8A

Energy

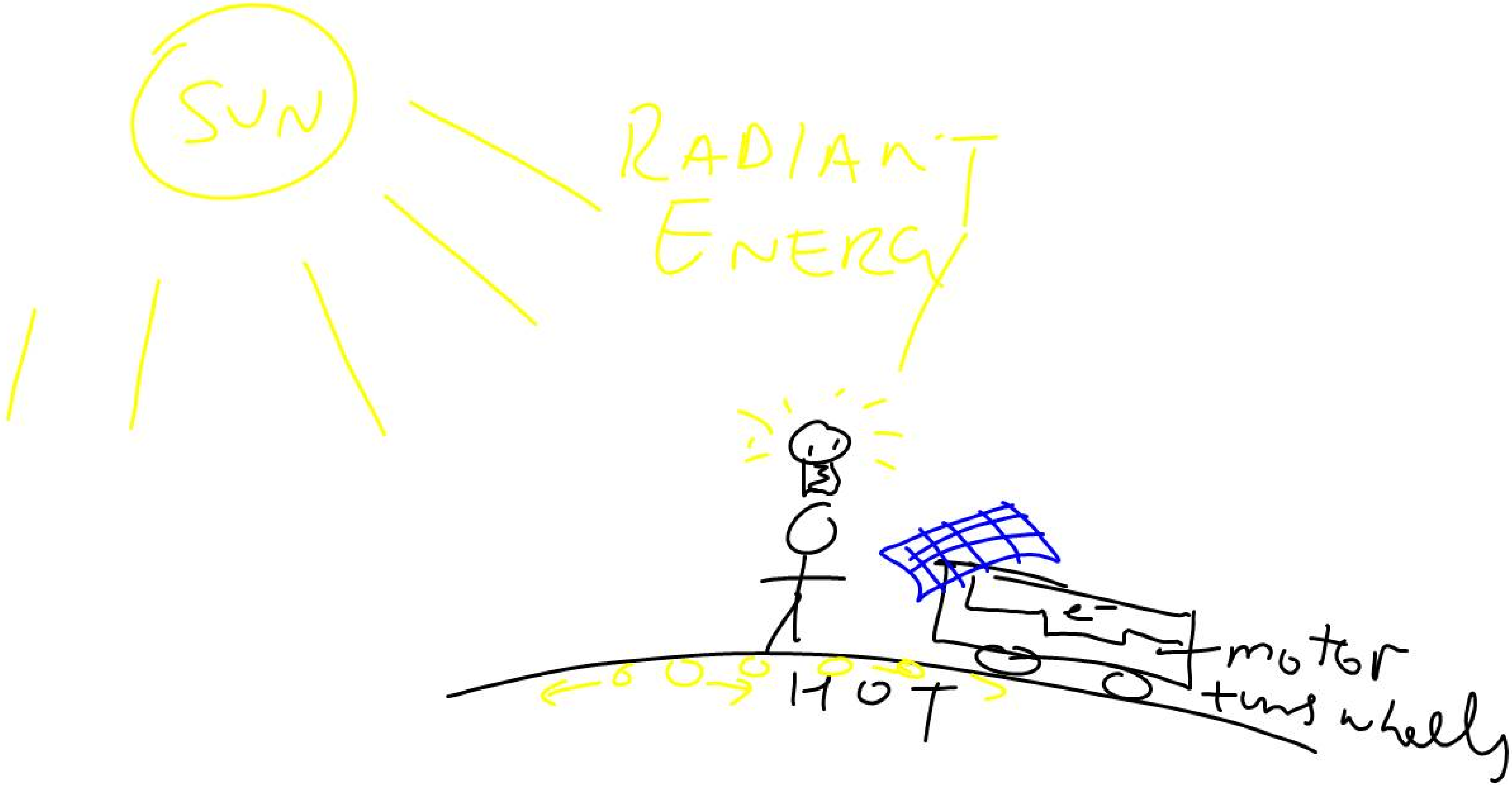
ENERGY: The ability to do work.

Force Applied

Move in the direction of the force.

Law of the Conservation of Energy

Energy can neither be created nor destroyed.



SUN
RADIANT ENERGY
HOT
e⁻
motor
turns wheels

8A

8C

8C

Renewable and Non Renewable Energy

RENEWABLE ENERGY SOURCES

SA

SC

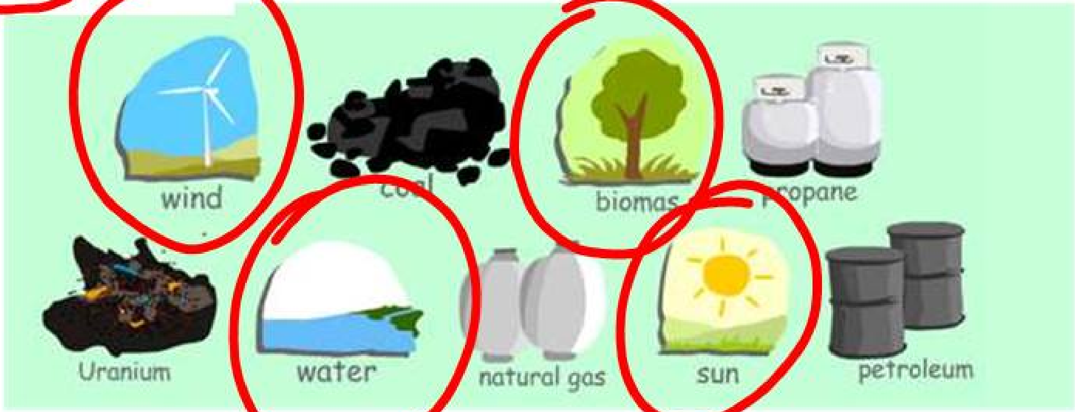
NON-RENEWABLE ENERGY

RENEWABLE ENERGY SOURCES

When can energy be called 'Renewable'?

- When its' source cannot run out (like the sun) or can easily be replaced (like wood, as we can plant trees to use for energy)
- When their sources are carbon neutral. This means they do not produce Carbon compounds (such as other greenhouse gases).
- When they do not pollute the environment (air, land or water)

Which is Renewable?



Renewable energy includes Biomass, Wind, Hydro-power, Geothermal and Solar sources. Renewable energy can be converted to electricity, which is stored and transported to our homes for use. In this lesson, we shall take a closer look at how renewable energy is converted into electricity.

8C

http://www.eschooltoday.com/energy/non-renewable-energy/what-is-non-renewable-energy.html

NON-RENEWABLE ENERGY

What is non-renewable energy?

Energy exists freely in nature. Some of them exist infinitely (never run out, called **RENEWABLE**), the rest have finite amounts (they took millions of years to form, and will run out one day, called **NON-RENEWABLE**).

- **The good thing is about fossil fuels is:**

Unlike many renewable sources of energy, fossil fuels are relatively less expensive to produce. This is probably why it is in higher demand as it tend to cost less.

- **The bad thing about fossil fuels is:**

Fossil fuels are made up mainly of carbon. When they are burned (used) they produce a lot of carbon compounds (carbon dioxide and other greenhouse gases) that hurt the environment in many ways. Air, water and land pollution are all consequences of using fossil fuels.

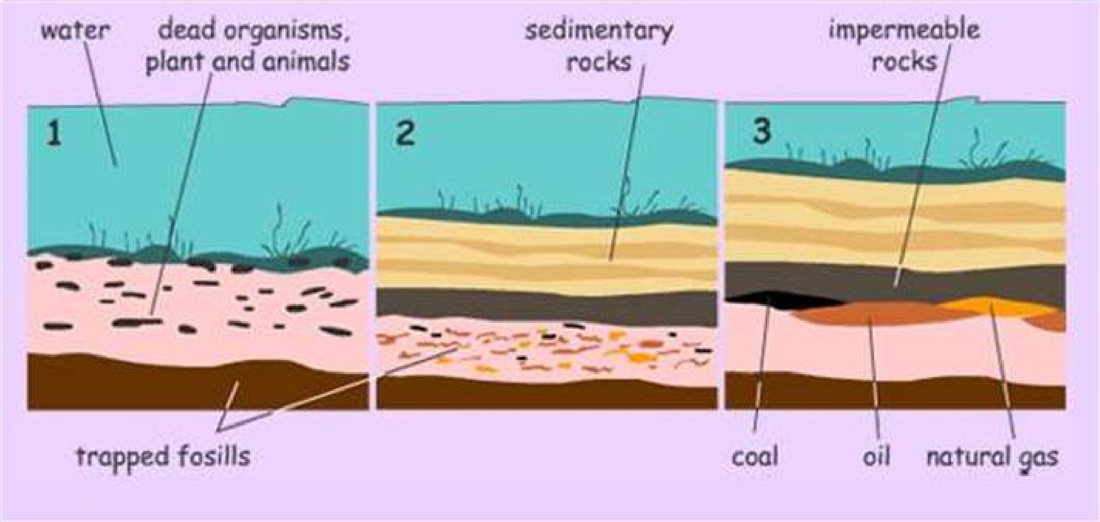
NON-RENEWABLE :

Non-renewable energy is energy from fossil fuels (coal, crude oil, natural gas) and uranium. Fossil fuels are mainly made up of Carbon. It is believed that fossil fuels were formed over 300 million years ago, when the earth was a lot different in its landscape. It had swampy forests and very shallow seas. This time is referred to as '***Carboniferous Period***'

Fossil fuels are usually found in one location as their formation is from a similar process. Let us take a look at the diagram below to see how fossil fuels are formed:

8A

8C



1. Millions of years ago, dead sea organisms, plants and animals settled on the ocean floor and in the porous rocks. These organic matter had stored energy in them as they used the sun's energy to prepare foods (proteins) for themselves (photosynthesis).

2. With time, sand, sediments and impermeable rock settled on the organic matter, trapping its' energy within the porous rocks. That formed pockets of coal, oil and natural gas.

3. Earth movements and rock shifts creates spaces that force to collect these energy types into well-defined areas. With the help of technology, engineers are able to drill down into the sea bed to tap the stored energy, which we commonly know as crude oil.

8A

8C

KINDS OF ENERGY

KE

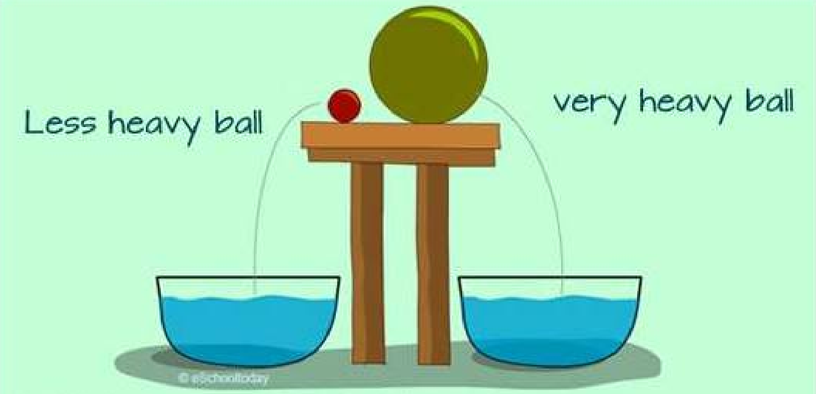
- * KINETIC ENERGY → E_k → Motion
- SOUND ENERGY
- THERMAL (HEAT)
- CHEMICAL ENERGY
- ELECTRICAL ENERGY
- * GRAVITATIONAL ENERGY → PE, E_p } Due to position above earth surface

8C

Kinetic Energy

Ek (Kinetic Energy)

All moving things have kinetic energy. It is energy possessed by an obje due to its' motion or movement. These include very large things, like planets, and very small ones, like atoms. The heavier a thing is, and the faster it moves, the more kinetic energy it has.

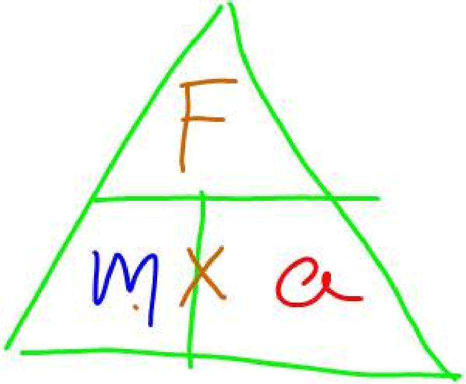


Let us say both balls will fall into the bucket of water.
Let's see what is going to happen.

You will notice that the smaller ball makes a little splash as it falls into the buc heavier ball makes a very big splash. Why?

Newton's 2nd Law

$$F = m \cdot a$$



F → force (N)

m → mass (kg)

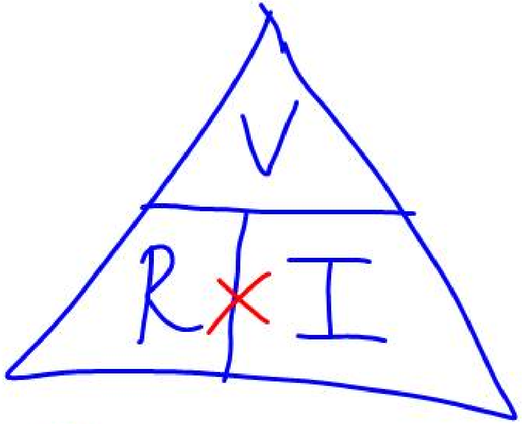
a → acceleration (m/s^2)

$$a = F/m = \frac{20}{2kg}$$

$$a = 10$$

$$\frac{40}{4} = 10$$

$$R = \frac{V}{I}$$



$$V = R \times I$$

$$I = \frac{V}{R}$$

R → Resistance

I → Electric Current

V → Potential difference.

(E_k) Kinetic Energy : ⇒ measured in joules (J)

(KE) Object has Kinetic Energy when it is moving -

(8 A)

$$E_k = \frac{1}{2} m v^2$$

KE

m ⇒ mass (kg)

V ⇒ Velocity (m/s)

An object is falling with a velocity of 2 m/s ($2\ m.s^{-1}$) it possesses 600J of energy. Calculate the mass of the object.

$V = 2\ m.s^{-1}$

$E_k = 600J$

$$E_k = \frac{1}{2} m v^2$$

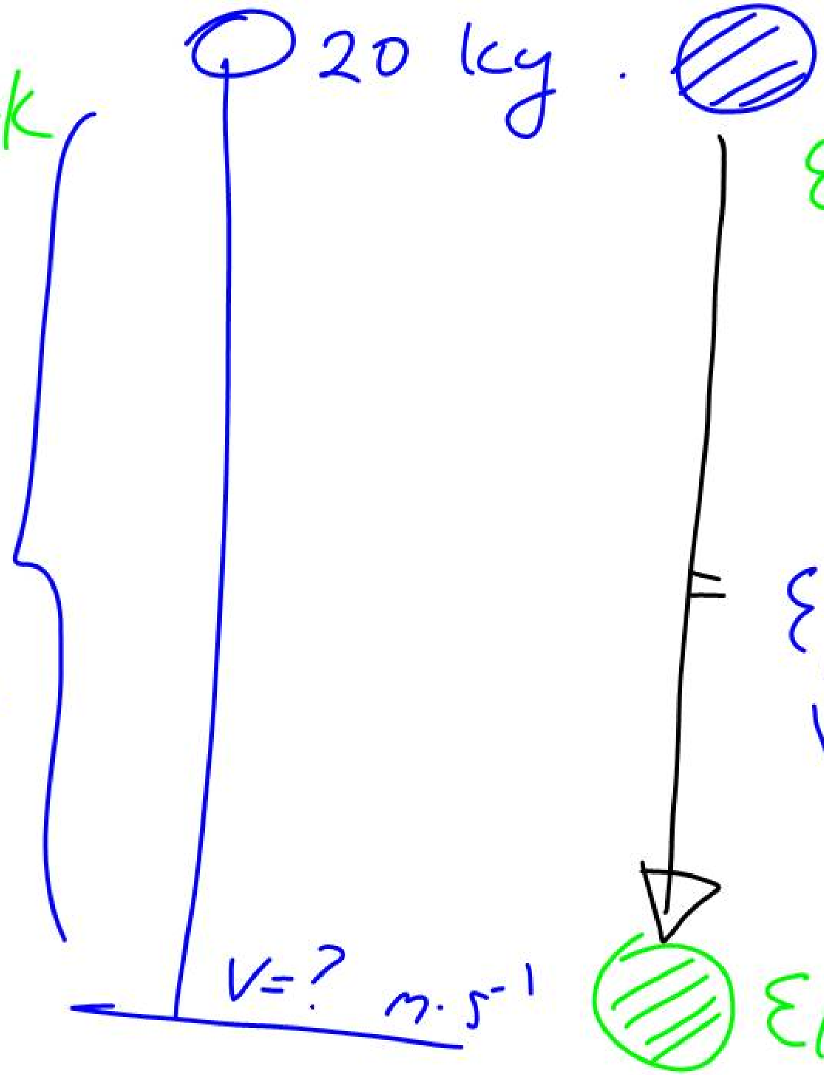
$$m = \frac{2E_k}{v^2}$$

$$= \frac{2 \times 600}{(2)^2} = \frac{1200}{4} = 300kg$$

$ME = E_p + E_k$

$h = 6\,m$

$g = 9{,}8\,m.s^{-2}$



E_p on top

$E_p = mgh$

$= 20 \times 9{,}8 \times 6$

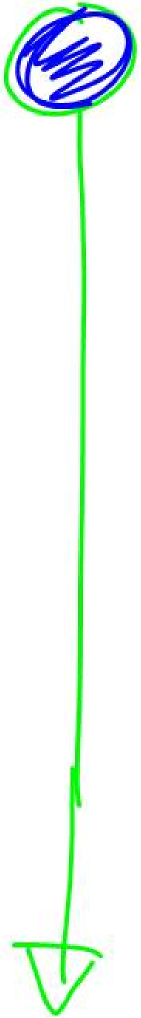
$= 1176\,J$

E_k @ bottom $= 1176\,J$

$E_k = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2(1176)}{20}}$

$= 10{,}84\ m.s^{-1}$



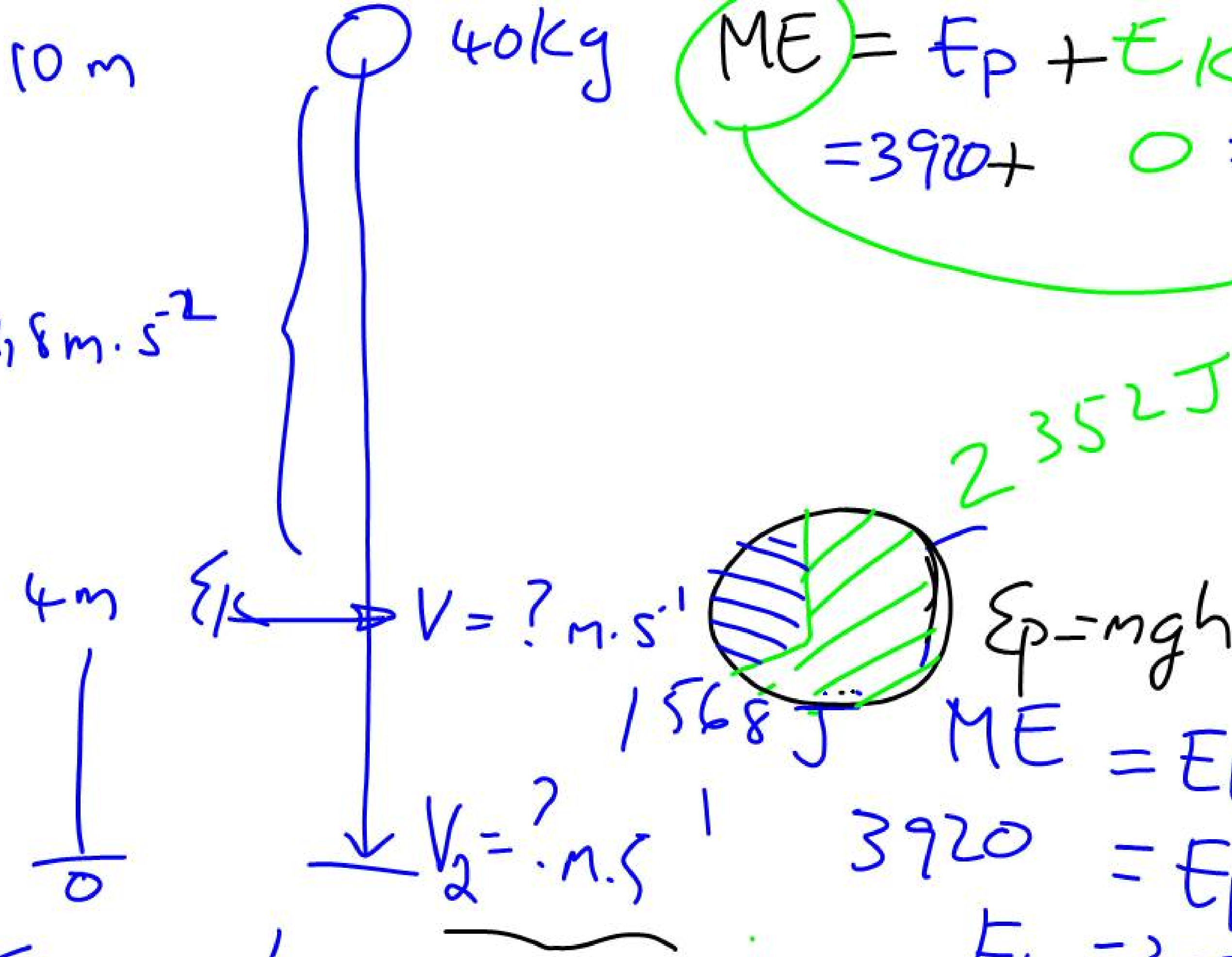
Top

$$ME = \mathcal{E}_p + \mathcal{E}_k = 1176 + 0 = 1176\ J$$

Bottom

$$ME = 1176 = \mathcal{E}_p + \mathcal{E}_k$$

$$1176 = 0 + \mathcal{E}_k$$



$g = 9{,}8\ m.s^{-2}$

$E_p = mgh$

$ME = E_p + E_k$

$= 3920 + 0 = 3920\ J$

$E_p = mgh = 40 \cdot 9{,}8 \cdot 4$

$= 1568\ J$

$ME = E_k + E_p$

$3920 = E_k + 1568$

$E_k = 3920 - 1568$

$= \underline{2352\ J}$

$E_k = 2352\,J$

$E_k = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2E_k}{m}}$

$= \sqrt{\frac{2(2352)}{40}}$

$= 10,84\ m \cdot s^{-1}$

Bottom

$v = \sqrt{\frac{2E_k}{m}}$

$= \sqrt{\frac{2 \times 3920}{40}}$

$= 14\ m \cdot s^{-1}$

Any height. $E_K = ME - E_P$

8A $E_K = \frac{1}{2} m v^2$ Kinetic Energy

E_K → Kinetic Energy → joules (J)

m → mass → kilograms (kg)

v → Velocity → meters per second (m/s)

8A) e.g. Calculate the energy possessed by a car travelling at 30 m/s If the car has a mass of 2500kg

$$E_K = \frac{1}{2} m v^2$$

$E_K = ?$ J

m = 2500

v = 30

STEP 1
FORMULA

STEP 2
SUBSTITUTION

STEP 3
Answer + unit

$$E_K = \frac{1}{2} \cdot m \cdot v^2$$

$$= \frac{1}{2} \times 2500 \times (30)^2$$

$$= 1125000 \text{ J}$$

Calculate the amount of energy Possessed by a ball of mass 500 g moving at 4 m/s.

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

change to kg

500g ÷ 1000

0,5kg

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

$= \frac{1}{2} \times 0,5 \times 4^2$

$= 4\ J$

Calculate the energy required to make a 6 kg object move 2 m.s⁻¹.

m/s

8A

$$E_K = \frac{1}{2} \cdot m \cdot v^2$$

$$= \frac{1}{2} \cdot 6 \cdot 2^2$$

$$= 12\ J$$

8A

Gravitational Potential Energy

E_p

$E_p = mgh$

Unit (joule)

(J)

$=$

3kg
3m

Calculate the energy gained by a stone of mass 3kg if its lifted 3m above the ground.

Calculate the Kinetic Energy of a marble of mass 500g rolling at a velocity of 2 m/s.

$E_k = ?\ J$

$m = 500g \div 1000 = 0{,}5kg$

$V = 2\ m/s$

$E_K = \frac{1}{2}mv^2$ ✓ ← FORMULA

$= \frac{1}{2}(0{,}5)(2)^2$ ✓

$= 1J$ ✓

Gravitational potential Energy (E_p)

$$E_p = mgh$$

E_p → Gravitational Potential Energy

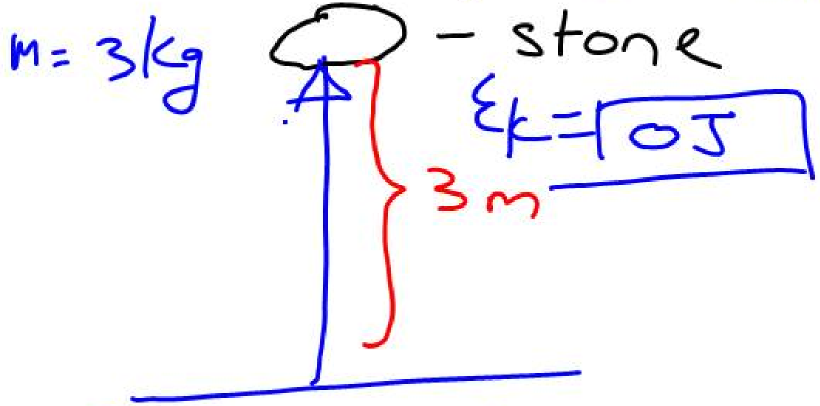
m → mass (kg)

h → height (m) above a given surface

g → acceleration due to gravity $= 9{,}8\ m/s^2$

Calculate the gravitational potential Energy gained by a stone of mass 3kg when it is lifted 3m from the ground.

$g = 9,8\ m/s^2$



$E_p = ?\ J$

$m = 3kg$

$g = 9.8\ m/s^2$

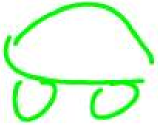
$E_p = m \cdot g \cdot h$

$= 3 \times 9,8 \times 3$

$= 88,2\ J$

8c) Kinetic Energy [Ek] or [KE]

$$E_k = \frac{1}{2} m v^2$$



120km/h

$E_k = ?$

4000kg

$$= \frac{1}{2}(4000)(33,3)^2$$

$$= 2217780 \text{ J}$$

120km/h

m/s

$$\frac{120\text{ km}}{1\text{ h}} = \frac{120000}{3600} = 33,3$$

3600

x60

x60

8c) What speed (velocity) is a car travelling at when it has Ek of 40 000J and a mass of 600kg?

$V = ?\ m/s$

$E_k = 40000J$

$m = 600kg$

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

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

$$E_k = \frac{1}{2} m v^2$$

$$\frac{2}{1} \times \frac{1}{2} m v^2 = E_k \times \frac{2}{1}$$

$$\frac{m v^2}{m} = \frac{2 \times E_k}{1 \quad m}$$

$$\sqrt{v^2} = \sqrt{\frac{2 \times E_k}{m}}$$

$$v = \sqrt{\frac{2 \cdot E_k}{m}}$$

$$=$$

$$V = I \times R$$

$$6 = 2 \times 3$$

$$V = I \cdot R$$

$$\frac{I \cdot R}{R} = \frac{V}{R}$$

$$I = \frac{V}{R}$$

$$2 = \frac{6}{3} \quad \frac{V}{R}$$

$$I = \frac{V}{R}$$

$$I = V \times R$$

$$I = \frac{R}{V}$$

$$V = IR$$

$$I \times R = V$$

$$R = \frac{V}{I}$$

$$V = u + at$$

$$at + u = V$$

$$a \times t = V - u$$

$$a = \frac{v - u}{t}$$

$$\frac{v-u}{t} = a$$

$$\frac{v-u}{a} = t \cdot a$$

$$\frac{v-u}{a} = t$$

$$t = \frac{v-u}{a}$$

$$a = \frac{F}{m}$$

$$\frac{F}{m} = a$$

$$F = m \times a$$

$m = ?$

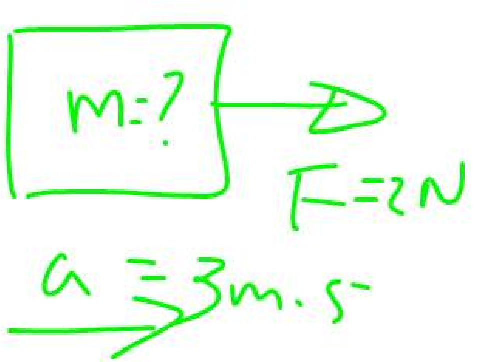
$a = 3\ m.s^{-2}$

$F = 2\ N$

$$a = \frac{F}{m}$$

$$m \times a = F$$

$$m = \frac{F}{a} = \frac{2}{3} = 0{,}67\ Kg$$



$$a = \frac{F}{m}$$

$$\frac{1}{a} = \frac{m}{F}$$

$$\frac{F}{a} = m$$

$$E_k = \frac{1}{2} m v^2$$

$$\frac{2}{1} \times \frac{1}{2} m \times v^2 = E_k$$

$$m \times v^2 = \frac{2}{1} E_k$$

$$m = \frac{2 E_k}{v^2}$$

$$\frac{2 \times 1}{1 \times 2}$$

$$\frac{2}{2} = 1$$

$$\frac{1}{2} m \times v^2 = E_k$$

$$\frac{1}{2} m = \frac{E_k}{v^2}$$

$$m = \frac{2}{1} \times \frac{E_k}{v^2}$$

Gravitational Energy, Potential Energy

It is important to know the difference between **potential energy** and **gravitational energy.**

Every object may have Potential energy but Gravitational energy is only stored in the height of the object. Any time that a heavy object is kept high up, a force or power is likely to be holding it up there. This is the reason why it stays up and does not fall. It is important to note that the heavier the object, the more its potential energy.

FORCE — mass

$F = mg$

1kg

mass 2kg

$\text{Weight} = m \cdot g$; g — 9,8 m/s²

$g = \dfrac{\text{Weight}}{\text{mass}} = \dfrac{9,8}{1\,kg} = 9,8$

acceleration due to gravity

$= \dfrac{19,6}{2\,kg} = 9,8$

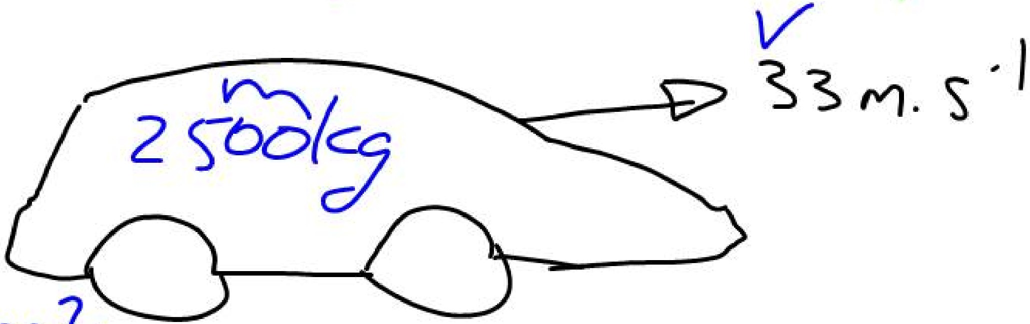
Kinetic Energy: $E_K = \frac{1}{2}mv^2$

E_K – Kinetic Energy (joule – J)

m – mass (kilogram – kg)

v – Velocity (m/s)

Calculate the Kinetic Energy Possessed by a car of mass 2 500kg traveling at a speed of 33 m/S



$E_k = ?$

$m = 2500 kg$

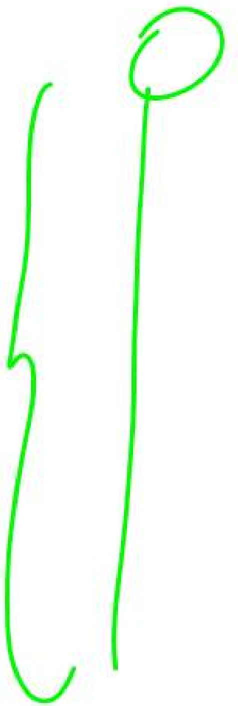
$v = 33 m/s$

$E_k = \frac{1}{2} m v^2$

$= \frac{1}{2} \times 2500 \times (33)^2$

$= 1\ 361250\ J$

3 kg $E_p = ?\ J$



3 m

$$E_p = mgh$$

$$= 3 \times 9{,}8 \times 3$$

$$= \underline{88{,}2\ J}$$

g → acceleration due to gravity ($9{,}8\ m/s^2$)

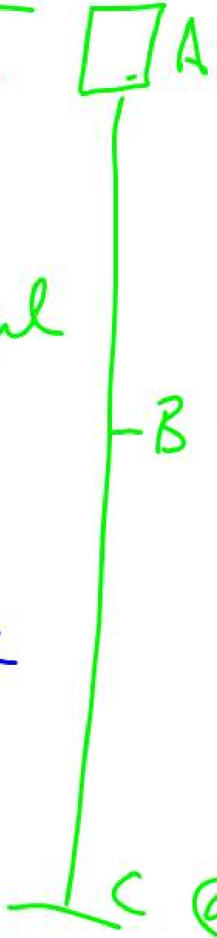
8A) Mechanical Energy → ME

$$ME = E_k + E_p$$

The sum of Kinetic Energy and Gravitational Potential Energy

In an isolated system (No external forces) The Mechanical Energy remains constant.

$E_p = 30J$



object standing still.

1) Calculate the mechanical Energy.

1) $ME = E_k + E_p$

$= 0J + 30J$

$ME = 30J.$

B half way

2) Work out E_p and E_k At point B (halfway)

$ME = 30J$

$30J = E_p + E_k$

$30J = 15J + 15J$

C @ bottom

$E_k = 30J$

$E_p = 0J$

$30 + 0 = 30J$ ME

Work

1. A force sets an object in motion. When the force is multiplied by the time of its application, we call the quantity ***impulse***, which changes the momentum of that object. What do we call the quantity ***force · displacement***, and what quantity does this change?

2. How much work is done in lifting a 300 Newton rock 10 meters off the ground?

3,000 J

3. A force of 200 Newtons is needed in order to push a wheelbarrow that weighs 1000 Newtons. If the wheelbarrow is pushed 30 meters, how much work is done on the wheelbarrow? What power is required if it takes 10 seconds to push the wheelbarrow?

6,000 J *600 W*

4. Work is required to lift a barbell. How many times more work is required to lift the barbell three times high?

5. Which, if either, requires more work, lifting a 10 kg load a vertical distance of 2 m or lifting a 5 kg load a vertical distance of 4 m?

6. 100 joules of work are done on an object when a force of 10 N pushes it. How far is the object pushed? What power is used if this is done in 4 seconds? *10 m* *25 W*

7. Calculate the work done when a 20 N force pushes a cart 3.5 m in 0.5 s. Calculate the power.

70 J *140 W*

KE & PE

8. What are the two main components of mechanical energy?

9. **(a)** Calculate the kinetic energy of a 3.1 kg toy cart that moves at 4.8 m/s. **(b)** Calculate the kinetic energy of the same cart at twice the speed. *36 J* *140 J*

10. Suppose an automobile has 20,000 J of kinetic energy. When it moves at twice the speed, what will be its kinetic energy? What's its kinetic energy at three times the speed? *80,000 J* *180,000 J*

11. If a mouse and an elephant both run with the same kinetic energy, can you say which is running faster? Explain in terms of the equation for KE.

12. A hammer falls off a rooftop and strikes the ground with a certain KE. If it fell from a roof that was four times higher, how would its KE of impact compare? How much faster would it be moving just before impact? (Neglect air resistance.)

13. **(a)** If you do 100 J of work to elevate a bucket of water, what is its gravitational potential energy relative to the starting position? **(b)** What would the gravitational potential energy be if the bucket were raised twice as high? **(c)** How much work would the bucket do on its surroundings as it fell back to its starting position?

14. Calculate the change in potential energy of 8,000,000 kg of water dropping 50.0 m over Niagara Falls. *4,000,000,000 J*

15. A 35 kg chair is lifted 5 m off the ground. What is its potential energy?