

Rms values, transformers and power lines

Physics grades 11-12 (A Level · IB · Class 11-12) · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to convert between peak and rms values, calculate mean power, apply the turns-ratio equation and work out the losses in transmission lines. They progress from single substitutions to full grid-design calculations.

They suit A Level, IB Physics, CBSE Class 12 and WAEC senior students. Treat transformers as ideal unless an efficiency is given.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.7.5

Problem 1 Peak from rms (easy)

Diego in Texas uses a 120 V rms outlet.

1. Calculate the peak voltage of the supply.

Problem 2 Rms current (easy)

The peak current in an ac circuit is 4.2 A.

1. Calculate the rms current.

Problem 3 Period and frequency (easy)

UK mains alternates at 50 Hz and Texas mains at 60 Hz.

1. Calculate the period of each in milliseconds.

Problem 4 Stove ring current (easy)

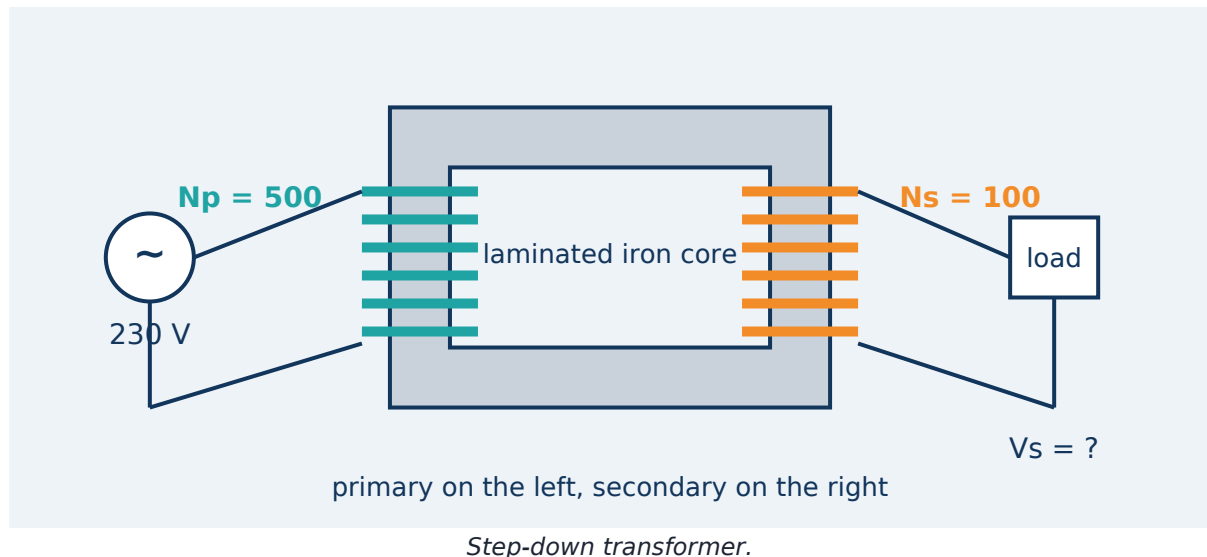
An electric stove ring in Kano, Nigeria, is rated 2.3 kW at 230 V rms.

1. Calculate the rms current.
2. Calculate the resistance of the ring.

Problem 5 Secondary voltage (easy)

The diagram shows a transformer with 500 primary turns and 100 secondary turns.

1. Calculate the secondary voltage when the primary is connected to 230 V rms.



Problem 6 Meaning of rms (easy)

Explain in your own words why the mean of an alternating voltage is not used to describe it, and what the rms value tells you instead.

Problem 7 High-voltage line data (easy)

A line carries 120 A at 11 kV.

1. Convert 11 kV to volts.
2. Calculate the power carried, assuming the voltage and current are in phase.

Problem 8 Currents in a transformer (medium)

An ideal transformer steps 230 V down to 12 V and supplies a 36 W load.

1. Calculate the secondary current.
2. Calculate the primary current.

Problem 9 Efficiency (medium)

A transformer takes 80 W from the supply and delivers 72 W to its load.

1. Calculate its efficiency.
2. Calculate the energy wasted in one hour.

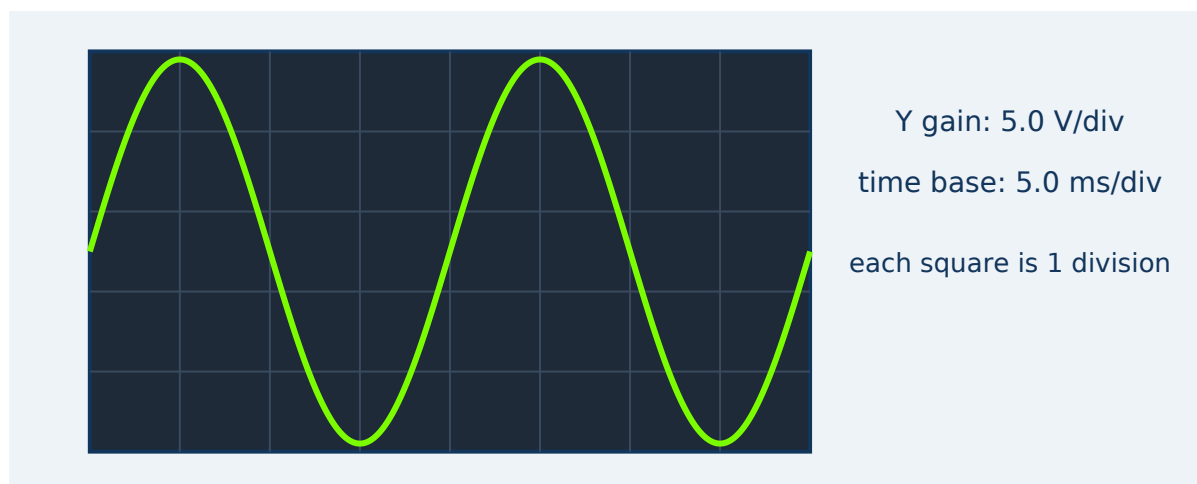
Problem 10 Loss in a village cable (medium)

Kofi in Accra sends 100 kW along a cable of resistance 5.0 Ω .

1. Calculate the current and power loss at 2.0 kV.
2. Calculate the same quantities at 20 kV.
3. Express each loss as a percentage of the power sent.

Problem 11 Oscilloscope trace (medium)

The oscilloscope trace shows an alternating voltage.



Oscilloscope trace of an alternating voltage.

1. Read the peak voltage.
2. Read the period and calculate the frequency.
3. Calculate the rms voltage.

Problem 12 Power in a resistor (medium)

A $40\ \Omega$ resistor is connected to an ac supply of peak voltage 30 V.

1. Calculate the rms voltage.
2. Calculate the mean power.
3. Calculate the peak power and explain why it differs from the mean.

Problem 13 Why high voltage? (medium)

Mei in Singapore asks why power stations send electricity at hundreds of kilovolts, when homes use 230 V.

1. Explain the advantage using $P = VI$ and $P = I^2R$.
2. Explain why transformers are needed.

Problem 14 Laminated core (medium)

A transformer core is built from stacked thin iron sheets separated by insulating varnish.

1. Explain why a solid iron block would waste more energy.
2. State why the core is made of soft iron.

Problem 15 Ac and dc heaters (medium)

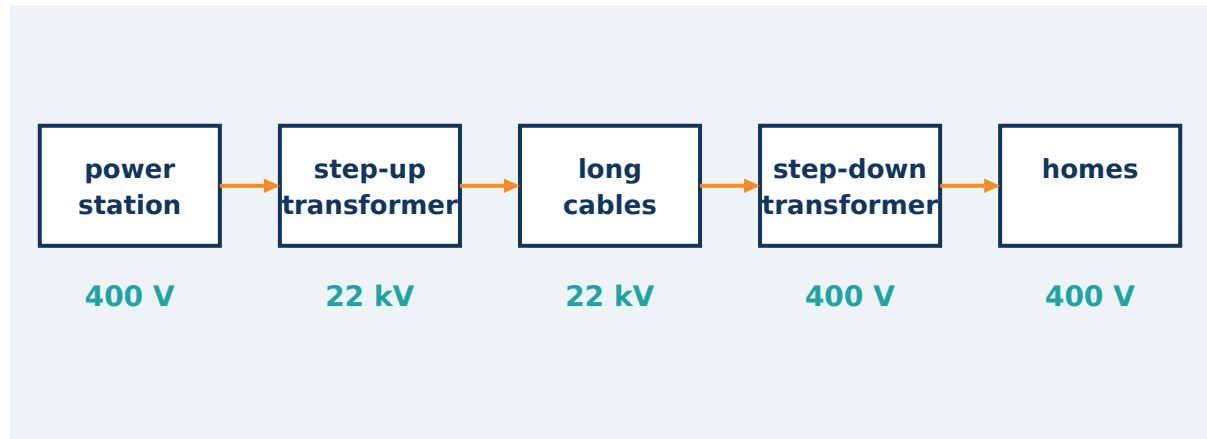
A heater connected to a 230 V dc supply produces 1.0 kW.

1. Calculate the power when it is connected to a 230 V rms ac supply.
2. Calculate the peak voltage of that ac supply.

3. Explain why the answers to parts 1 and 2 are consistent.

Problem 16 Village supply (hard)

A generator produces 440 kW at 400 V. A step-up transformer raises the voltage to 22 kV for a cable of total resistance 8.0Ω to the village, where a step-down transformer restores 400 V. Assume ideal transformers.



Village supply with a step-up transformer, a cable and a step-down transformer.

1. Calculate the current in the cable.
2. Calculate the power lost in the cable.
3. Calculate the voltage drop along the cable.
4. Calculate the percentage of the power that reaches the village.

Problem 17 Real transformer (hard)

A transformer with an efficiency of 92 % converts 230 V to 24 V and supplies a 60 W resistive load.

1. Calculate the secondary current.
2. Calculate the input power.
3. Calculate the primary current.

Problem 18 Instantaneous mains voltage (hard)

A mains supply has $V = 325 \sin(100\pi t)$, where V is in volts and t in seconds.

1. State the peak voltage and the frequency.
2. Calculate V at $t = 4.0$ ms.
3. Calculate the first time after $t = 0$ at which V reaches 230 V.

Problem 19 National grid design (hard)

A power station produces 200 MW at 25 kV. A 150 km line has a total resistance of 12Ω .

1. Calculate the line current and the power loss if the power is sent at 400 kV.
2. Calculate the line current and the power loss if it were sent at 25 kV, and comment.
3. State the power loss at 400 kV as a percentage of the power sent.

Problem 20 Spot the errors (hard)

A student writes: "A 100 W lamp runs on 230 V rms, so the peak current is $100/230 = 0.43$ A." Another says: "A transformer with 920 primary turns changes 230 V to 12 V, so $N_s = 920 \times 230/12 = 17\,600$ turns."

1. Identify and correct the first mistake.
2. Identify and correct the second mistake.
3. State a quick check that would have caught the second.