JAF COMPREHENSIVE COLLEGE 2019

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WORK, ENERGY AND POWER.

These three terms are somehow related.

Energy → Work ⟶ Power.

Without work there cannot be power and without energy there cannot be work.

WHAT IS ENERGY?

Energy is the ability or capacity to do work.

Examples of energy include:

* Heat energy or thermal energy
* Light energy
* Chemical energy
* Atomic energy
* Solar energy
* Electrical energy (list others)
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LAW OF CONSERVATION OF ENERGY- This law states that energy cannot be created nor destroyed, but can be transformed from one form to another.

This law gives two main ideas.

1). Energy cannot be created and cannot be destroyed.

2). Energy can be transformed (changed) from one form to another.

TRANSFORMATION OF ENERGY

Energy transformation means change of energy from one form to another. When this occurs, it must be in a closed system or isolated system-i.e. where energy cannot be gained/received or lost/ given out apart from energy in operation

Instrument	Initial Energy	Transformed to	
Press Iron			
Water Heater			
Cooking Stove			
Motor Car			
Electric Bulb			
Tree			
Generator			
Candle			
Speaker			
Microphone			
Battery			

TYPES OF MECHANICAL ENERGY

Mechanical Energy involves two forms of energies namely:

1. Potential Energy: - this is energy at rest. It depends on mass and height of the object.

Potential Energy

Potential Energy

(E) = mass x acceleration to gravity x height.

Potential Energy E=m x g x h

E=mgh

Examples of potential include magnetic potential energy, Electric potential Energy, Elastic potential energy, Chemical potential energy as in generator.

CLASSWORK

(1). A stone of mass 80 kg rests on the surface of the ground, if the area of the stone $40m^2$, calculate the potential energy.

(2). A mango of 250kg hang on the top of a tree of height 6.5m, calculate its potential energy.

(3). A mango has a potential energy of 600N at a height of 50m; calculate its mass at that height.

(4). A cocoanut at the top of a tree 15m high has a potential energy of 930 J. Calculate the mass of the cocoanut.

(5). Calculate the potential energy of a ball of mass 7.5kg at a height of 60m.

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(6). A stone fell from the height of 45m, if the potential energy is 900J calculate the mass of the stone.

KINETIC ENERGY

This is the energy possessed by a body on motion. It depends on the velocity of the object.

Kinetic Energy (K.E.) $=^1/2$ * MASS * (Velocity)

K.E. $= {}^1/_2mv^2$. The unit is also Joule (J).

RELATIONSHIP BETWEEN POTENTIAL AND KINETIC ENERGY

When kinetic energy is reducing, the potential energy will be increasing, so that the **sum of energy in that system is always constant.** Fill in the empty space below.

	2	4	6	8	10	12	14	16	18
Kinetic Energy	0	20		50	60	75	80	90	
Potential Energy	100	80	65		40		20		0

Potential energy of an object at the top = Kinetic energy below at the surface of the ground.

Note: P.E. = KE so mgh= $^1/2mv^2$.

Calculation of kinetic energy.

(1)A stone moves at a velocity of 20m/s, calculate the kinetic energy if the mass is 50kg.

(2)A ball of mass 75kg moves at a velocity of 11m/s, calculate the kinetic energy.

(3)A mango fell from a tree 1.8m high; calculate the velocity with which it struck the ground. Calculate the kinetic energy just before it stuck the ground.

(4)A mango of mass 20kg fell from the top of a tree of 7.2m tall, calculate the velocity with which it struck the ground. Calculate the kinetic energy just before it stuck the ground.

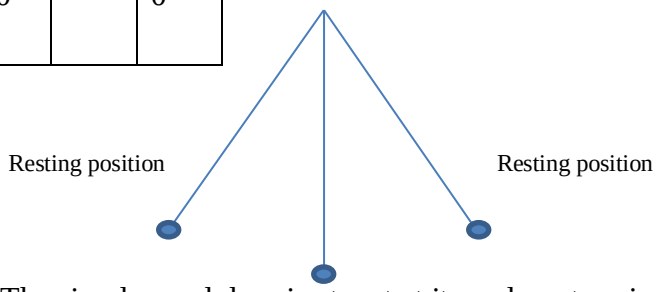
(5)A car of mass 90kg accelerates uniformly from rest at 7.0m/s^2 in 5 seconds, calculate its kinetic energy.

(6) A mango fell from a tree 0.5km tall to the ground at a velocity of 10m/s, if the mass of the mango is 20kg, calculate the

1. Kinetic energy.
2. Potential energy.

ENERGY TRANSFORMATION IN SIMPLE HARMONIC MOTION.

Simple Harmonic Motion is to and fro movement about a point.



The simple pendulum is at rest at its ends or terminals. It attains maximum energy at the mid-point of maximum velocity. Energy is being transformed from kinetic energy to potential energy as it moves from the Centre to the terminals.

Hence, the maximum height of the pendulum can be calculated.

PE at end = KE at the middle point or mgh=$^1/_2mv^2$

SOURCES OF ENERGY

There are two types of energy resources

1. **Renewable** Energy Sources
2. **Non-renewable** Energy Sources.

1**Renewable Energy Sources** are those that can be replaced as they are used. They are continually replenished. E.g. solar energy, wind energy, water energy.

2.Non-renewable Energy Resources are energy resources that are depleting, they cannot be replenished as they are used.

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E.g petroleum and natural gas, Nuclear energy from radioactive materials.

Non-renewables

- Coal, oil, and natural gas are fossil fuels. Even though they all get their energy from the sun, none of them are renewable. They all emit CO_2 and other emissions when burned.
- Nuclear is also non-renewable, but *not* a fossil fuel. It is carbon-free, but result in radioactive waste.
- Most importantly, for all intents and purposes, whatever coal, oil, natural gas, and nuclear exists today is all that we will ever have.

Renewables

- Solar, wind, and hydro are renewable and carbon-free, and effectively inexhaustible.
- Bioenergy is renewable and carbon-neutral. It emits CO_2, but no more CO_2 than was originally pulled from the atmosphere. Even though it is considered renewable, it is possible to use bioenergy unsustainably by harvesting it more quickly than it can be replenished.

WORK

In physics, work is done only when a force moves an object through a distance. Hence, a man carrying a load of 1,590kg for 600 days does no work.

Work done is the product of force and the displacement in the direction of the force.

Work done =force x displacement

Note that force = m a and a= $^{v-u}/t$.

Hence work done =ma x s or

Work done = $^{m(v-u)}/t$ x s where s is displacement

(1) A force of 200N carried a load through a distance of 25m, calculate the work done.

(2) Work done of 500 J was done when a force carried a load through a distance of 12.5M, calculate the force applied.

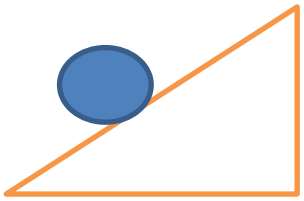
(3) A lorry of mass 600kg moving at an acceleration of 2.5m/s^2 travelled a distance of 30m, calculate

(i) force applied (ii) work done.

(4) A train of mass 550kg moved a distance of 20m at an acceleration of 4 m/s^2, calculate the (i) force applied (ii) work done.

In lifting an object through an incline plane as shown below.

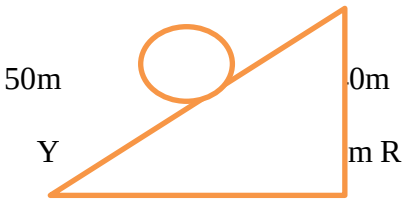
The height (h) is used in calculation and not the length (l).



Work done =mass x height x gravity.

Workdone= mgh.

(1) A man pushes a drum of oil of mass 50kg up an incline plane xy as shown below



Calculate (a) the potential energy at x (b) workdone by the man (c) workdone if the load had been lifted from R to X.

POWER

Power is defined as the rate of doing work. (Rate in Physics means the quantity divided by time).

Power = workdone per unit time.

Power = workdone/time.

The unit of power is watt or joule per second or horse power.

(1) A force of 200N moved a ball of mass 60kg through a distance 5m in 10 seconds. Calculate (a) acceleration (b) workdone (c) power.

Remember Power =workdone/time, but workdone = FS

Power = Force X displacement/time

Velocity = displacement/time

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Power =Force X Velocity.

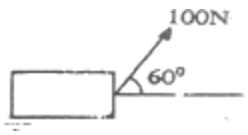
(2) A ball 20kg moved from rest to a final velocity of 15m/s in 5 seconds. Calculate (a) acceleration (b) displacement (c) force (d) workdone (e) power.

(3) A drum of mass 50kg moved from rest to a final velocity of 30m/s in 6 seconds. Calculate

(a) acceleration (b)displacement (c) force (d) workdone (e) power.

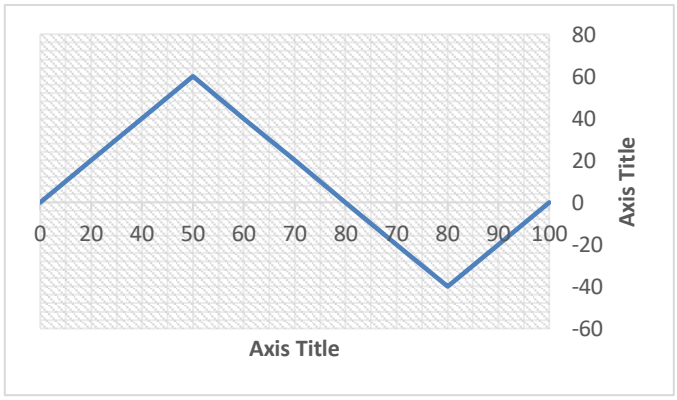
1). Body of mass 5kg falls from a height of 10m above the ground.

1. If a body of mass 5 kg is thrown vertically upwards with velocity u, at what height will the potential energy equal to the kinetic energy? Write formula



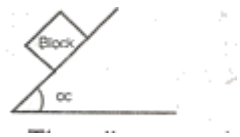
ln the figure above, the work done by the force of 100N inclined at an angle of 60° to the object dragged horizontally to a distance of 8 m is

2. A bob of weight 0.1 N hangs from a mass-less string of length 50 cm. A variable horizontal force which increases from zero is applied to pull the ,bob until the string makes an angle of 60° with the vertical. The work done is



3. From the diagram above, calculate the work done when the particle moves from x_1 = 0m to x_2 = 80m

The diagram above shows a wooden block just about



to slide down an inclined plane whose inclination to the horizontal is oc. The coefficient of frictional force between the block and the plane is

4. An object is moving with a velocity of $5ms^{-1}$ At what heigl1t must a similar body be situated to have a potential energy equal in value with kinetic energy of the moving body?

5. lf a pump is capable of lifting 5000 kg of water through a vertical height of 60 m in 15min. the power of the pump is

6. An object of mass 20kg is released from a height of 10m above the ground level. The kinetic energy of the object just before it hits the ground is

7. A body is released from rest and allowed to fall freely from a given height under gravity. The kinetic energy at its half-way point is A. a little above half of its initial energy

B. a little below half of its initial energy

C. a half of it

s initial energy

D. a little above its initial energy

E. a little below its initial energy.

8. A mango fruit drops from a branch 10m above the ground. Just before hitting the ground its velocity is ($g= 10ms^{-2}$).

9. A man of mass 50kg ascends a flight of stairs 5m high in 5 seconds. lf acceleration due to gravity is $10ms^{-2}$, the power expended is

10. Which of the following best describes the energy changes which take place when a steam engine drives a generator which lights a lamp?

A. Heat -a Light -> Sound -> Kinetic

B. Kinetic -> Light e Heat -> Electricity

C. Heat -> Kinetic -> Electricity -> Heat and Light

D, Electricity -> Kinetic -> Heat -> Light

E. Heat -> Sound -> Kinetic -> Electricity

11. How long will it take a 60kg man to climb a height of 22m if he expended energy at the rate of 0.25kW?

12. A stone and a feather are dropped from the same height above the earth surface.ignoring air resistance, which of the following is correct?

1. A body of mass 0.6kg is thrown vertically upward from the ground with a speed of $20ms^{-1}$. Calculate its (i) potential energy at the maximum height reached. (ii) kinetic energy just before it hits the ground (WASSCE JUNE 2000)