

Transformer Turns Ratio Formula:

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Rearranged Forms:

$$V_s = V_p \times \frac{N_s}{N_p} \quad \left| \quad N_p = N_s \times \frac{V_p}{V_s} \quad \left| \quad N_s = N_p \times \frac{V_s}{V_p} \right. \right.$$

Variables & Units:

V_p : Primary voltage (Volts, V) V_s : Secondary voltage (Volts, V)

N_p : Primary turns (no unit symbol) N_s : Secondary turns (no unit symbol)

Section A: Formula Recall & Unit Conversions

1. State the correct SI unit and symbol (if applicable) for each variable in the transformer turns ratio formula:

- a) Primary voltage (V_p): _____
- b) Secondary voltage (V_s): _____
- c) Primary turns (N_p): _____
- d) Secondary turns (N_s): _____

2. Rearrange the transformer turns ratio formula $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ to make each of the following the subject:

- a) Secondary voltage (V_s): _____
- b) Primary turns (N_p): _____
- c) Secondary turns (N_s): _____

3. Perform the following unit conversions, which are common in transformer calculations:

- a) Convert 0.4 kV to V: _____
- b) Convert 250 mV to V: _____
- c) Convert 15000 V to kV: _____
- d) Convert 0.002 kV to V: _____

Section B: Transformer Calculations

4. Solve the following problems using the transformer turns ratio formula. Show your working clearly, including the equation used and unit conversions where necessary.

- a) A step-down transformer has a primary voltage of 230 V and 1000 turns on its primary coil. If the secondary coil has 50 turns, calculate the secondary voltage.

- b) A step-up transformer is designed to convert 12 V to 240 V. If the primary coil has 60 turns, how many turns must the secondary coil have?

- c) A transformer has 800 turns on its primary coil and 40 turns on its secondary coil. If the secondary voltage is 6 V, what is the primary voltage?

- d) A transformer is used to step down a voltage from 400 V to 20 V. If the secondary coil has 150 turns, calculate the number of turns on the primary coil.

Section C: Application & Challenge

5. Consider a transformer used in a phone charger, which steps down the mains voltage.

- a) The primary coil of the charger's transformer is connected to the 230 V mains supply and has 4600 turns. The secondary coil provides 5 V to the phone. Calculate the number of turns on the secondary coil. If the charger delivers 2.0 A to the phone, calculate the power delivered to the phone.

- b) Explain why step-up transformers are used at power stations for long-distance electricity transmission. In your answer, refer to the transformer turns ratio, current, and power loss.
