"What one man calls God, another calls the laws of physics."

-Nikola Tesla

TOPIC 19: PRACTICAL ELECTRICITY

THE ABOUT

CHAPTER ANALYSIS

TIME

- Last chapter of electricity
- Focuses more on real-life applications of electricity
- Some form of calculations related to **P =VI**

EXAM

- Will always be tested
- Important to be able to articulate how certain features help protect users from dangers of electricity

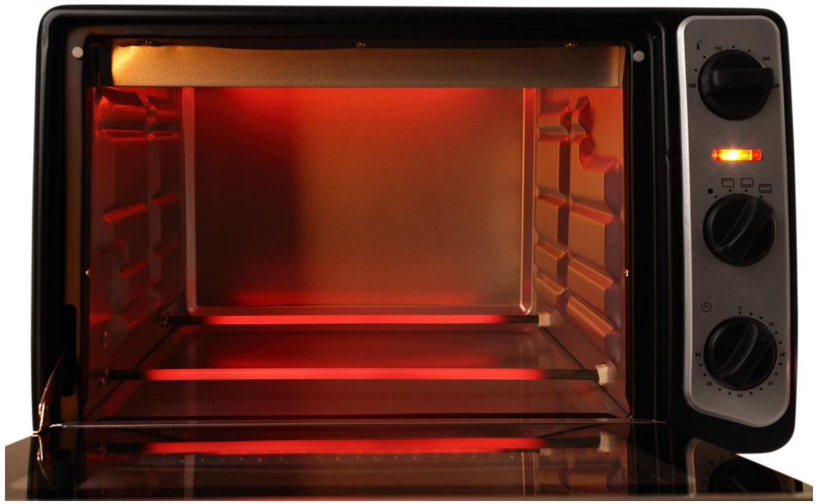
WEIGHTAGE

- Light-medium overall weightage
- Constitute to around **4%** of marks for past 5 year papers

KEY CONCEPT

HEATING EFFECT OF ELECTRICITY
APPLICATIONS

HEATING EFFECT OF ELECTRICITY



Nichrome is commonly used in ovens as well!

HEATING EFFECT

When current flows through a circuit, it may create a heating effect due to the resistance of the components.

Heating element are usually made of nichrome wire coiled around an insulating fireproof material.

Nichrome is the most commonly used due to:

- high resistance, therefore heats up quickly
- high melting point
- does not oxidise or rust easily

APPLICATION

Electric Kettle

The heating element is enclosed in a metal tube and when a current flows through the heating element, the water around the element is heated by conduction and thermal energy is then transferred throughout the fluid by convection.

Electric Iron

Thermal energy produced is spread evenly over a large metal base which conducts thermal energy well.

Electric irons usually contain a thermostat which switches the current off when it gets too hot and switches it back on when the iron cools below selected temperature.

KEY CONCEPT

ENERGY SOURCES
ELECTRICAL POWER
ELECTRICITY CONSUMPTION

SUMMARY TABLE

ENERGY SOURCES

	Renewable Energy		Non-Renewable Energy	
	Pros	**Cons**	**Pros**	**Cons**
Solar Energy	Harnessing free energy. Does not produce greenhouse gas.	Solar panels are still rather expensive and inefficient.		
Wind Energy	Harnessing free energy. Does not produce greenhouse gas.	Wind farms take up a lot of land and is inefficient.		
Hydroelectric Energy	Harnessing free energy. Does not produce greenhouse gas.	Affects aquatic life. May cause flooding downstream.		
Fossil Fuels			Cheaper.	Fossil fuels produce large amount of greenhouse gas. Air pollution due to ash.
Nuclear Energy			Does not produce greenhouse gas.	Nuclear waste is hard to store.

ELECTRICAL POWER

When we buy light bulbs, there's usually a rating like **'230V, 40W'.**

This means that the light bulb has a potential difference of 230V. Each charge is required to 'deposit' 230 J of electrical energy to go across the component.

The 40W means that for the light bulb to produce light, 40 J of electrical energy is used per second.

If we apply **P = VI**, we can then derive that for the light bulb to operate, it needs to draw a current of 0.17A.

(Since each charge brings 230J while only 40J is consumed each second, only 0.17 charge needs to flow per second.)
(Recall rate of flow of charges is known as current.)

ELECTRICAL POWER

Electrical power is defined as the rate at which electrical energy is converted to other forms of energy due to the circuit components.

Units: **Watts (W)**

$$P = E / t$$

Where,
P = Power
E = Energy converted
t = time

In 'current electricity', we learnt that

$$V = E / Q$$
$$E = VQ$$

If we combine the 2 formulas,

$$P = VQ / t$$

Current is charge over time, I = Q / t

Hence,

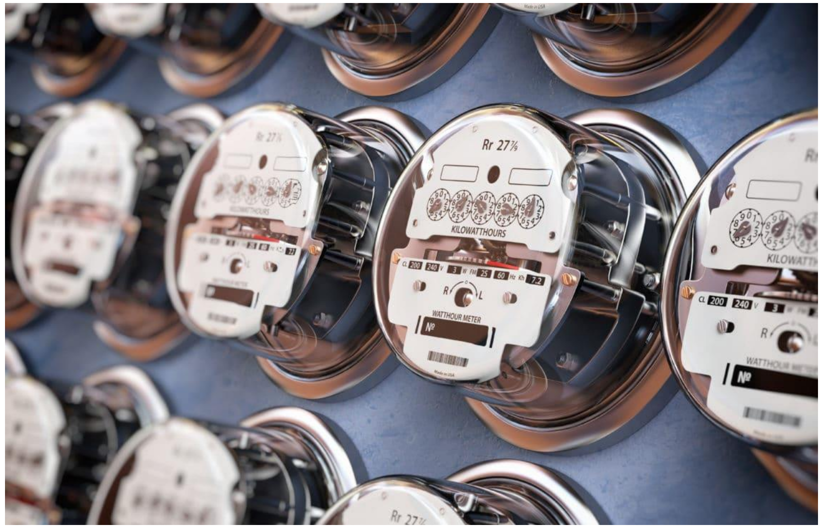
$$P = VI$$

If we sub in V = RI, we can also get,

$$P = I^2R$$

$$P = V^2 / R$$

ELECTRICITY CONSUMPTION



How much will the cost be if you uses a 3500W air-con for 30 days straight every night for 8 hours?

The cost is 25 cents per kWh.

Total electricity consumed = 3.5kW x 8 x 30
= 840kWh

Total cost = 840 x 0.25
= $210

(You are an expensive kid. RIP electricity bills)

ELECTRICITY CONSUMPTION

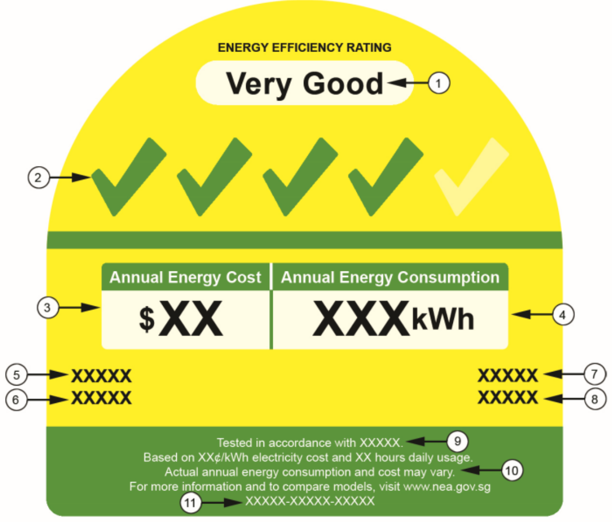
Joule or even kilo-Joules are too small units to measure electricity consumption.

Hence the electricity consumption is measured in terms of **kilowatt-hour (kWh)**.

Energy used = Power x Time
1kWh = 1kW x 1 hour
= 1000W x 3600s
= 3 600 000 J
= 3.6 MJ

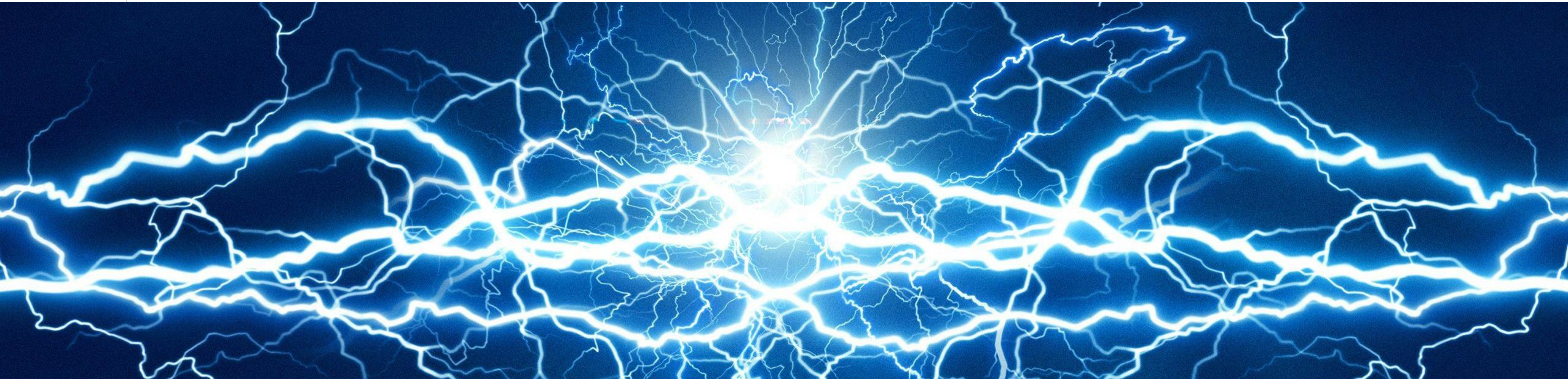
So technically, 1kWh is 3.6 MJ.

(1) Energy Efficiency Rating
(2) Ticks
(3) Annual Energy Cost
(4) Annual Energy Consumption (kWh)
(5) Brand name
(6) Model
(7) Type
(8) Size
(9) Test Standards
(10) Disclaimer
(11) Registration Number



KEY CONCEPT

DANGERS OF ELECTRICITY
SAFE USE OF ELECTRICITY
EARTH WIRE



SUMMARY TABLE

DANGERS OF ELECTRICITY

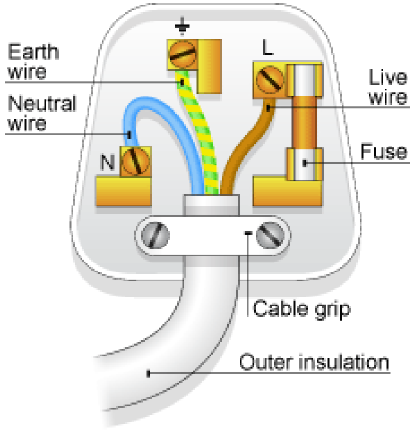
Dangers	Effects
Damaged insulation	○ due to wear and tear ○ metal casing may become live ○ exposed live wire can cause an **electric shock** if someone touches it ○ may result in **short circuit** between the live and neutral wires, causing a surge in current and a **fire**
Overheating of cables	○ **thinner wires may be cheaper but have a higher resistance,** producing more heat → can catch fire if current flow is high (i.e. when used for appliances which require high power) ○ **overloading outlets** (i.e. usage of extension cords and adaptors) increases current drawn from the mains, heating up the wires, causing a **fire**
Damp conditions	○ minerals in skin dissolve in water, becoming an electrical conductor ○ water lowers resistance of human skin, causing electrocution ○ dry skin has a resistance of 100 000Ω or more, while wet skin can have a resistance of as low as a few hundred ohms

SUMMARY TABLE

SAFE USE OF ELECTRICITY

Safe Use	Effects
Three pin plug	Three wires: **Live** wire (**brown**) - 230V **Neutral** wire (**blue**) - 0V **Earth** wire (**green & yellow stripes**) - 0V ○ only needed when appliance has a **metal casing** ○ connects outer metal casing to the ground ○ **prevents electric shock** in case the live wire touches the metal case - **providing a path for charges to travel from the metal casing to the ground**
Double insulation	○ **two layers of electrical insulation,** to prevent current carrying wire & metal parts from being in contact with users. ○ **two pin plug** with only the live and neutral wire. Casing is usually made of insulators like plastic.
Switch (Always on live wire.)	○ connected to **live wire** so it can be disconnected when the switch is open ○ if the switch is placed on the neutral wire, the appliance will still be at high voltage even if the switch is open since it is still connected to the live wire → large current will flow through the person
Fuse (Always on live wire.)	○ A safety device made of metal strips which melts when too big a current flows through it. When **current slightly above fuse rating** passes through, fuse **melts and breaks** the circuit. ○ Protects circuit components & users. Always on **live wire.** ○ Common Fuse rating : 3.0A, 5.0A, 10.0A, 13.0A
Circuit breaker (Always on live wire.)	○ An automatic switch that can be found in your household electrical box. **Can be switched back** on unlike fuse which needs to be replaced once activated. ○ some modern consumer units have a main switch known as the **earth leakage circuit breaker (ELCB)** which will disconnect all circuits in the house from the mains if an earth leakage occurs. ○ most modern units contain **miniature circuit breakers (MCB)** which control separate circuits in the house. When current is too high, a fault is detected, MCBs will switch off (tripped).

IMPORTANCE OF EARTH WIRE



Live wire (**brown**) - 230V
Neutral wire (**blue**) - 0V
Earth wire (**green & yellow stripes**) - 0V

Memorising tips:

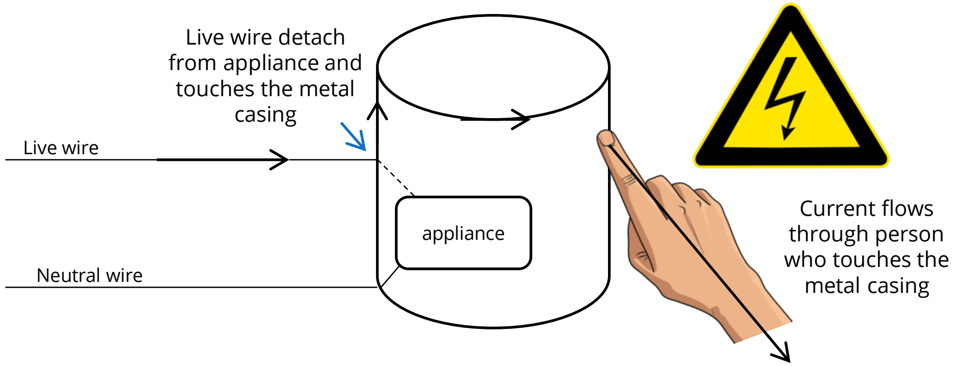
Life is like shit (brown)
Water is neutral (blue)
Earth is soil (green & yellow)

WIRING IN ELECTRICAL SYSTEMS

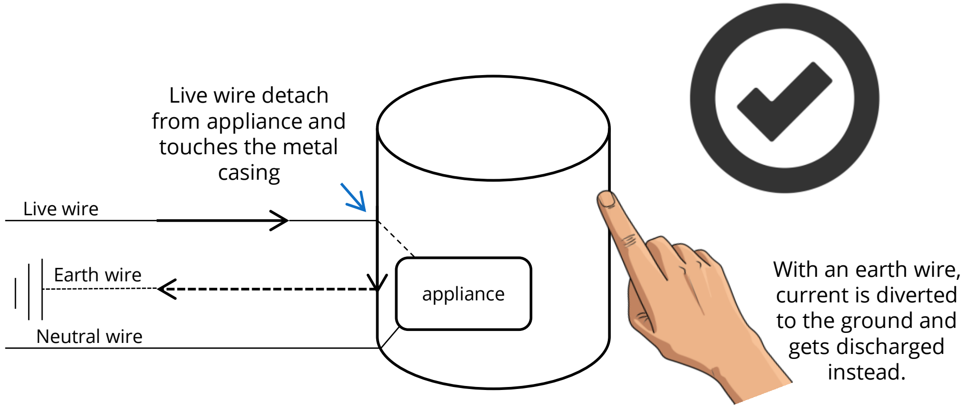
Live wire is always at high voltage as it draws current from the socket at high voltage.

Neutral wire is at zero voltage as the components would have used up the electrical energy.

Without Earth wire:



With Earth wire:



OVERMUGGED

By Tutors, For Students

For more notes & learning materials, visit:
www.overmugged.com

IG handle:
@overmugged

Join our telegram channel:
@overmugged

'O' levels crash course program

Professionally designed crash course to help you get a **condensed revision** before your 'O' Levels!

The **4 hour session** focuses on going through **key concepts** and **identifying commonly tested questions!**

Our **specialist tutors** will also impart valuable **exam pointers and tips** to help you maximise your preparation and ace your upcoming national exam!

The crash courses will begin in **June 2021 and last till Oct 2021**.

Pre-register now on our website and secure your slots!

Need help?

Darrell Er
(Private tutor with **8 years** of experience)

8777 0921
(Whatsapp)

@DarrellEr
(telegram username)