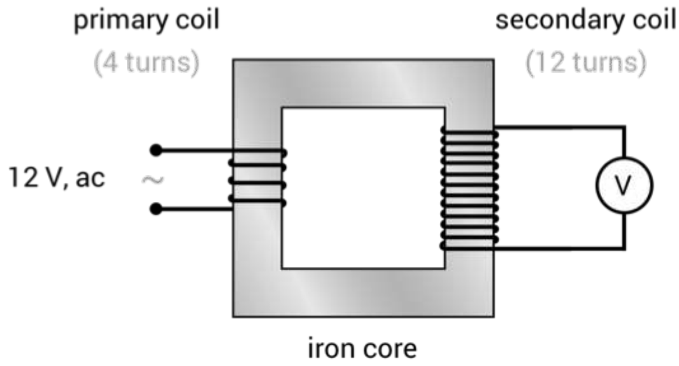
0 1 A student connects the below device in a physics lab.



0 1 . 1 State the name which is given to this type of device.

Step-up [1] transformer [1].

0 1 . 2 When a current flows through its primary coil, a potential difference is measured across its secondary coil. Explain this observation.

The flow of an alternating current through the primary coil leads to the generation of alternating magnetic field (around this coil and in the iron core) [1]. Because the magnetic flux through the secondary coil is changing (magnetic field lines are 'cutting through' this coil) a potential difference will be *induced* across the ends of this coil [1].

0 1 . 3 Use the information which is provided in the above diagram to calculate the value of the potential difference measured across the secondary coil.

$V_p \div n_p = V_s \div n_s$
$12 \div 4 = V_s \div 12$
$3 = V_s \div 12$
$V_s = 3 \times 12 = \underline{\mathbf{36\ V}}$

0 1 . 4 The student switches off the supply, then connects the device so that the ac supply is connected to the 12-turn coil, and the voltmeter, to the 4-turn coil. She then turns on the supply again.

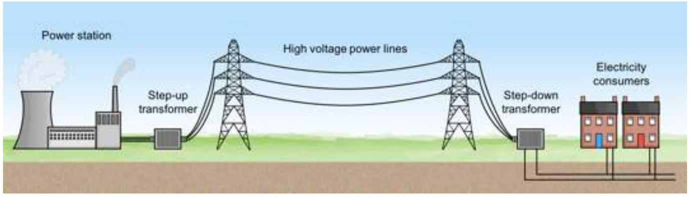
Describe and explain the effect which these changes to the circuit will have on the voltmeter reading.

The voltmeter reading will be smaller (than 12 V) [1] because the device will now be operating as a step-down transformer / there are less turns on its secondary coil than on its primary coil [1].

Can you prove to yourself that the p.d. across the secondary coil (V_s) will be 4 V when the transformer is switched around like this?

0 2

The generator of a power station is supplying electrical energy to a nearby town, as described in the below diagram.



Information on the **step-up** transformer which is being used in this system is provided in the below table.

Potential difference across primary coil, V_p	30 kV
Number of turns on primary coil, n_p	5,000
Number of turns on secondary coil, n_s	50,000

0 2 . 1

The power output of the generator is **6 MW**. Show that the current in the **primary coil** of the step-up transformer is 200 A.

$P_p = I_p V_p$
$6{,}000{,}000 = I_p \times 30{,}000$
$I_p =$ **200 A**

Use *standard form* here if you like ($6 \times 10^6 = I_p \times 30 \times 10^3$)

0 2 . 2

Calculate the potential difference across its **secondary coil**.

$V_p \div n_p = V_s \div n_s$
$30{,}000 \div 5{,}000 = V_s \div 50{,}000$
$V_s = 300{,}000$ V = **300 kV**

Take care here: the answer has to be written in kilovolts (kV)

0 2 . 3

Hence (or otherwise) calculate the current in the high voltage power lines. You may assume that the transformer is 100% efficient.

EITHER
$V_s I_s = V_p I_p$
$300{,}000 \times I_s = 30{,}000 \times 200$
$I_s =$ **20 A**

OR
$P_s = I_s V_s$
$6 \times 10^6 = I_s \times (300 \times 10^3)$
$I_s =$ **20 A**

0 2 . 4

These power lines have a combined resistance of 150 Ω. Assuming that the step-down transformer is also 100% efficient, and that the only dissipation of energy from this system comes from the electrical resistance of the power lines, calculate the efficiency with which electrical power is delivered between the power station and the town.

Efficiency = (Useful power output ÷ total power input)
Total power input = 6,000,000 W
Power dissipated in cables, $I^2 R = 20^2 \times 150 = 60{,}000$ W
Useful power output (power delivered to town) = 6,000,000 – 60,000
Useful power output (power delivered to town) = 5,940,000 J
Efficiency = 5,940,000 ÷ 6,000,000 = 0.99 = **99%**