Transformers: turns and alternating voltage

Student activity • demonstration and reasoning

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The question

How does changing secondary turns affect an alternating output voltage?

Observe a staff-operated educational transformer at low voltage, then apply the idea to power transmission.

Equipment

- Staff rated transformer kit: 200-turn primary; 100, 200 and 400-turn secondaries; laminated core
- Isolated current-limited a.c. source and two RMS a.c. voltmeters
- Booklet and calculator

Staff operation only. No mains-connected coils, high-turn secondaries or d.c. connection. Secure the core against falling and pinching. Switch off before changes; stop on warming or unexpected readings. Keep input at 2.0 V RMS, output below 6 V RMS and current at or below 0.10 A and manufacturer ratings.

Course coverage: Physics only: 6.17P–6.18P. Transformer structure and transmission applications.

Plan, model or apparatus sketch

Draw labelled coils, field directions, motion and circuit connections as relevant.

Method and reasoning

Read the whole sequence before starting

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1. Staff assemble rated educational coils on a secured laminated iron core with the supply off. Use an isolated, current-limited a.c. source set to 2.0 V RMS and a primary of 200 turns.

2. Connect a suitable a.c. voltmeter across the primary and another across an unloaded 100-turn secondary. Staff energise briefly, record the actual RMS voltages, then switch off.

3. Repeat with 200-turn and 400-turn secondary coils, keeping the primary, supply setting and core arrangement fixed. Repeat each pair of readings once. Switch off before every coil change.

4. Calculate the measured secondary-to-primary voltage ratio and compare with the turns ratio. Describe losses and imperfect coupling rather than forcing exact agreement.

5. Draw the two insulated coils and shared core. Explain why an alternating primary current produces the changing field needed for a sustained secondary alternating voltage. Do not test a steady d.c. supply on the transformer.

6. Use a diagram to explain step-up transmission voltage, lower current for the same transferred power, and reduced heating loss in cables. Explain why voltage is stepped down near users.

Cleanup

- Turn off the source, disconnect and store coils and core securely.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Use the specified 200-turn primary and secondaries no greater than 400 turns, giving an ideal maximum of 4 V RMS at the stated input. Staff verify actual output remains below 6 V RMS and primary current below 0.10 A or lower manufacturer limits. No load or high-voltage transmission demonstration is used.

Ns / turns	Repeat	Vp / V RMS	Vs / V RMS	Vs/Vp
100	1			
100	2			
200	1			
200	2			
400	1			
400	2			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What kind of input is required for sustained transformer action?

2. What links the two coils magnetically?

3. Predict output for 100 secondary turns.

4. Predict output for 400 secondary turns.

5. Does a step-up transformer create energy?

6. Why transmit at higher voltage for a given power?