WORK AND ENERGY

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Q:6.2:

Define work. What is its SI unit?

Ans:

Work

Work is done with a force acting on a body displays it in the direction of a force.

Unit

the SI unit of work is joule (J).

Q:6.3:

When does a force do work? Explain.

Ans:

Suppose of force "**F**" is acting on a body. It makes the body to move from point "**A**" to "**B**". If the distance between these two points is "**S**" as then we say that force has done some work as shown in the figure:

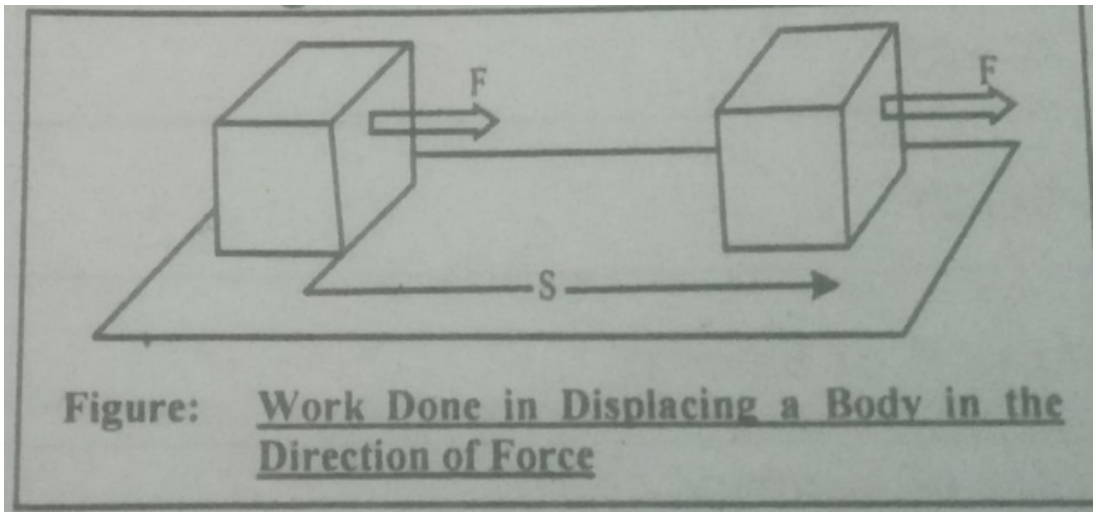

Figure: Work Done in Displacing a Body in the Direction of Force

if "**W**" stand for work, "**F**" force and "**S**" for distance.

Then,

$$\text{Work} = \text{Force} \times \text{Displacement}$$

$$W = FS$$

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Q:6.4:

Why do we need energy?

Ans:

We need energy to do different types of work in our daily life. When we say that body has energy we mean that it has the ability to do work.

Q:6.5:

Define energy; give two types of mechanical energy.

Ans:

Energy

A body possesses energy if it is capable to do work.

Types of Energy

Energy exists in various forms such as mechanical energy, heat energy, light energy, sound energy, electrical energy, chemical energy, and nuclear energy etc .

Mechanical energy

Mechanical energy possessed by a body is of two types:

Kinetic energy:

Processor by a body due to its motion is called Kinetic energy

Potential energy:

The energy possessed by a body due to its position is known as potential energy.

Q:6.6:

Define K.E. And drive its relation.

Ans:

Kinetic energy

The energy possessed by a body due to its motion is called Kinetic energy. It is denoted by K.E and its formula is given below:

$$K.E = 1/2 \times mv^2$$

Derivation

Let a body of mass m is moving with velocity v. An opposing force **F** such as force of friction acting through a distance **S** brings it to rest. The body possesses kinetic energy and is capable to do work against opposing force **F** until all of its kinetic energy in used up.

K.E of the body = work done by it due to motion

$$K.E = FS$$

$$v_i = v$$

$$v_f = 0$$

$$F = ma$$

$$a = - F/m$$

Since motion is opposed, hence, acceleration "**a**" is negative.

Using 3 equation of motion:

$$2 a S = vf^2 - vi^2$$

$$2 (-F/m)S = (0)^2 - (v)^2$$

$$FS = 1/2 mv^2$$

As we know that K.E is equal to the work done,

So,

$$K.E = 1/2 mv^2$$

The above equation gives the K.E possessed by a body of mass M moving with velocity v.

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Q:6.7:

Define potential energy and drive its relation.

Ans:

Potential energy

The energy possessed by a body due to its position is called potential energy. Potential energy is denoted by P.E. and formula is given below:

$$P.E. = m\ g\ h$$

Derivation

Let a body of mass "**m**" raised up through height "**h**" from the ground the body will acquire potential energy equal to do work done in lifting it to height **"h"** shown in the figure:

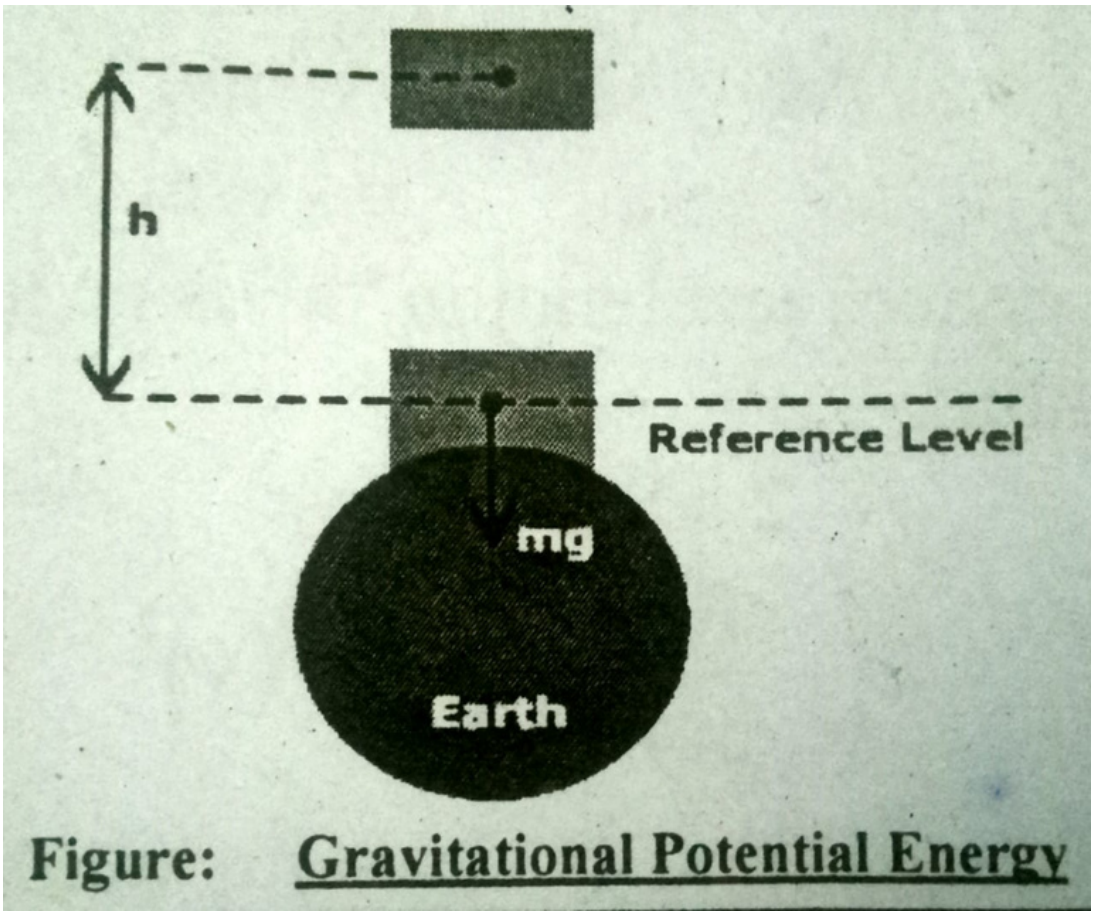

Figure: Gravitational Potential Energy

Thus, potential energy = f x h

= w x h

As we know that weight of the body = w = mg

P.E. = w h = m g h

Q:6.8:

Why fossils fuels are called non-renewable from energy?

Ans:

The fossil fuels took millions of year for their formation. They are known as non-renewable resources. Why are using fossil fuels at a very first rate. Their use is increasing day by day to meet them at the present rate, they will soon be exhausted. Once their supply is exhausted, the world would face serious energy crises.

Q:6.9:

Which form of energy is most preferred and why ?

Ans:

Solar energy is most preferred form of energy due to following reasons:

- It is easily available and it is most cheapest form of energy
- It can easily be converted into other forms of energy
- It is comparatively pollution-free form of energy.

Q:6.10:

How is energy converted from one form to another? explain.

Ans:

Processes in nature are the results of energy changes. For example, some of the heat energy from the sun is taken up by water in the oceans. This increases the thermal energy. Thermal energy causes water to evaporate from the surface to form water vapors. These vapors rise and form clouds. As they cool down, they form water drops and fall down as rain. Potential energy changes to kinetic energy as the rain Falls. This rainwater may reach a lake or a dam. As the rainwater flows down, its kinetic energy changes into thermal energy while parts of the kinetic energy following water is used to wash away soil particles of rocks known as soul erosion.

Q:6.11

Name the five devices that convert electrical energy into mechanical energy.

Ans:

Following devices convert electrical energy into mechanical energy:

- Electric motor
- Electric fan
- Elevator
- Drill machine
- Grinder
- Electrical sewing machine

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Q:6.12:

Name devices that convert mechanical energy into electrical energy.

Ans:

Electric generator is a device which is used to convert mechanical energy into electrical energy.

Q:6.13:

What is meant by efficiency of a system?

Ans:

Efficiency of a system is the ratio of the required form of energy obtained from a system as output to the total energy given to it as input. Efficiency is a ratio between two similar quantities so it has no unit. It is measured in percentage.

Q:6.14:

How can you find the efficiency of a system?

Ans:

Efficiency of a system is the ratio of required form of energy obtained from a system as output to the total energy given to it as input. Mathematically, it is calculated as:

Efficiency = required form of output/total input energy

Q:6.15:

What is meant by the term power?

Ans:

"Rate of doing work with respect to time is called the power".
Since work is a scalar quantity power is also a scalar quantity. In system International, the unit of power is watt(W)
The formula for power is given below:

Power = work/time

Q:6.16:

Define watt.

Ans:

In System International, the unit of power is watt (W). If a body does a work of one Joule in one second then its power will be one **watt.**

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NUMERICAL PROBLEMS

Q:6.1:

A man has pulled a cart through 35 m applying a force of 300 Newton. Find the work done by the man.

Solution:

Given data:

Force applied = F = 300 N

Distance moved by cart = S = 35 m

To find:

Work done by the man = W =?

Solution:

As we know that,

$$W = F \times S$$

By putting the values, we have

$$W = 300 \times 35$$

$$W = 10500 \text{ J}$$

Result:

Hence, the work down by the man on the cart will be 10500 J.

Q:6.2:

A block weighing 20 N is lifted 6 m vertically upward. Calculate the potential energy stored in it.

Solution:

Given Data :

Weight of the block = W = 20 N

Distance moved vertically upward = h = 6 m

To find :

Potential energy of the block = P.E =?

Calculations:

As we know that,

$$W = F \times S$$

By putting the values, we have

$$W = 20 \times 6$$

$$W = 120 \text{ J}$$

Result:

Hence, the potential energy of the block will be 120 J.

Q:6.3:

A car weighing 12 kN has a speed of 20 ms^{-1}. Find the kinetic energy stored in it.

Solution:

Given data:

Weight of the car = w = 12 kN

Speed of the car = v = 20 ms -1

To find:

kinetic energy stored in the car = K.E =?

Calculations:

As we know that, we have

$$K.E. = 1/2\ mv^2$$

By putting the values, we have

$$K.E. = 1/2 \times 1200 \times (20)^2$$

$$K.E. = 1/2 \times 1200 \times 400$$

K.E. = 240000 J

K.E. = 240 Kj

Result:

Hence, the kinetic energy stored in car will be 240 kJ.

Q:6.4:

A 500g stone is thrown up with a velocity of 15ms^{-1} Find its:

(i) P.E. At its maximum height

(ii) K.E. When it hits the ground

Solution:

Given data:

Mass of the stone = m = 500 g = 0.5 kg

Valocity of the stone = v =15ms^{-1}

To FInd:

P.E. At its maximum height = P.E. =?

K.E. When it's hit the ground = K.E. =?

Calculations:

As we know that

The potential energy at maximum height = kinetic energy while throwing

The potential energy at maximum height = $1/2^{2}$ mv

By putting the values, we have

Potential energy at maximum height = 1/2 x 0.5 x $(15)^{2}$

Potential energy at maximum height = 1/2 x 0.5 x 225

The potential energy at maximum height = 56.25 J

potential energy of the stone at maximum height is 56.25 J

Also will know that
Kinetic energy while heating the ground = potential energy at maximum height
As potential energy at maximum height = 56.25 J
So Kinetic energy while hitting the ground = 56.25 J
The kinetic energy of the stone while hitting the ground is 56.25 J

Result:

Hence,the P.E. At its maximum height will be 56.56 J and K.E. when it hits the ground will be 56.56 J.

Q:6.5:

On reaching the top of a slope 6 m high from its bottom, a cyclist has a speed of 1.5 ms^{-1}. Find the kinetic energy and the potential energy of the cyclist. The mass of the cyclist and his bicycle is 40 kg.

Solution:

Given data:

Speed of cyclist = v = 1.5 ms
Height of slope = h = 6 m
Mass of cyclist and bicycle = m = 40 kg

To find:

Kinetic energy of the cyclist = K.E. =?
Potential energy of the cyclist = P.E. =?

Calculations:

As we know that

$$P.E. = mgh$$

By putting the values, we have

$$P.E. = (40)(10)(6)$$

$$P.E. = 2400\ J$$

As we know that

$$K.E. = 1/2\ mv^2$$

By putting the values, we have

$$K.E. = 1/2 \times 40 \times (1.5)^2$$

$$K.E. = 1/2 \times 40 \times 2.25$$

$$K.E. = 45\ J$$

Result:

hence, the Kinetic energy of the cyclist will be 45 J and potential energy of the cyclist will be 2400 J.

Q:6.6:

Moves at steady speed of 4 ms^{1}. Water resistance acting on it is 4000 N. Calculate the power of its engine.

Solution:

Given data:

Speed of motor boat = v = 4

Water resistance acting on board = 4000 N

To find:

Power of the engine of motor boat =?

Calculations:

As we know that

$$P = W/t$$

$$= FS/t = F(S/t)$$

$$P = F \times v$$

By putting the values we have

$$P = 4000 \times 4$$

$$P = 16000\ W$$

$$P = 16\ KW$$

Result:

hence, the power of the engine motor boat will be 16 KW.

Q:6.7:

A man Pulls a block with a force of 300 N through 50 m in 60 s. Find the Power by him to pull the block.

Solution:

Given data:

Force applied on the block = F = 300 N

Distance covered by the block = S = 50 m

Time taken = t = 60 s

To find:

Power used to pull the block = P =?

Calculation:

As we know that

$$P = W/t$$

$$= FS/t = F(S/t)$$

By Putting the values, we have

$$P = 3000\ X\ 50 / 60$$

$$P = 150000 / 60$$

$$P = 250\ W$$

Result:

Hence, the power used to pull the block will be 250 W.

Q:6.8:

A 50 kg man moves 25 steps up in 20 seconds. Find his power, if each step is 16 cm high.

Solution:

Given data:

Mass of man = m = 50 kg

Height of each step = h = 16 cm = 0.16 m

Number if steps = n = 25

Time taken = t = 20 s

To find:

Power of the man = P =?

Calculation:

Since,

$$F = w$$
$$= mg$$
$$= (50)(10)$$
$$= 500\ N$$

Height reached by man = h = 0.16 x 25

$$= 4\ m$$

As we know that

$$P = W/t$$
$$= FS/t = F(S/t)$$

By putting the values, we have

$$P = 500 \times 4 / 20$$
$$P = 2000 / 20$$
$$P = 100\ W$$

Result:

Hence, the power of the man will be 100 W.

Q:6.9:

Calculate the power of a pump that can lift 200 kg of water through a height of 6 m in 10 seconds.

Solution:

Given data:

Mass of the water = m = 200 kg

Height attained = h = 6 m

Time taken = t = 10 s

Given data:

Power of the pump = P =?

Calculations:

Since

$$F = w$$
$$= mg$$
$$= 200 \times 10$$

As we know that

$$P = W/t$$
$$= FS/t = F(S/t)$$

By putting the values, we have

$$P = 2000 \times 6/ 10$$
$$P = 12000 / 10$$
$$P = 1200\ W$$

Result:

Hence, the power of the pump will be 1200 W.

Q:6.10:

An electric motor of 1 HP is used to run a water pump. The water pump takes 10 minutes to fill and overhead tank. The tank has a capacity of 800 L and height of 15 m. Find the actual work done by the electric motor to fill the tank. Also find the efficiency of the system.(density of water = 1000 kgm)(ess of 1 liter of water = 1 kg)

Solution:

Given data:

Power of the motor = P = 1 hp

Time taken by pump = t = 10 mins = 600 s

Capacity of tank = v = 800 liters

Height of the tank = h = 15 m

To find:

Work done by the motor = W =?

Efficiency of the system =?

Calculations:

As we know that

$$P = W / t$$

By putting the values, we have

$$W = 1\ hp \times 600s$$

$$W = 746\ w \times 600s = 447600\ J$$

Virtual work done by the electric motor is 447600J.

$$\text{Now output} = W = mgh$$

By putting the values, we have

$$\text{Output} = 800 \times 10 \times 15$$

$$\text{Output} = 12\ 0000$$

We also know that

$$\%\ \text{efficiency} = \text{required form of output} / \text{total input energy} \times 100$$

By putting the values, we have

$$\%\ \text{efficiency} = 12\ 0000\ J / 447600\ J \times 100$$

$$\%\ \text{efficiency} = 0.268 \times 100$$

$$\%\ \text{Efficiency} = 26.8\%$$

So,

The efficiency of the electric motor is 26.8%

Result:

Hence, the work done by the motor will be 447600 J, and the efficiency of the system will be 26.8%.