BAL BHARATI PUBLIC SCHOOL, PITAMPURA, DELHI – 110034

SUBJECT:-PHYSICS
CLASS IX

TOPIC : WORK,ENERGY AND POWER

Week:14th December to 19th December, 2020
No of blocks: 1

GUIDELINES FOR STUDENTS:

Dear students,

- There is only one assignment detailed as follows:
- Assignment1: Based on Work
- Solve the assignment in the Physics notebook
- Suitable Video links have been provided for better understanding of the concept.
- Do read NCERT for better understanding of these concepts

SUBTOPICS:

WORK

Instructional aids /Resources:

NCERT LINK FOR THE CHAPTER:

http://ncertbooks.prashanthellina.com/class_9.Science.Science/CHAP%2011.pdf

(**Page no 146 to 149)**

YouTube Links:
https://youtu.be/xGc9f0SUq2w (WORK)
https://youtu.be/plbMU6fXqoM (ITS TYPES)

Learning Outcomes:

Each learner will be able to:

1. Define work scientifically

2. Identify the work done as positive, negative or zero.

3. Name the SI unit of work.

4. Solve numericals based on work.

Activities:

YouTube links

Lesson Development:

INTRODUCTION

In the previous e -lessons, we talked about different ways of describing the motion of objects and the cause of motion and gravitation. Another concept that helps us understand and interpret natural phenomena is **'work'**. Closely related to work are energy and power. You climb up the steps of a staircase and reach the second floor of a building just to see the landscape from there. You may even climb up a tall tree. If we apply the scientific definition, these activities involve a lot of work. In day-to-day life, we consider any useful physical or mental labour as work. Activities like playing in a field, talking with friends, humming a tune, watching a movie, attending a function are sometimes not considered to be work.

Work

There is a difference in the way we use the term 'work' in day-to-day life and the way we use it in science

NOT MUCH 'WORK' IN SPITE OF WORKING HARD!

- Anjali is preparing for examinations. She spends lot of time in studies. She reads books, draws diagrams, organizes her thoughts, collects question papers, attends classes, discusses problems with her friends, and performs experiments. She expends a lot of energy on these activities. In common parlance, she is 'working hard'. All this 'hard work' may involve very little 'work' if we go by the scientific definition of work.
- You are working hard to push a huge rock. Let us say the rock does not move despite all the effort. You get completely exhausted. However, you have not done any work on the rock as there is no displacement of the rock.
- You stand still for a few minutes with a heavy load on your head. You get tired. You have exerted yourself and have spent quite a bit of your energy. Are you doing work on the load? The way we understand the term 'work' in science, work is not done.
- You climb up the steps of a staircase and reach the second floor of a building just to see the landscape from there. You may even climb up a tall tree. If we apply the scientific definition, these activities involve a lot of work.

❖ In day-to-day life, we consider any useful physical or mental labour as work. Activities like playing in a field, talking with friends, humming a tune, watching a movie, attending a function are sometimes not considered to be work. What constitutes 'work' depends on the way we define it. We use and define the term 'work' differently in science.

SCIENTIFIC CONCEPTION OF WORK

To understand the way we view work and define work from the point of view of science, let us consider some situations:

- Push a pebble lying on a surface. The pebble moves through a distance. You exerted a force on the pebble and the pebble got displaced. In this situation work is done.
- A girl pulls a trolley and the trolley moves through a distance. The girl has exerted a force on the trolley and it is displaced. Therefore, work is done
- Lift a book through a height. To do this you must apply a force. The book rises up. There is a force applied on the book and the book has moved. Hence, work is done.

So the above situations reveal that two conditions need to be satisfied for the work to be done:

(i) a force should act on an object, and

(ii) the object must be displaced.

- **WORK DONE BY A CONSTANT FORCE**
- We shall first consider the case when the force is acting in the direction of displacement. Let a constant force, F act on an object. Let the object be displaced through a distance, s in the direction of the force (Fig. 11.1). Let W be the work done. We define work to be equal to the product of the force and displacement.
- Work done = force × displacement
- W = F s

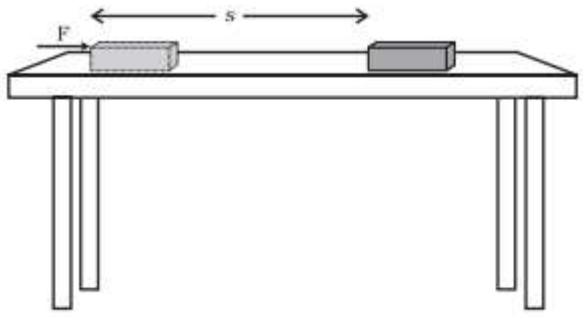

Fig. 11.1

Thus, work done by a force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction.

Unit of work

We know

$$W = F\ s$$

if F = 1 N and s = 1 m then the work done by the force will be 1 N m. Here the unit of work is newton metre (N m) or joule (J).

Thus 1 J is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.

Sign Conventions for Work Done

- When both the force and the displacement are in the same direction, positive work is done.
  $W = F \times s$
- When force acts in a direction opposite to the direction of displacement, the work done is negative.
  $W = -F \times s$

  Angle between force and displacement is 180°.
- If force and displacement are inclined at an angle less than 180°, then work done is given as:
  $W = Fs\cos\theta$
- If force and displacement act at an angle of 90° then work done is zero.

Consider a situation in which the force and the displacement are in the same direction: a baby pulling a toy car parallel to the ground, as shown in Fig. 11.4. The baby has exerted a force in the direction of displacement of the car. In this situation, the work done will be equal to the product of the force and displacement. In such situations, the work done by the force is taken as positive

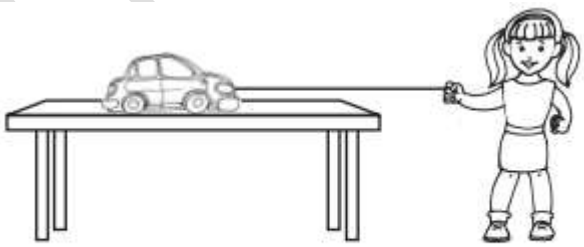

Fig. 11.4

Consider a situation in which an object is being displaced by the action of forces and we identify one of the forces, F acting opposite to the direction of the displacement s, that is, the angle between the two directions is 180º. In such a situation, the work done by the force, F is taken as negative and denoted by minus sign.

The work done by the force is F × (–s) or (–F × s).

- If the directions of force and the displacement are perpendicular to each other, the work done by the force on the object is **zero**.

A man is carrying the heavy luggage from one platform to the other of a Railway station but still according to the logics of science his work done is said to be zero as the force is acting perpendicular to the direction of displacement of luggage.

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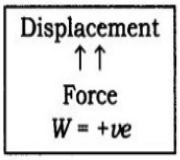
For example, when we push hard against a wall, the force we are exerting on the wall does no work, because in this case the displacement of the wall is d = 0. However, in this process, our muscles are using our internal energy and as a result we get tired.

LET US SEE MORE EXAMPLES OF POSITIVE, NEGATIVE AND ZERO WORK

(Case I)

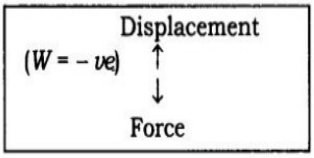
If displacement is in the direction of the force

$W = F \times s$



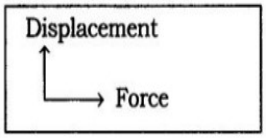
If displacement is in the direction opposite to the force

$W = -F \times s$



(Case II)

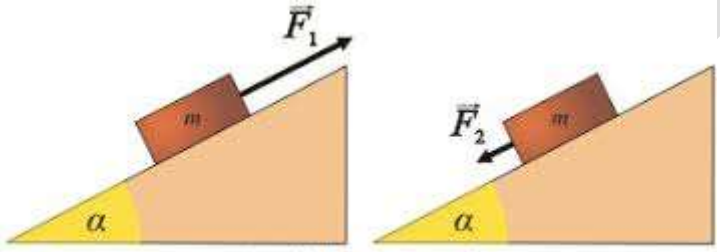
If displacement is perpendicular to the force work done is zero.



Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket Work done is positive as the bucket moves in the direction of force applied by the man

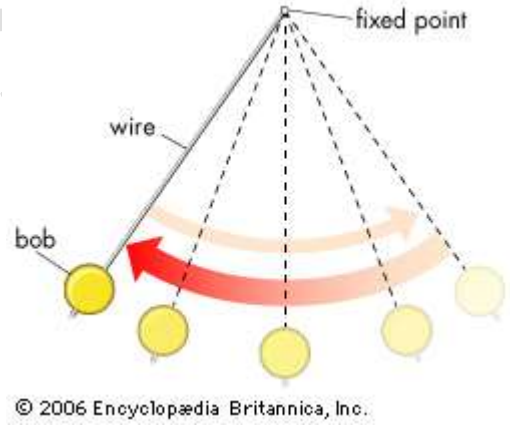
In the above case, work done by the gravitational force is negative, as the bucket moves upwards i.e., opposite to the gravitational force.

Work done by friction on a body sliding down an inclined plane- Work done is negative, as frictional force acts opposite to the direction of motion of the body.

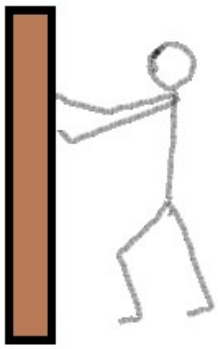


http://physicstasks.eu/

Work done by resistive force of air on a vibrating pendulum in bringing it to rest -Work done is negative because the resistive force of air always acts opposite of the direction of motion of the vibrating pendulum.



For example, when we push hard against a wall, the force we are exerting on the wall does no work, because in this case the displacement of the wall is d = 0. However, in this process, our muscles are using our internal energy and as a result we get tired.



CASE STUDY QUESTION 2:

Read the information and answer the questions that follow

(Go through activity 11.4 on page 148 of NCERT)

Work done by force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction Consider a situation in which an object is being displaced by the action of forces and we identify one of the forces, F acting opposite to the direction of the displacement s, that is, the angle between the two directions is 180º. In such a situation, the work done by the force, F is taken as negative and denoted by the minus sign. The work done by the force is F × (–s) or (–F × s). It is clear from the above discussion that the work done by a force can be either positive or negative

(I) Does the work done depend upon the velocity of the body?

(II) In a tug-of-war one team gives way to the other. What work is being done and by whom?

(III) List two essential conditions for the work to be done

(IV) A force of 10 N acts on an object. The displacement is, say 2 m, in the direction of the force. Let us take it that the force acts on the object through the displacement. What is the work done in this case?

ASSIGNMENT

Do Q1 on page 148 and Q1 TO 4 on page 149

Do Q 1, 2, 12, 18.19 on page no 159.