which is

$$\mathbf{W = mg}$$

Substitute the equation for the weight into the equation

$$\mathbf{W = Fd}$$
$$\mathbf{= mgd}$$

The equation W = mgd is the working equation

c) Substitute the given quantities into the working equation

$$\mathbf{W = 2\ kg \times 9.8\ m/s^2 \times 1.5\ m}$$

d) Do the needed mathematical operation:

$$\mathbf{W = 19.6\ kg\ m/s^2 \times 1.5\ m}$$

$$\mathbf{= 29.40\ kg\ m/s^2 \times m}$$

e) Answer: W = 29.40 N-m or

29.40 joules

Example 3

A cart load of sand is pulled 5 m across the ground as shown below. The tension in the rope is 300 N and is directed 30 degrees above the horizontal. How much work is done in pulling the load?

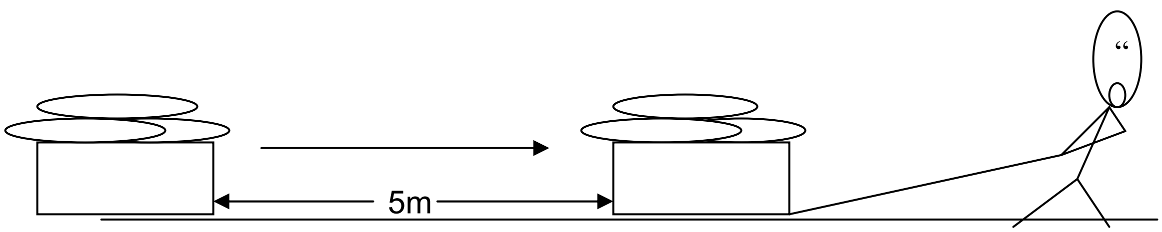


Figure 1.3 A cart load of sand is pulled across the ground

Solution: a. Write the given quantities.

The given quantities are:

d = 5 m

F = 300 N

θ = 30 degrees

b. Write the equation:

The basic equation is also the working equation, which is

Work = Fcos θ d

c. Substitute the given quantities into the working equation:

Work $= 300\ N \times \cos 30^o \times 5\ m$

$= 300\ N \times 0.866 \times 5\ m$

= 1 299 joules

What you will do

Self-Test 1.2

Let us see if you can follow the solutions given in the sample problems. Below are simple problems for you to solve. Follow the procedures in solving the problems.
Problems:

1. Suppose you lift a 3 kg book from the table onto a shelf 2 m high. a) What force must you apply to move the book at constant velocity? b) What work is done by this force?

2. How much work is done to carry a 3 kg book from one shelf to another 4 cm away but at the same level?

Key to answers on page 40

Are you through solving the problems? If yes, please go over your solutions to make sure you did not make any mistake. If you are sure your solutions are correct, refer to the answer key. If you have an error in your solution, go over the sample problems again, then study the concepts discussed in the lesson. Review your solution. This time, I am sure you will get the right answer. Keep working!

Lesson 2 Energy

You always hear the word energy. Comments like *"You feel tired because you do not have energy"* or *"You could not raise your hand because you do not have energy*" are quite common. In this lesson you will learn more about energy. Are you ready to do the following activity?

What you will do

Activity 2.1 Energy: an ability to do work

1. Get a big nail and push its sharp end on a wooden block or on the soil to make it stand.
2. Hold a piece of rock above the nail about half a meter from the nail's head.
3. Let the rock fall straight onto the nail. Be careful. You might drop the rock onto your foot.
4. Observe what happens to the nail.

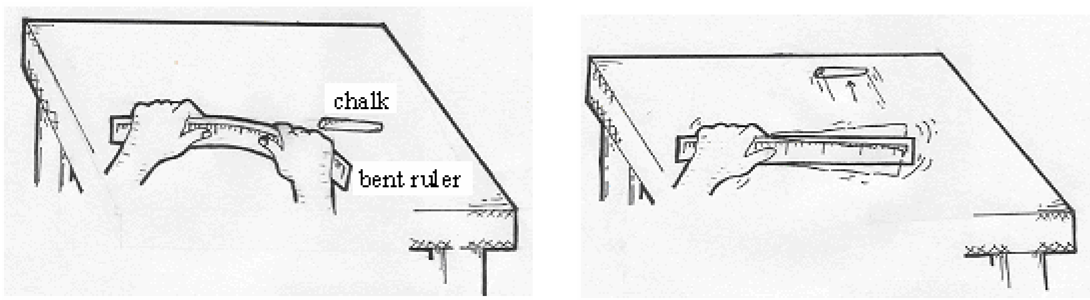
When you dropped the rock onto the nail, you observed that the nail was pushed down the wood or the soil. You could not push the nail if you just held the rock close to the nail. What you did was to raise the rock and to let it fall on the nail. Did you exert force when you raised the rock? How much force did you exert? Was work done on the nail?

When you raised the rock to a certain height, you actually exerted force to overcome its weight. The force you exerted had the same magnitude as the rock's weight but opposite in direction. Since the rock was moved in the same direction as the force applied, work was done on the rock. In that raised position, the rock had the ability to do work. So, when you let the rock fall on the nail, the nail was pushed onto the ground or onto the wooden block. The rock did work on the nail. The rock, in its raised position, had the ability to do work or its **energy** increases. This energy was gravitational potential energy. **Gravitational potential energy** is energy due to the object's position with reference to the earth's surface.

What you will do
Activity 2.2

1. Get a plastic ruler that could be bent without breaking.

2. Hold it on the table, then, bend it. Place a piece of chalk near the bent end of the ruler.



(a) (b)

Fig. 2.1 a) A ruler is bent with a piece of chalk near the bent end. b) The bent end is released

3. Release the bent end of the ruler. Describe what happened to the chalk.

Key to answers on page 41

Work was done when you bent the ruler. Energy is transferred from you to the ruler. Because of its bent position, the ruler possesses energy. This energy due to its bent position is **elastic potential energy**. If you place an object beside the bent end of the ruler, and then, release the bent end of the ruler, the object would be hit and pushed to a distance.

A slingshot with its rubber stretched also has elastic potential energy. If a stone is placed in between the stretched rubber, the slingshot can do work by releasing the rubber from your hold.

Gravitational Potential Energy

One of the most familiar forms of potential energy is gravitational potential energy. In the previous section of this lesson, you learned about potential energy. You also learned about what gravitational potential energy is. In this section, you will learn how to determine gravitational potential energy. Consider again an object of mass, *m*, lifted to a certain height, *h*. Work done on the object gives this object gravitational potential energy. The change in the object's gravitational potential energy is the work done in raising it to that height. Since the work done on the object to raise it at that height is given by the equation,

$$W = mgh$$

then, the change in the object's gravitational potential energy is

$$\Delta PE = mgh$$

where h = the height above the reference level. If the object is raised from the ground, the reference level is the ground. If the object, however, is raised from the table, the table is the reference level.

Using the equation we have derived, could you give the unit of gravitational potential energy? Yes, you are right! The unit of gravitational energy is the same as the unit of work, joule. To understand more about gravitational potential energy, let us use the equation in solving problems. Study very well the following sample problems.

Example 1

How much potential energy is gained by a 2-kg book when it is raised 1.5 m above the table?

Take note that we are looking for the increase in gravitational potential energy with reference to the table top. So, the zero level is the table top.

Solution:

Let h = height above the table top

1. Write the equation that relates the given quantities and the unknown quantities. This equation is $\Delta PE = mgh$
2. Substitute the given quantities into the working equation. The basic equation is also the working equation

$$\Delta PE = mgh$$
$$\Delta PE = (2\ kg)(9.8\ m/s^2)(1.5\ m)$$
$$= 29.4\ joules$$

Example 2

A book with mass of 1.5 kg on a table that is 1.2 m high is raised onto a shelf. The shelf is 2 m from the table top. a) What is the gravitational potential energy of the book relative to the table top? b) What is the gravitational potential energy of the book relative to the floor?

a) The zero level is the table top.

Solution:

1. The equation is: **$\Delta PE = mgh$**

2. Substitute the given quantities into the equation.

$$\Delta PE = (1.5\ kg)(9.8 m/s^2)(2m)$$
$$= 29.4\ joules$$

b) The zero level is the floor.

Solution:

1. The equation is: **$\Delta PE = mgh$**
2. Substitute the given quantities into the equation, then do the necessary mathematical operations. We have

$$\Delta PE = (1.5\ Kg)(9.8\ m/s^2)(\ 3.2\ m)$$
$$= 47.04\ joules$$

Are you ready to do the practice exercises? If not, go over the examples and study the solutions. Once you are ready, go on with the practice exercises.

What you will do

Self-Test 2.1

Read and understand the problems very well. Write your answers on a piece of paper.

1. A bag of groceries with mass of 5 kg is lifted to a height of 1 m. What is the increase in potential energy of the bag at this point?

2. What is the increase in potential energy of a 5-kg barbell when it is lifted by the weightlifter 2 m above the floor?

Key to answers on page 41

Kinetic Energy

The total work done on a body is related not only to the body's displacement but also to the changes in its speed. Work done is transformed into energy due to motion, or **kinetic energy**.

To derive an expression for kinetic energy, let us analyze what happens to a body when a constant force, **F**, is exerted on it along the horizontal. Due to this force, the body moves a distance, **d**. We say work is done on the body, which is, W = Fd. Using Newton's second law, we can replace the force by the product of mass and acceleration giving us

$$W = (ma)(d).$$

If the body was initially moving in the direction of **F** with a speed v_1, then after moving through a distance **d** it will have a speed v_2. Using the equation for motion you studied in the previous modules, this speed may be expressed as

$$v_2^2 = v_1^2 + 2ad$$

Rearranging the last expression and multiplying by m/2, we have,

$$2ad + v_1^2 = v^2$$
$$2ad = v_2^2 - v_1^2$$
$$(2ad = v_2^2 - v_1^2)\ m/2$$
$$mad = \tfrac{1}{2}\ mv_2^2 - \tfrac{1}{2}\ mv_1^2.$$

But, the expression (ma)(d) = W, so,

$$W = \tfrac{1}{2}\ mv_2^2 - \tfrac{1}{2}\ mv_1^2.$$

Recall that work done on the body in this case changes the body's motion. The quantity $\frac{1}{2}\ mv^2$ is called **kinetic energy**, KE. The equation $W = \frac{1}{2}\ mv_2^2 - \frac{1}{2}\ mv_1^2$ means that the work done on a body by the net force acting on it is equal to the change in kinetic energy of the body.

Think about it!

What is the SI unit of kinetic energy?

Using the equation $KE = \frac{1}{2}\ mv^2$, we can derive the SI unit of kinetic energy. Since the SI unit of m is kg and the SI unit of v is m/s, then, the SI unit of KE is

$$KE = \tfrac{1}{2}\ mv^2$$

$$\text{joule} = \text{kg(m/s)}^2$$
$$= \text{kgm}^2/\text{s}^2$$

The unit, kgm^2/s^2 may also be written as $(\text{kgm/s}^2)(\text{m})$, or N-m. Do you still recall that the unit N-m was given a special name, joule?

Let us use the equation we just derived to solve problems on kinetic energy.

Example 1

A 5-kg body moves with a speed of 7m/s. What is its kinetic energy?

Solution:

1. The basic equation is **KE = ½ mv²** ($KE = \frac{1}{2}mv^2$)
2. Substitute the given quantities into the equation. We have

$$KE = \tfrac{1}{2}mv^2$$
$$= \tfrac{1}{2}(5\text{ kg})(7\text{ m/s})^2$$
$$= 122.5\text{ joules}$$

Example 2

What is the kinetic energy of a baseball with mass of 2kg moving at a speed of 4m/s?

Solution:

1. The basic equation is **$KE = \frac{1}{2}mv^2$.**
2. Substitute the given quantities into the equation:

$$KE = \tfrac{1}{2}mv^2$$
$$= \tfrac{1}{2}(2\text{ kg})(4\text{ m/s})^2$$
$$= 16\text{ joules}$$

What you will do
Activity 2.3

Study the example problems using the equation for kinetic energy. Then, try solving the problems that follow.

1. A 2-kg fish is swimming with a speed of 0.1 m/s. What is its KE?

2. What is the KE of a 5-kg object moving at a speed of 4 m/s?

Key to answers on page 41

What you will do
Self-Test 2.2

Tell whether each statement is true or false:

1. When work that is done on a body increases its velocity, then, there is an increase in the kinetic energy of the body.
2. The kinetic energy of a more massive object at rest is greater than that of a less massive moving object.
3. If the velocity of a moving object is doubled, its kinetic energy is also doubled.
4. The unit of kinetic energy is the same as the unit of work.
5. The unit kg m^2/s^2 is also a unit of energy.

Key to answers on page 41

Conservation of Mechanical Energy

Let us try to examine what happens to the mechanical energy of a free falling body. But, before that, let us first recall the concept of free fall.

What you will do
Activity 2.4

Look at Fig. 2.2 below showing the position of a free falling body. Using the data in the figure, answer the following questions:

1. What is the speed of the object when it is still held at the starting point?
2. What happens to the speed of the object as it falls?
3. What is the change in velocity per unit time or the acceleration of the object?

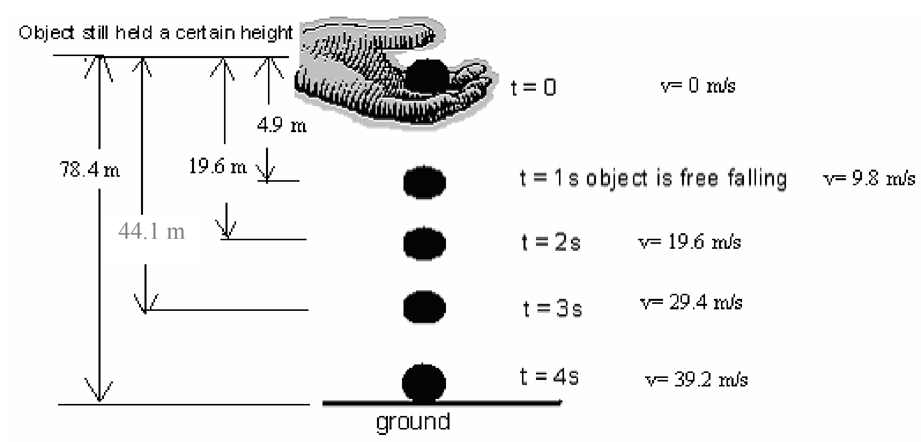


Fig. 2.2 An object held a certain height is released

4. What is the total distance of the object from the ground when it is at the starting point (t = 0 s)?
5. What happens to the object's distance from the ground as it falls?

Key to answers on page 42

Did you observe that the speed of the object increased as it falls? The speed increased at the rate of 9.8 m/s every second or its acceleration was 9.8 m/s^2. Do you remember that this is the acceleration due to gravity?

Did you also observe that the total distance of the object from the ground at the initial position was 78. 4 m, and as the object fell, its distance from the ground decreased?

Now let us determine what happens to the free falling object's kinetic energy and potential energy.

What you will do

Activity 2.5

1. Study the solution in determining the kinetic energy and the potential energy at t = 0 s and t = 1 s. Then, compute the KE and PE at the other remaining positions. Enter your results in the summary in Table 2.1 (Assume mass of the object is 1.0 kg).

2. Compute also the change in PE and the change in KE at every position and enter results in Table 2.1

Example 1

At t = 0 s, the object is 78.4 m from the ground. Assuming that the mass of the object is 1 kg, and using the equations for PE, we have

$$\begin{aligned} \mathbf{PE} &= \mathbf{mgh} \\ &= \mathbf{(1\ kg)(9.8\ m/s^2)(78.4\ m)} \\ &= \mathbf{768.32\ J} \end{aligned}$$

The KE at t = 0 s is,

$$\begin{aligned} \mathbf{KE} &= \mathbf{½\ mv^2} \\ &= \mathbf{½\ (1kg)(0)^2} \\ &= \mathbf{0} \end{aligned}$$

The total mechanical energy of the free falling object at t = 0s is

$$\begin{aligned} \mathbf{TME} &= \mathbf{PE + KE} \\ &= \mathbf{768.32 + 0} \\ &= \mathbf{768.32\ J} \end{aligned}$$

At t = 1 s, the potential energy is,

$$PE = mgh$$
$$PE = (1\ kg)(9.8\ m/s^2)(78.4\ m - 4.9\ m)$$
$$PE = (9.8 kg\ m/s^2)(73.5\ m)$$
$$PE = 720.30\ J$$

The kinetic energy at t = 1 s is,

$$KE = \frac{1}{2}\ mv^2$$
$$KE = \frac{1}{2}(1\ kg)(9.8\ m/s)^2$$
$$KE = 48.02\ J$$

The total mechanical energy is,

$$TME = PE + KE$$
$$TME = 720.30\ J + 48.02\ J$$
$$TME = 768.32\ J$$

Table 2.1 Summary of the Mechanical Energy of a Free Falling Body

Time (s)	PE (J)	KE (J)	TME (PE + KE) J	Change in PE (J)	Change in KE (J)
0	768.32	0	768.32	0	0
1	720.30	48.02	768.32	48.02	48.02
2					
3					
4					

Key to answers on page 42

Were you able to complete the table correctly. If yes, congratulations! You may proceed to the next activity. If not, go over your solutions again. Do not stop unless you master the computations, and you have completely filled up the blank spaces in the table. Keep working! Have patience! You may also ask your teacher to help you in case you have difficulty completing the table.

What you will do

Activity 2.6

Using the data on Table 2.1 of a free falling object, answer the following questions:

1. What happens to the potential energy as the object freely falls?
2. What happens to the kinetic energy as the object freely falls?
3. Compare the change in potential energy with the change in kinetic energy as the object freely falls.
4. Describe the total mechanical energy as the object freely falls.
5. Is mechanical energy conserved? Explain your answer.

Key to answers on page 42

Did you observe that the potential energy decreased as the object fell? Did you also observe that in a freely falling body, as the potential energy decreases, the kinetic energy increases? Notice that as the object freely falls, the change in potential energy equals the change in kinetic energy. For example, at t = 1 s, the decrease in potential energy, 48.02 J, is the same as the increase in kinetic energy. At all positions, the change in kinetic energy is equal to the change in potential energy. We may conclude that mechanical energy is conserved. What is lost as potential energy becomes kinetic energy. What you observed is a good example of **conservation of energy.**

From the activities can you now give a general definition of energy? How do you differentiate potential energy from kinetic energy?

Energy is the ability to do work.

The two basic forms of energy are potential energy and kinetic energy.

Potential energy is energy due to position while **kinetic energy** is energy due to change in position.

Think about this!

As an object falls, will the change in kinetic energy be always the same as the change in potential energy? What do you think will happen if air friction acts on an object as it falls?

If air friction acts on the object, potential energy still decreases, but the decrease in potential energy is no longer equal to the change in kinetic energy. Actually, it will be greater than the change in kinetic energy. Potential energy lost is not totally converted to kinetic energy. Some of the energy is converted into thermal energy of the molecules of air the object encounters. If you could measure the temperature of the air around the object, there would be a little increase in the temperature of the air.

The Law of Conservation of Energy states that in an isolated system, the total amount of energy is conserved.

The law of conservation of energy tells us that, although energy changes to other forms in a given system, the total amount of energy cannot change. For example, when an object freely falls, the total energy gained when it is raised from the ground to a certain height remains the same. It is only transformed from gravitational potential energy to kinetic energy. When it rests on the ground, the kinetic energy is transformed to thermal energy of the ground and the part of the object that touches the ground.

What you will do

Activity 2.7

Tie a stone at the end of a string. Hold the string at the other end. Set the stone into vibration. This will be your swinging pendulum.

1. Explain how conservation of mechanical energy is involved in the swinging of the pendulum.
2. What enables the Space Shuttle in the Enchanted Kingdom to loop a loop?

Key to answers on page 42

Sources of Energy

Conservation of energy happens everywhere. Energy constantly changes from one form to another and the flow of energy never stops. But, the total energy remains the same. When you turned on the electric lamps, energy changes from electrical to light and heat.

But, if you trace where this electrical energy comes from, you will find that there are many sources of energy.

Sources of Electrical Energy

The most common source of electrical energy worldwide is coal. It is burned in coal fired power plants. The heat obtained from burning coal is used to boil water and produce steam. The steam runs the turbines where electricity is generated. Electricity, in turn, is distributed to the community by electric companies. When you turned on the electric lamps, you tapped into that energy.

Heat from under the earth is another source of electrical energy being harnessed in geothermal power plants. Steam from underneath the earth is tapped. It is used to turn the blades of the turbines. The generator converts the mechanical energy in the turbines to electrical energy.

Another source of electrical energy is the energy released by atomic nucleus during controlled nuclear reaction in nuclear power plants. A large amount of energy is released during the fission of the nucleus of an atom of a radioactive element like uranium. This tremendous amount of energy is used to run the turbines in nuclear power plants. Electricity is thus generated and distributed to the community.

Generally, the basic processes in power plants are the same. The blades of the turbines must be made to turn to generate electricity. Thus, mechanical energy is converted to electrical energy. The difference among these power plants is the source of energy that turns the blades of the turbines.

What you will do

Activity 2.8

Answer the following questions:

1. Identify the sources of electrical energy discussed in this module.
2. What are the basic processes common to all power plants?

Key to answers on page 42

Research Work

1. Are there power plants in your locality? What are the sources of electrical energy in these power plants?
2. Aside from producing electrical energy, what are the other uses of energy derived from fuels such as coal?

Nonrenewable Resources

Fuels are substances that may be burned to produce heat, light, or power. The most commonly used fuels are dried dung or animal wastes, wood, peat, and coal. There are also manufactured fuels such as charcoal, coke, and water gas. Lately, petroleum and natural gas have come in widespread use.

Fossil fuels are carbon–rich deposits of ancient life that burn with flame. These have been the most important energy source during the past centuries. Fossil fuels include coal, oil or petroleum, and natural gas. They account for approximately 90% of all energy consumed by industrial nations.

Estimates by geologists reveal that it takes millions of years to form fossil fuel deposits. Although the natural processes involved in the formation of fossil fuels still continue today, the rate of using fossil fuels is very, very much greater than the rate of their formation. They are, therefore, classified as nonrenewable resources. They cannot easily be replaced.

What you will do

Activity 2.9

Answer the following questions:

1. Give one nonrenewable energy source.
2. What form of energy is present in the following?
   a. a swinging pendulum
   b. a uranium atom underneath the earth
   c. water in dams
   c. fossil fuels
3. How do you think can you help to solve the problem of energy shortage?

Key to answers on page 43

Lesson 3 Machines and Power

You may have observed some people pushing a heavy rock using a piece of wood. There are also those who carry water in a pail using a piece of wood. A pail of water is hung at each end of the pole with its middle resting on the shoulder. Have you noticed the device used at the top of the flag pole to raise the flag? These are simple machines. Simple machines are tools with one or two parts that make work easier.

What are machines? These are devices that help us do work easier. In what way do machines help us do work easier? Suppose that you want to transfer a heavy rock in your garden. You could not do this using your bare hands. Probably, you will use a long piece of wood or a crowbar, if you have. Look at the picture below to see how a lever, like the crowbar works.

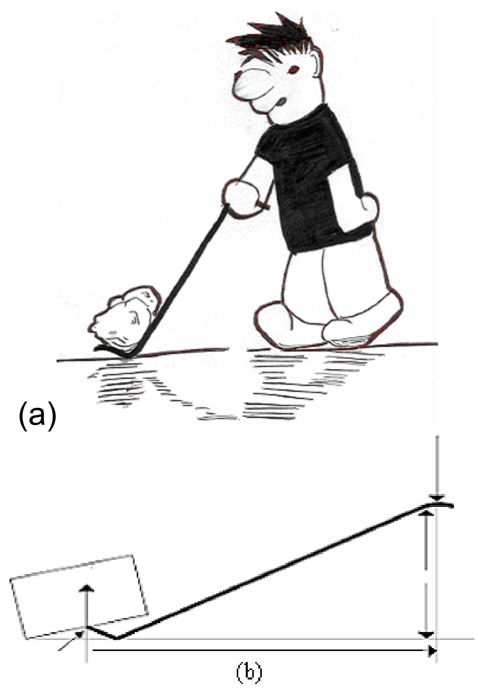


Fig**. 3.1 a)A rock being transferred using a long piece of wood or crowbar. b) Schematic diagram for a).**

Basic Types of Machine

There are only two basic types of machines. These are the lever and the inclined plane. The other simple machines are modifications of the lever or the inclined plane.

The Lever

A lever has a **fulcrum**. This is the point where the lever is supported. Can you identify in the picture (Figure 3.1) where the fulcrum is? Notice that the man pushes down on one side of the bar. The opposite side of the bar pushes up on the rock and lifts one side of the rock. The distance from the man's force (effort) to the fulcrum is the **effort arm**. The distance from the rock (the resistance) to the fulcrum is the **resistance arm**. In using a lever, you apply less effort, but this is used to lift heavy load. The lever helps us do work by increasing the force we exert.

What you will do

Activity 3.1

1. Find a heavy rock in your backyard. Try to lift and move it 0.5 m across.
2. Place one end of the bamboo pole or any wooden pole under the rock and pull up on the end not under the rock. What do you observe?
3. Repeat #2 until the rock is moved 0.5 m across the ground.
4. Compare the force you exerted to move the rock.
5. How did the lever (the bamboo pole) help you do work?

Key to answers on page 43

Did you notice that you exerted less effort in transferring the rock across the ground using the lever? However, you could move the rock only a little distance at a time. The lever helps you do work by increasing the force you apply, but this is done at the expense of speed. Using the lever, you do the work easier, that is, you exert less effort, but you do the work slowly.

Three Classes of Lever

Think of the tools you used at home that are examples of lever. Aside from the seesaw, there are many tools used at home and in your community that are lever. There are three classes of levers: first class, second class and third class levers (Fig. 3.2)

The seesaw is a first class lever. The fulcrum is between the effort and the resistance. The wheelbarrow is an example of a second class lever. The resistance is between the effort and the fulcrum. The ice tong is a third class lever. Effort is exerted at the middle to close the open ends in picking up the ice. The other end joined by a screw is the fulcrum.

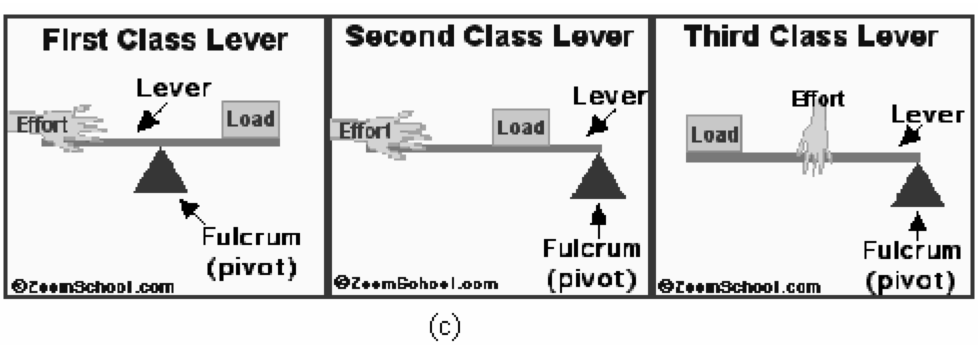


Fig. 3.4 Three Classes of lever

The Inclined Plane

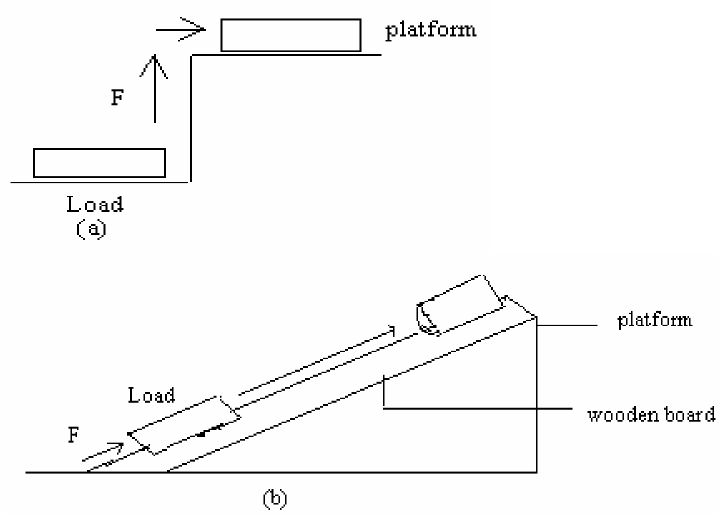
Suppose that you want to raise a heavy load unto the truck. To do this, you use a wooden plank, one end of which is on the ground while the other end is resting on the rear of the truck. The load is pushed up or pulled up along the plank. You would probably find out that it is easier to push the load up the plank than to lift it. To find out how this plank helps you do work, do the activity that follows.

What you will do

Activity 3.2

1. Get a heavy load, let's say, one sack of rice or one sack of sand.
2. Try to lift this onto a platform as shown in Figure 3.3 (a)

a.



3. Now, place a plank or a piece of wooden board to a support as shown (Fig. 3.3 b).
4. Place the heavy load on the lower end of the plank, and then push this along the plank onto the raised end. Feel the force that you apply.
5. Compare the force you need to exert in lifting the load with the force needed to push it along the plank.

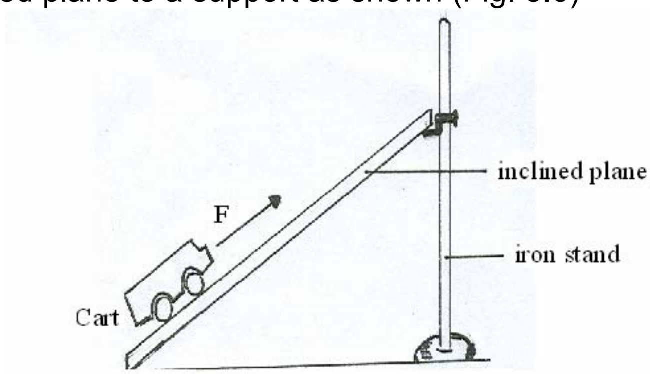
The plank is an inclined plane. The plank helps you do work by exerting lesser force than when lifting the object. The force you apply in using an inclined plane is used to lift heavy load.

To have more quantitative results and to understand very well how the inclined plane works, do this activity in school. Ask your teacher to help you get the materials for this activity.

What you will do

Activity 3.3

1. Place an inclined plane to a support as shown (Fig. 3.6)



1.

2. **Fig. 3.6 An inclined plane**

3. Pull a cart with a 500-g load along the inclined plane with a spring balance. While pulling the load constantly, get the reading on the spring balance and record it.
4. Multiply the load of 500 grams by 980 cm/s^2. This is the weight of the load. This is also the resistance force.
5. Compare the resistance with the force obtained in no.2.

In the activity, notice that the force applied in pulling the load up the inclined plane is less than the weight of the load. The inclined plane helps us do work by exerting less effort in moving a heavy load to a certain height. This simple machine helps us do work by increasing the force we apply.

Work on an Inclined Plane

Lifting the load directly requires a large force acting through a small distance, such as the height of the truck. If the load is pushed up the inclined plane onto the truck, a smaller force is needed, but the load moves a greater distance, the length of the inclined plane. The force exerted in pushing the load is the **effort**, E. The length of the inclined plane is the distance the effort is moved. This is the **effort distance**, d_E. If the magnitude of this force is multiplied by the distance the effort is moved, what do we have? You are right! Work is done. This work is the input work. In equation,

Input work = E x d_E

What is the effect of doing this work? Very good! The load is moved to the top of the inclined plane, and onto the rear of the truck. The load is raised to a certain height. The weight of the load is the **resistance**, R while the height of the inclined plane is the distance the resistance is moved. This is the **resistance distance**, d_R. If the magnitude of this force is multiplied by the resistance distance, the product is the **output work** or the work done by the machine. In equation,

Output work = R x d_R

It is a common observation that it is easier to walk or push or pull up a long gentle slope than a short, steep one. Less force is exerted on the long slope than on the short one.

Other uses of Machines

The bicycle helps us do work by increasing the speed. However, this is done at the expense of force. When you step in the pedal and exert force, the pedal rotates around the crank axle. The pedaling action is transmitted to the rear wheel causing it to rotate and drive the bicycle forward. You need to exert greater force than the force you exert when you just walk. But work is done faster.

Do you notice how a single fixed pulley at the top of the flagpole operates? How does a single-fixed pulley help us do work? To raise the flag to the top of the flagpole, the rope to which the flag is attached is pulled down. The rope passes through the grove of the pulley. The magnitude of the force applied is no greater than the force due to the flag's weight. Force applied is not increased using the single-fixed pulley. Instead, the pulley helps us do work by changing the direction of the force.

Another way by which a machine helps us do work is by transforming energy. A generator transforms mechanical energy to electrical energy.

Think about it!

How else do machines help us do work?

Mechanical Advantage

In the activity on the inclined plane, notice also that the force applied in pulling the load up the inclined plane is less than the weight of the load. The inclined plane helps us do work by exerting less effort in moving a heavy load to a certain height. Do you recall that this simple machine helps us do work by increasing the force we apply? The number of times a machine multiplies force is its **mechanical advantage**. To determine this, we divide the resistance force by the effort. This is the actual mechanical advantage, AMA. In equation,

$$AMA = \frac{Resistance}{Effort} \quad or$$

$$AMA = \frac{R}{E}$$

If friction is neglected, the mechanical advantage is the ratio of the effort distance to the resistance distance. This is the ideal mechanical advantage, I.M.A. , or

$$I.\ M.A. = \frac{length}{height}, \ or$$

$$I.M.A. = \frac{L}{H}$$

Other Simple Machines

The other simple machines like the wheel and axle, wedge, screw, and the pulley are modifications of the lever and the inclined plane. You have seen one use of the pulley, that of changing the direction of the force. Combination of two or more pulleys has another use. Have you seen how a car mechanic raises the engine of a car that is to be repaired? A system of pulleys is used for this purpose. To find out how a combination of pulleys work, do the activity below.

What you will do
Activity 3.4

Ask your teacher to help you secure the materials you will need in this activity. You will need the following:

- 2 pulleys
- strong string about 3 m long
- 1 500 - g standard mass
- 1 spring balance

Procedure:

1. Arrange the pulleys as shown in figure 3.7
2. Lift a 500-g load, and as you lift it determine the reading in spring balance.
3. Record data on a sheet of paper.
4. Do steps 1-3 but use a different load.

Answer the questions that follow:

1. Compare the readings in the spring balance with the weight of the load.
2. What does the reading in the spring balance represent?
3. What does the 500-g load represent?

The force obtained by multiplying the 500-g load by the acceleration due to gravity is the resistance force. The reading in the spring balance is the effort.

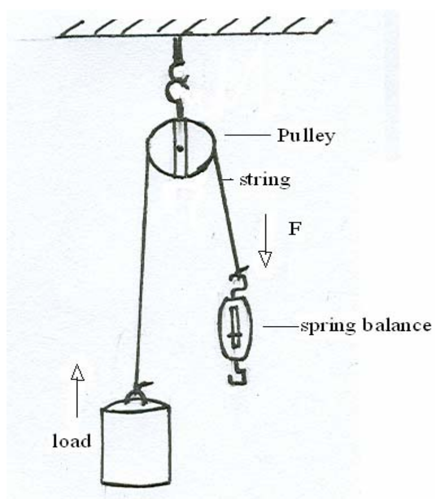
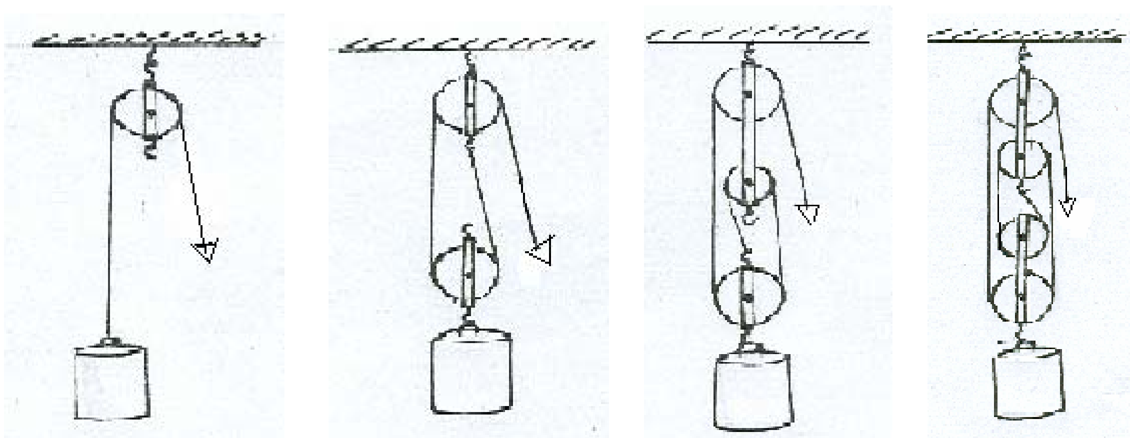


Fig. 3.7 A single fixed-pulley

What you will do

Activity 3.5

1. Study Fig. 3.8 showing how pulleys are used to lift objects.



a b c d

Fig. 3.8 Different types of pulley

1. Answer the questions that follow:

    a. How many strands support the weight in Fig. a? What is its IMA?
    b. How many strands support the weight in Fig. b? What is its IMA?
    c. How many strands support the weight in Fig. c? What is its IMA?
    d. How many strands support the weight in Fig. d? What is its IMA?

Key to answers on page 43

Notice that in figure **a**, there is only one strand supporting the load. The IMA is 1. In figure **b**, there are two strands supporting the load and the IMA is 2. In figure **c**, there are three strands supporting the load and the IMA is 3. In figure **d**, there four strands supporting the load and the IMA is 4.

Generally, the IMA of a pulley system is the number of strands supporting the load.

What you will do

Self-Test 3.1

Fill in the blanks with the correct words or phrases to complete the statements:

1. _________ are devices that help us do work.
2. The two basic types of machines are the _________ and ________.
3. There are ________ classes of lever.
4. The point where the lever is supported is called _________.
5. The effort multiplied by the effort distance gives the machine's _________.
6. _______is the product of the resistance and the resistance distance.
7. The number of times a machine multiplies force is its________.
8. ________ determines the IMA of the pulley system.

9. The IMA of a pulley system is determined by counting the ___________ supporting the load.
10. The single fixed pulley has an IMA equal to _______.

Key to answers on page 43

You often hear somebody saying that an athlete is more powerful than another, or that animals are more powerful than humans. What really is power?

Power provides a measure of both the amount of work done or the amount of energy expended and the time it takes to do it. If you do a physical task quickly you have more power than when you do the same task slowly.

In science, power is defined as the rate at which work is done or the rate at which energy is expended, or is transferred, or transformed. In equation,

Power = work/time

or

Power = energy/time

What is the SI unit of power? Since the SI unit of work is joule and the SI unit of time is second, the SI unit of power is Joule/second. This is given a special name, watt, in honor of James Watt. So,

1 watt (W) = 1 joule (J)/second (s)

A bigger unit, kilowatt (kW) is also commonly used. This is the commonly used unit of electrical power. However, we still use the English system unit of power which is the horsepower. The power of some electrical devices like the motor of air-condition is still expressed in horsepower.

1 horsepower (hp) = 746 watts

You might be familiar with the unit kilowatt hour (kWh) seen on electrical bills. What quantity has this as the unit? The equation defining power as energy divided by time maybe written as

Energy = power x time

Using the above equation, if power is expressed in kilowatt and time is in hour, the unit of energy is kilowatt-hour.

What you will do

Self- Test 3.2

Fill in the blank to complete each statement:

1. ________ is defined as the rate at which work is done.
2. The SI unit of power is j/s which is given a special name _________.
3. A horsepower is equivalent to _________watts.
4. _______ is equal to power x time.
5. Kilowatt-hour is a unit of ________.

Key to answers on page 43

What you will do

Activity 3.6

Look at the power rating in the electrical devices you use at home. Indicate this opposite the electrical device in the table below:

Electrical Device	Power Rating (W)	Power Rating (hp)
Electric fan		
Refrigerator		
Rice cooker		
Flat iron		
Television set		

Key to answers on page 43

Many power tools are still in horsepower. Some air conditioners, for example, have power rating of 1 hp, others with power ratings of 2 hp. An electric household mixer uses a motor with a power of ¼ hp.

Which is more powerful?

Suppose that hollow blocks are to be loaded onto a truck. What are two ways of doing this? First, a person could lift the hollow blocks one at time and place them on the truck. Second, a forklift could be used to lift the hollow blocks all at the same time. Compare the work done when a person is able to lift all the hollow blocks one at a time and the work done using the forklift.

You are right! The same amount of work is done. The force on each hollow block is equal to the magnitude of the weight of the hollow block. The total force exerted to lift all the hollow blocks times the distance they are moved (the height of the truck) is the same whether the blocks are loaded one at a time or all at the same time. But, the power in lifting the hollow block one at a time is lesser than when the blocks are loaded at once.

Example Problem 1

Suppose that the mass of all the hollow blocks is 900 kg. If the truck bed has a weight of 1.3 m, how much work is done in lifting the hollow blocks onto the truck bed? If the forklift does the work in 15 seconds, what is the power? If the person does the same work in 1 hour, what is the person's power? In which situation is power greater?

Solution:

The amount of work done in lifting the hollow blocks is

Work = mgd
= 900 kg x 9.8 m/s^2 x 1.3 m
= 11 466 J

The power of the forklift is

Power = Work/Time
= 11446 joules/15 seconds
= 764.4 W

The power of the person is

Power = Work/time
= 11 446 J / 1 h
= 11 446 J / 3600 s
= 3.185 W

Notice that in problem 1, the forklift has greater power than the person. The same amount of work is done, but work was done in a shorter time using the forklift.

What you will do

Activity 3.7

Read and understand the following problems. Then, solve. If you are through, check your solution.

1. How much electrical energy per second is consumed in an incandescent bulb that has a power rating of 50 watts?

2. What is the power of an engine that does 3000 joules of work in 4 seconds?

Key to answers on page 44

Let's summarize

1. Work is done on a body when force is applied causing that body to move.
2. Work is defined as the product of the magnitude of the force and the distance through which the object moves. In equation,

$$W = F \times d, \text{ or}$$

$$W = F \cos \Theta \, d.$$

The SI unit of work is Nm or joule.

3. Energy is the ability to do work. Doing work on a body increases its energy.
4. Kinetic energy is energy due to motion. To calculate the increase in kinetic energy of a body, we use the equation

$$KE = \frac{1}{2} mv^2$$

5. Potential energy is energy due to position. To determine the gravitational energy we use the equation

$$PE = mgd.$$

The SI unit of energy is the same as the unit of work which is joule.

6. The kinetic energy of a free falling body increases while its potential energy decreases.
7. The total mechanical energy of a free falling body remains the same or is conserved. The loss in potential energy equals the increase in kinetic energy.
8. Some sources of energy are heat from under the earth, energy released by atomic nucleus and fossil fuels.
9. Machines help us do work by multiplying force, changing the direction of force, transferring energy, transforming energy, and increasing speed.
10. Mechanical advantage is the number of times a machine multiplies force. Actual mechanical advantage is the ratio of the resistance to the effort while ideal mechanical advantage is the ratio of the effort distance to resistance distance.
11. Power is the rate of doing work. In SI it is expressed in watts.

Posttest

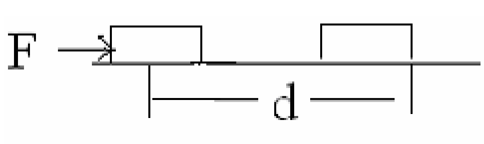
I. Complete each of the following sentences with a word or phrase that will make the sentence correct.

1. ____________ is the ability to do work.
2. The energy stored in a stretched spring is called ____________.
3. The total mechanical energy of a body is the sum of its potential energy and ____________ energy.
4. In the presence of _____________, the final mechanical energy is less than the initial mechanical energy.
5. When a basketball and a pingpong ball are thrown with the same velocity, the kinetic energy of the basketball is ____________ the kinetic energy of the pingpong ball.
6. The mechanical energy of a free-falling body is ____________.
7. Efficiency of a machine is the ratio of its actual mechanical advantage to its ____________.
8. ____________ is the amount of work done per unit time.
9. ____________ is the rate of doing work.
10. A ¾ -hp motor has a power equal to ____________ watts.

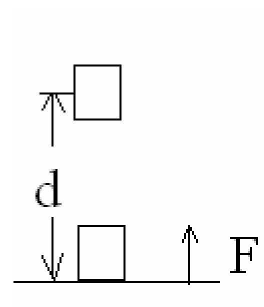
II. Choose the letter of the best answer and write this on a piece of paper.

1. In science, which statement correctly describes work?
    a. Work is done whenever force is applied.
    b. Work is done when you are paid for the effort exerted.
    c. Work is done when force applied moves the object through a distance.
    d. Work is done when force is applied for a longer time.

2. In which situations shown in the figures below is work done equal to zero?



(a)



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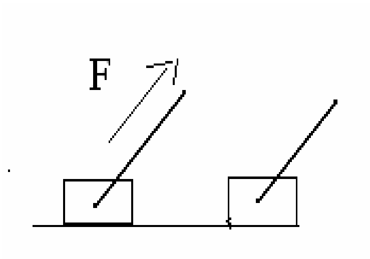
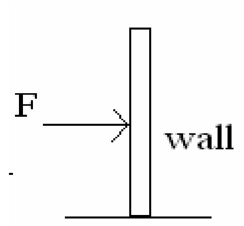


(c)



(d)

3. A force of 25 N is used to slide a 150-N sofa, 5 m across a floor. How much work is done on the sofa?
   a. 0 joule b. 125 joules c. 245 joules d. 750 joules
4. How much work is done in holding a 2-kg book 2 m above the ground?
   a. 0 joule b. 4 joules c. 19.6 joules d. 39.2 joules

5. An object lifted to a height of 5 meters gained 1000 J of potential energy. Then, it is allowed to freely fall. What is its kinetic energy when it hits the ground?
   a. zero J c. 5000 J
   b. 1000 J d. 50000 J

6. A 1-kg ball rolling with a speed of 2 m/s has a kinetic energy equal to
   a. 1 J c. 4 J
   b. 2 J d. 8 J

7. If air resistance is zero, the kinetic energy of a falling object at the lowest position is ________ its potential energy at the highest position.
   a. less than c. greater than
   b. equal to d. not related to

8. Which description of the following machines is INCORRECT?
   a. wheelbarrow – 1st class lever
   b. seesaw – 1st class lever
   c. ice tong – 3rd class lever
   d. human arm – 1st class lever

9. How does the pulley in the flagpole help us do work? It
   a. increases the force applied.
   b. makes work faster.
   c. changes the direction of force.
   d. transforms energy.

10. The rate at which work is done is called
    a. power.
    b. displacement.
    c. kinetic energy.
    d. potential energy.

Key to answers on page 44

Key to Answers

Pretest

1. d	
2. c	9. d
3. a	10. c
4. d	11. d
5. a	12. c
6. c	13. b
7. c	14. b
8. a	15. c

Lesson 1

Activity 1.1

3. a. Yes. Force is applied in lifting the book. Force is also applied in pushing the table.
b. The force in lifting the book is directed upward while the force in pushing the book is directed parallel to the floor.
c. Yes. The objects moved.
d. The book was moved in the same direction as the force applied on it. The table was also moved in the same direction as the force applied on it.

Self-Test 1.1

1. W
2. N
3. N
4. W
5. W

Self – Test 1.2

1. a. Given:
$m = 3$ kg
Required:
F
Equation:
$F = mg$
$= 3 \text{ kg} \times 9.8 \text{ m/s}^2$
$= 29.4 \text{ N}$
b. Given:
$F = 29.4\text{N}$
$d = 2$ m
Required:
W

Equation:

$W = F \times d$

$= 29.4\ N \times 2\ m$

$= 58.8\ J$

Lesson 2

Self – Test 2.1

1. Given:

m= 5 kg

h= 1 m

Required: ΔPE

Solution:

$\Delta PE = mgd$

$= mgh$

$= 5\ kg \times 9.8\ m/s^2 \times 1\ m$

$= 49.0$ Joules

2. Given:

m= 5 kg

d= 2 m

Required: ΔPE

Solution:

$\Delta PE = mgd$

$= 5kg \times 9.8\ m/s^2 \times 2\ m$

$= 98$ Joules

Activity 2.2

3. the chalk was pushed forward when the ruler was released from being bent.

Activity 2.3

1. Given:

m= 2 kg

v= 0.1 m/s

Required: KE

Solution:

$KE = ½\ mv^2$

$= ½\ (2kg)(0.1\ m/s)^2$

$= 1\ kg\ (.01\ m^2/s^2)$

$= .01\ kg\ m^2/s^2$ or

$= .01\ J$

2. Given:

m= 5 kg

v= 4 m/s

Required: KE

Solution:

$KE = \frac{1}{2} mv^2$

$= \frac{1}{2} (5\ kg)(4 m/s)^2$

$= 40\ J$

Activity 2.4

1. speed = 0
2. The speed of the object increases as it falls.
3. Acceleration = 9.8 m/s^2
4. Total distance of the object when it is at the starting point is 78.4 m.
5. The object's distance from the ground decreases as it falls.

Activity 2.5

Table Summary of the Mechanical Energy of a Free Falling Body

Time (s)	PE (J)	KE (J)	TME (PE +KE) J	Change in PE (J)	Change in KE (J)
0	768.32	0	768.32	0	0
1	720.30	48.02	768.32	48.02	48.02
2	576.24	192.08	768.32	192.08	192.08
3	336.14	432.18	768.32	432.18	432.18
4	0	768.32	768.32	768.32	768.32

Activity 2.6

1. The potential energy decreases as the object freely falls.
2. The kinetic energy increases as the object freely falls.
3. The change in potential energy is equal to the change in kinetic energy at every position as the object freely falls.
4. The total mechanical remains the same as the object freely falls.
5. Yes. Mechanical energy is conserved. Although the potential energy decreases, the kinetic energy increases. Whatever is lost as potential energy is gained as kinetic energy, so the total mechanical energy remains the same.

Activity 2.7

1. There is a continuous change of PE to KE to PE as the object swings back and forth.
2. The change in potential energy as the space shuttle moves down is converted to kinetic energy that enables it to move upward. Energy is conserved.

Activity 2.8

1. The sources of electrical energy are coal, geothermal or heat from under the earth, nuclear energy or energy from fission of nucleus.
2. The blades of the turbines must turn to generate electricity.

Activity 2.9

1. The nonrenewable energy source is fossil fuel like coal.
2. a) PE and KE c) mechanical energy
   b) nuclear d) chemical energy
3. We can help solve the problem of energy shortage by living a simple life. Use electrical devices when needle. Ride a bus instead of driving car when alone. Join car pools.

Lesson 3

Activity 3.4

1. The reading in the spring balance is equal to the magnitude of the weight of the load.
2. The reading in the spring balance represents the effort force.
3. The force obtained by multiplying the 500 – g load by the acceleration due to gravity represents the resistance force.

Activity 3.5

2. a. There is one strand supporting the weight in Fig. a. The IMA of the pulley is 1.
   b. There are two strands supporting the load, so the IMA is 2.
   c. There are 3 strands supporting the load in Fig. c, so the IMA is 3.
   d. There are 4 strands supporting the load in Fig. d, so the IMA is 4.

Self –Test 3.1

1. machines
2. lever; inclined plane
3. three
4. fulcrum
5. input work
6. output work
7. actual mechanical advantage
8. number of strands supporting the load
9. number of strands
10. one

Self –Test 3.2

1. power
2. watt
3. 746
4. work or energy
5. work or energy

Activity 3.6

Sample answer

Electric Fan

Power rating = 75 watts

Power rating in hp = 75 W x 1hp / 746 W

Power rating = .10 hp

Activity 3.7

1. Given:

P= 50 W

T= 1 s

Required: E

Solution:

E= Pt

= 50 W X 1s

= 50 J/s X 1s

E= 50 J

2. Given:

Work= 3000 J

t= 4 s

Required:

Power

Solution:

Power= work/time

= 3000 J/4 s

Power= 750 watts

Posttest

I. 1. Energy
2. Elastic Potential energy
3. Kinetic
4. friction
5. greater
6. conserved
7. ideal mechanical advantage
8. power
9. power
10. 559.3

2.

1. c	6. b
2. d	7. b
3. b	8. a
4. a	9. c
5. b	10. a

-End of Module-

References

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