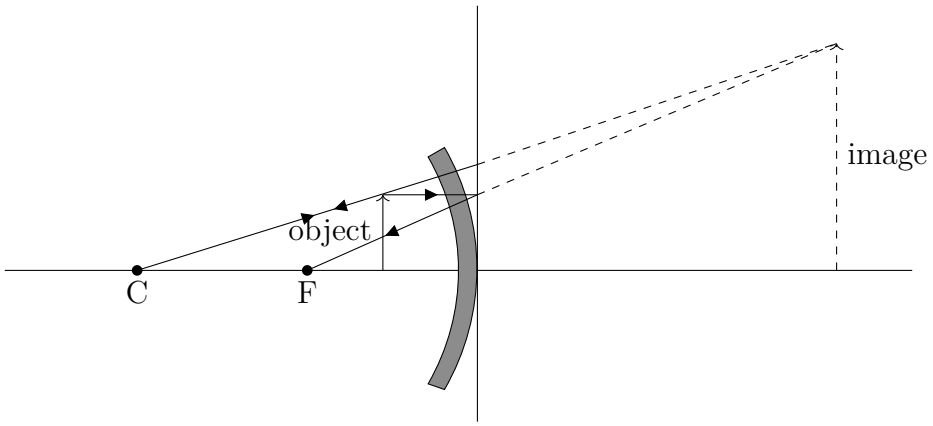
RARE PHYSICS

Item 1

The mirror A is a concave mirror. While standing close the mirror, the person stands between the principal focus and the pole of the mirror. The image formed in always virtual, upright and magnified.



from

$$v = \frac{2d}{t}$$

d is the distance between the Kyle and his neighbor's wall. $d = 60 + 8 + y$

$$330 = \frac{2(60 + 8 + y)}{0.5}$$

$$330 \times 0.5 = (2 \times 60) + (2 \times 8) + (2 \times y)$$

$$165 = 120 + 16 + 2y$$

$$165 - 136 = 2y$$

$$29 = 2y$$

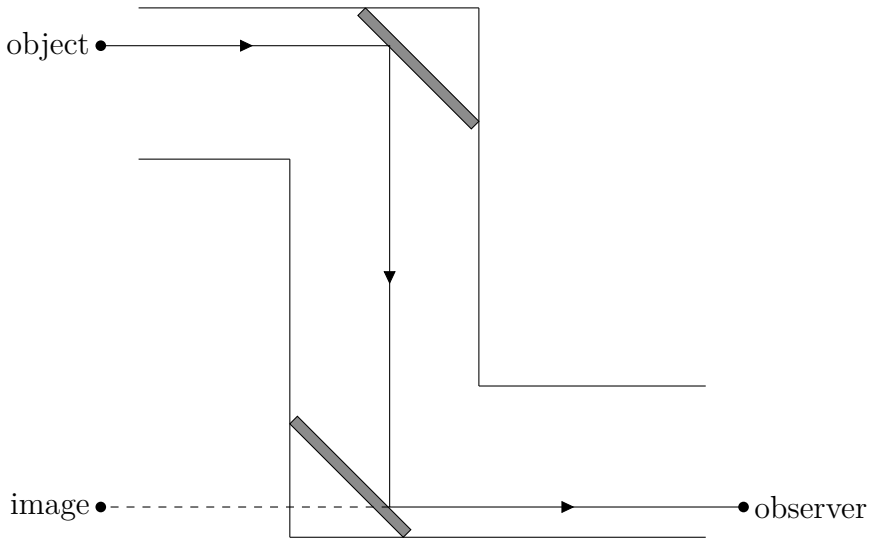
$$y = \frac{29}{2}$$

$$y = 14.5m$$

Kyle's wall is 14.5m away from the road which is greater 10m hence his wall won't be broken down.

mirror B is a plane mirror. The optical instruments to design is a periscope. This can view over the top of the wall keeping Kyle out of view.

In order to design a periscope, Kyle should fix the two plane mirrors inside a tube with their reflecting surfaces facing each other inclined at angles of 45^o to the line joining them .



Light from the object is reflected by the first mirror downwards to the second mirror. On entering the observer's eye, he sees a virtual image of the object.

Item 2

Radioactive materials emit radiations such as alpha particles, beta particles and gamma rays which are dangerous to human life in various ways; They
cause genetic mutations
cause skin burns
damage body cells
affect eye sight

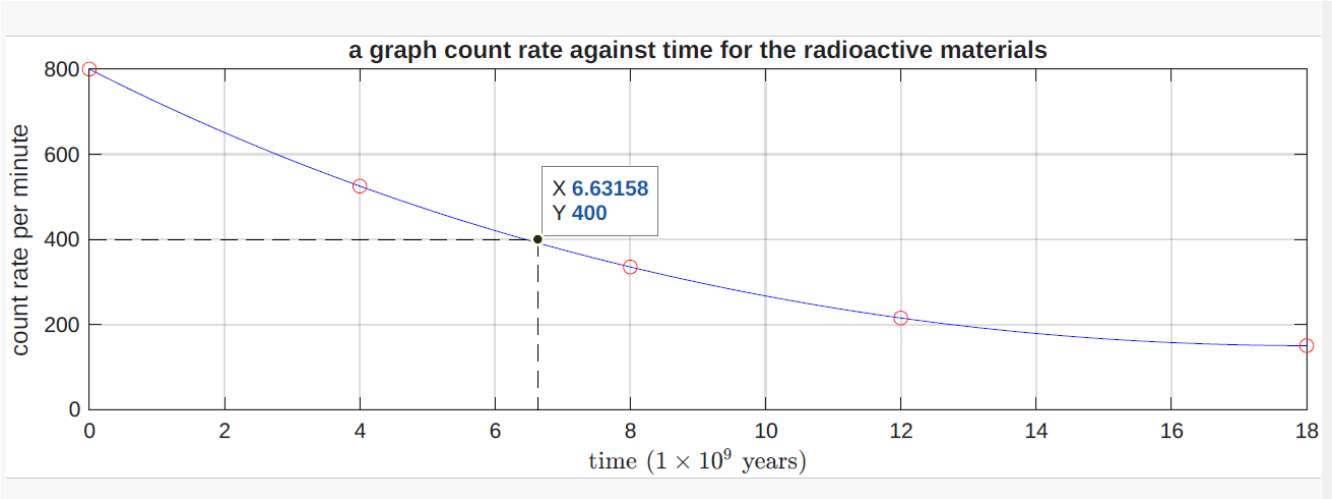


Figure 1

$halflife = 6.6 \times 10^9$ years
from

$$\frac{A_o}{A} = 2^{\frac{t}{t_{\frac{1}{2}}}}$$

$$\frac{800}{35} = 2^{\frac{t}{6.6\times10^9}}$$

$$22.86 = 2^{\frac{t}{6.6\times10^9}}$$
$$log22.86 = \frac{t}{6.6 \times 10^9} log2$$
$$\frac{log22.86}{log2} = \frac{t}{6.6 \times 10^9}$$
$$\frac{1.359}{0.301} = \frac{t}{6.6 \times 10^9}$$
$$4.5 = \frac{1}{6.6 \times 10^9}$$
$$t = 4.5 \times 6.6 \times 10^9$$
$$t = 29.7 \times 10^9 years$$

The community members will settle around the power plant when time goes beyond 29.7×10^9 years

Radioactive materials are used in detecting leakages in underground pipes. The radioactive material is dissolved in the liquid flowing through the pipe at the source and traced over the ground. A high count rate shows the area where the leakage is.

Radioactive materials are used in estimating the thickness of paper. A source of beta particles is placed in front of the sample paper and a detector connected to a counter behind it. The higher the count rate,the thinner the paper.

Other applications include; carbon dating, sterilizing medical equipment, detecting brain tumors, smoke detectors

Item 3
The rise and fall of water levels in the ocean is known as ocean tides. These are mainly caused by the gravitational pull the moon exerts on the earth. The rise in water levels which the sailor saw are known as high ocean tides. These occur in areas that are closest to the moon and the areas that are furthest from the moon.

The application works with help of the GPS. This works with help of navigation satellites and a receiver in the phone.
The receiver is always in site of at least 4 satellites. The satellites continuously send signals carrying information on the accurate time at which the signal has been sent from the satellite and the precise location of the satellite.
The receiver calculates the duration between the arrival time of the signal and the time at which it was sent from the satellite.
It then calculates the distance between itself and the satellite. Using the distances from all the satellites, the receiver is able to find its location.

During night the light intensity reduces, the resistance of the LDR increases. The pd across it increases. The input, A of the not get is high(1) and the output B is low. The LED is on when the input is low(0).

During day, the light intensity is high. The resistance of the LDR is low. The pd across it is high. The input A of the not gate is low(0) and the output is high(1). The LED is off when the output is high(1).

Water from the ocean floods low lying coastal areas. This creates salt pans where sea water can be stored. This is used in the manufacturing of salts and other economic activities.
The water can be used in the production of tidal energy which is a clean source of electricity.

Item 4
The noise is due to friction force between parts of the bicycle that rub against each other as it moves. The work done in overcoming the friction force is converted into heat and sound energy thus the noise.
This can be reduced by lubricating the rotating parts of the bicycle.

distance = average velocity × time

remaining distance = 10 - 6 = 4km
for the remaining 4 km,
u = 5, v = 15 ms^{-1}
4km=6×1000 = 4000 m.
$4000 = \frac{5+15}{2} \times t$
4000=10t
t=$\frac{4000}{10}$=400 seconds
The rate of change of velocity is acceleration.

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

$$a = \frac{15-5}{400} = 0.025ms^{-1}$$

His rate of change of velocity was 0.025 ms^{-1}.

Figure 2

The vacuum minimizes heat losses by convection and conduction since its lacks a medium of heat transfer.
The silvered walls minimize heat losses by radiation since it reflects heat back into the liquid
The stoppers minimize heat loss by conduction since they are insulators.

Radiation is applied in car radiators while cooling the engine. The radiator is designed in such a way that it easily gives away heat via radiation.
Convection is applied in water heaters. The heater is placed at the bottom of the tank so that when water is heated, the hot less dense water at the bottom rises and is replaced by the cold denser water. The convectional currents heats up the whole water.
Conduction is applied in cooking of food. The saucepans are made from good conducting materials such that when heated, they easily transfer heat to the food being cooked.

Item 5
The pressure in liquids increases with depth. At the top of the dam the pressure is a low thus a thin wall can withstand it. As depth increases, the pressure increases thus the thickness of the walls is increased depending on depth to withstand the high pressure.

$$Young's\ modulus = \frac{stress}{strain}$$

$$stress = \frac{force}{cross\ sectional\ area}$$

$$area = \pi r^2$$

$$= 3.14 \times (\frac{2.5 \times 10^{-2}}{2})^2$$

$$= 3.14 \times 1.25 \times (10^{-2})^2$$

$$= 3.14 \times 1.5625 \times 10^{-4}$$

$$4.91 \times 10^{-4} m^2$$

$$stress = \frac{7.7 \times 10^5}{4.91 \times 10^{-4}}$$
$$= 1.57 \times 10^9 Pa$$
$$strain = \frac{extension}{originallength}$$
$$= \frac{0.2 \times 10^{-4}}{3.2}$$
$$= 6.25 \times 10^{-6}$$
$$young's\ modulus = \frac{4.91 \times 10^9}{6.25 \times 10^{-6}}$$
$$= 7.86 \times 10^{15} Pa$$

The stress to strain ratio is 7.86×10^{15} which exceeds 2.1×10^{11} hence the steel bars are of good material.

What they experienced was a sea breeze. It occurs during day. The sun heats up the land faster than the sea water. The air above the ground expands and becomes less denser that the air above. This rises and is replaced by the cool more denser air from above the sea. This also replaced by the air above hence the land breeze.
The sea breeze regulates temperature on sea shores during day. Houses ventilation systems are designed while considering the breeze.
The sea breeze can be used to run wind mills hence generating power. The winds are arranged in such a way that they can be run by the breeze.

Item 6
The business man needs a step-up transformer. It has more turns on the secondary winding than the primary windings.

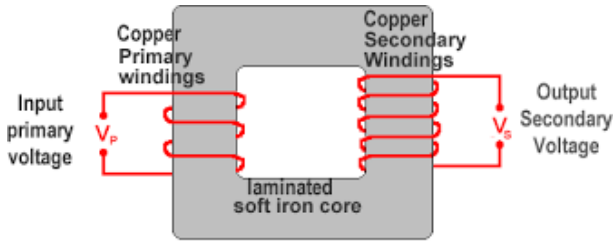


Figure 3

The transformer works on the principal of mutual induction.
The alternating voltage to be stepped- up is applied to the primary coil. This causes an alternating current to flow the the primary coil that produces a varying magnetic flux that links the secondary coil. This produces an alternating voltage in the secondary coil whose value depends on the turn ratio and the primary voltage.

2kW = 2×1000W. from
$$P = IV$$
$$2000 = 2000I$$

$$I = \frac{2000}{2000}$$
$$I = 1A$$

The power lost during transmission is dissipated as heat in the wires; from

$$P = I^2R$$

$$P = 1^2 \times 2$$

$$P = 2W$$

The power loss is 2W which is less than 5W thus the machine is efficient.

The power losses in the transformer can be minimized by;
Using thick copper wires to minimize energy losses in form of heat due to current in the coils of wire.
laminating the iron core to minimize energy losses that arise from the heating effect of eddy currents.
Winding the secondary coil on top of the primary coil to minimize energy losses due to some of the magnetic flux from the primary coil not linking the secondary coil.
Using soft iron core to minimize energy losses due to hysteresis.

Item 7
the missing components include;
Fuses, transformer, rectifier, switches
Fuse: It controls the amount of current reaching the electrical component. When it exceeds a certain value, it heats up and melts thus breaking the circuit thus protecting the electrical component.
Step-down transformer: This steps down the voltage to that which is required by the component.
Rectifier: This changes alternating current to direct current.
Switch. This controls current flow thus switching on or off the electrical device.

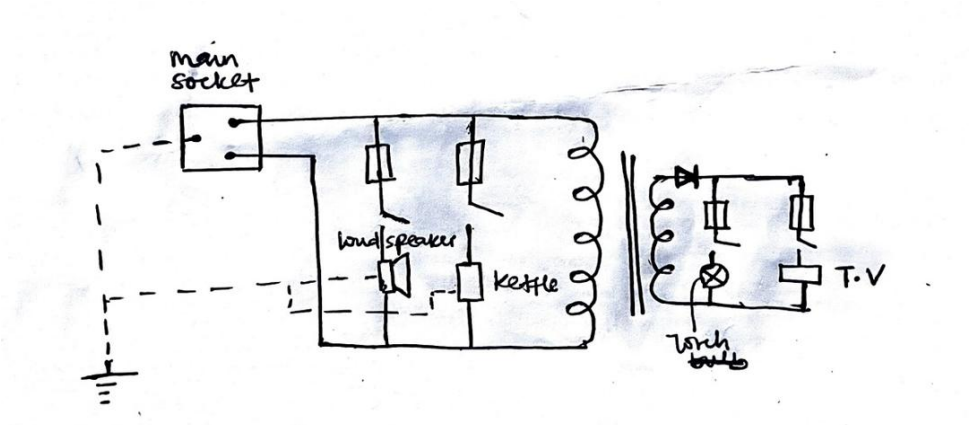


Figure 4

$$Cost\ of\ electicity = number\ of\ units \times unit\ cost$$

$$number\ of\ units = Power(KW) \times time(hours)$$

$$= 1 \times 10 \times 7$$

$$= 70\ units$$

$$Cost\ of\ electicity = 70 \times 600$$

$$= shs.41000$$

The business needs shs.41000 to operate the loudspeaker.

Minimizing energy losses.
Switch off the appliances from the wall. The appliances still use some power when not turned off form the wall
While cooking water in the kettle, cook only the required amount at a time. Cooking a lot of water consumes more power yet its not needed.
Ensure that the appliances are in good mechanical condition. If not then they should be repaired.
Using more efficient devices that do save the electricity yet they can also do the required work.