Transformers

1. Use the formula for an ideal transformer,

$$\frac{\text{secondary e.m.f.}}{\text{primary e.m.f.}} = \frac{\text{turns in secondary}}{\text{turns in primary}} \quad \text{or} \quad \frac{V_s}{V_p} = \frac{N_s}{N_p}$$

to calculate the **value** of the missing quantities in the table.

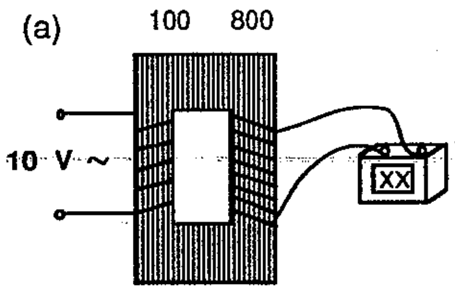
V_s(V)	V_p(V)	N_s	N_p
30	240	-	4000
8	240	-	6000
12	240	30	-
300	12	500	-
-	240	50	1200
20	-	500	6000

2. A **step-down** transformer has a turns ratio of 30:1. It has 6000 turns in the primary coil. Calculate the **number** of turns in its secondary coil.

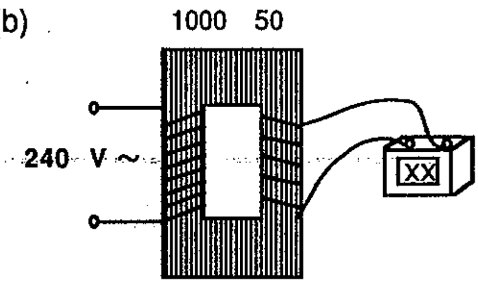
3. How many **turns** are in the primary winding of a transformer if, when connected to 240 V a.c., the 200 turn secondary has a voltage of 8 volts ?

4. For each of the transformers below, state the **reading** on the **voltmeter** connected across the secondary winding.

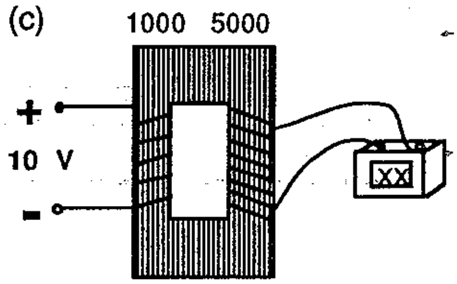
(a)



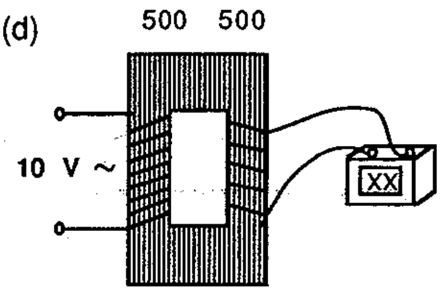
(b)



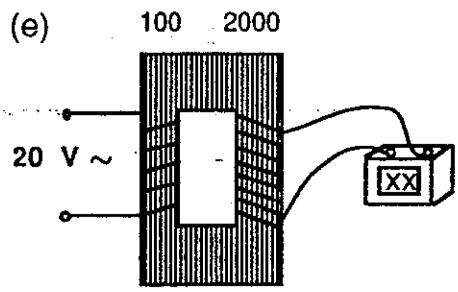
(c)



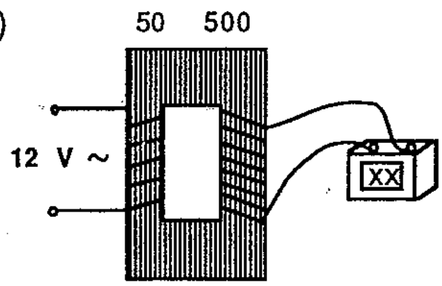
(d)



(e)



(f)

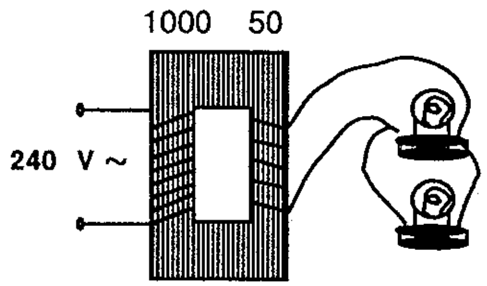


5. In a very well constructed transformer which has very few energy losses, how does the **secondary output power** compare with the **primary input power** ?

6. Assuming that a transformer is 100% efficient, how much **power** would need to be supplied to the primary if a 12 volt, 24 watt lamp was lit at its rated voltage from the secondary ?

7. Calculate the **current** drawn from the 240 V a.c. mains by the primary winding of a transformer which supplies 24 watts of power to a lamp across the secondary winding. (Assume the transformer does not lose any energy).

8. In the circuit shown, a mains step-down transformer supplies power to two 12 V, 24 W lamps in parallel.



Calculate (a) the **current** in the secondary winding and (b) the **current** in the primary winding. (Assume the transformer is very efficient).

9. A doorbell for a house works from 8 V a.c. To operate the bell from the 240 V mains supply, a transformer can be used. How many **turns** would be in the *primary* winding for *each* turn in the secondary winding ? Would the transformer be a *step-up* or a *step-down* type ?

10. To produce an output of 48 V a.c. from an input of 240 V a.c., how many **turns** would be required in the primary winding if there were 100 in the secondary ?

11. State the **output voltage** produced by a transformer with 100 turns in the primary coil and 600 turns in the secondary coil when connected to the following input voltages:

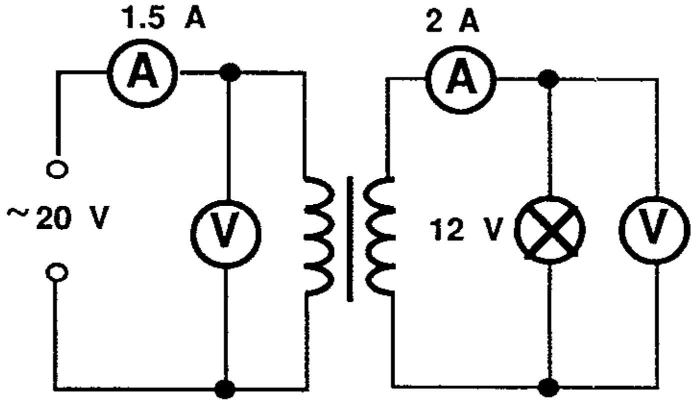
    (a) 12 V a.c. (b) 12 V d.c. (c) 240 V a.c.

12. The input voltage to a step-down transformer is 240 V a.c. at a frequency of 50 Hz. If the primary winding has 6000 turns and the secondary 300 turns, what is the **voltage output** and what is its **frequency** ?

13. A step-up transformer has 500 turns in the primary coil and 10000 turns in the secondary coil. If a voltage of 250 V a.c. is applied to the primary at 50 Hz, what are the **voltage** and **frequency** of the output at the secondary ?

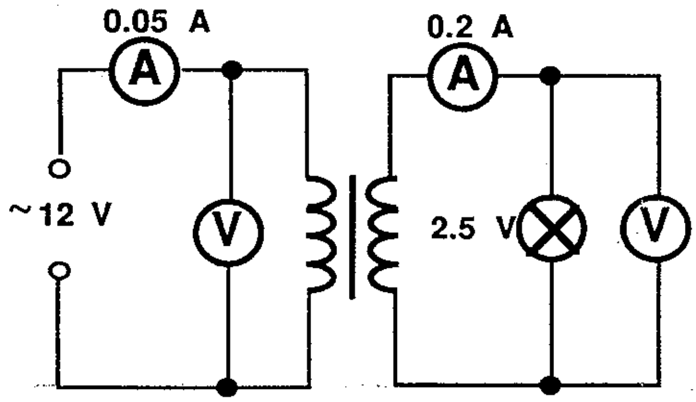
14. A 12 volt car battery is placed across the primary coil of a 1:20 step-up transformer. What is the **output voltage** across the secondary ?

15. A pupil makes a basic step-down transformer and sets up the circuit shown to light a 12 V lamp.



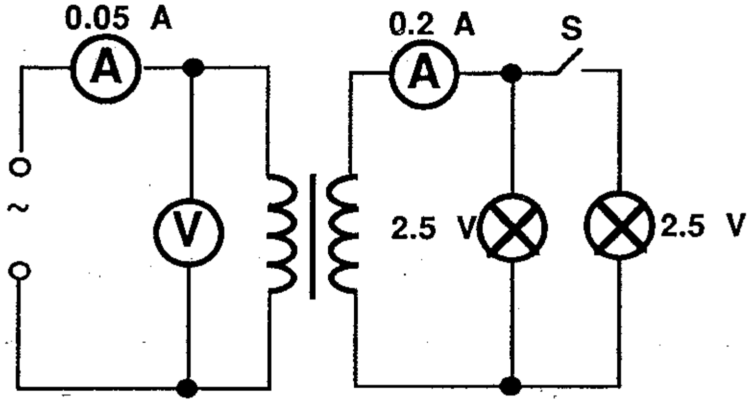
(a) Calculate the **input power** and the **output power** of the transformer.
(b) How much **energy** is *wasted* every second in the transformer ?

16. A transformer is used to step down the voltage from a 12 V a.c. supply to light a 2.5 V lamp.



Calculate (a) the **energy per second** wasted in the transformer and
(b) the **percentage efficiency** of the transformer.

17. A transformer is operated from a constant voltage a.c. supply. The readings on the ammeters in the primary and secondary circuits are as shown when just *one* lamp is lit. The lamps are identical.



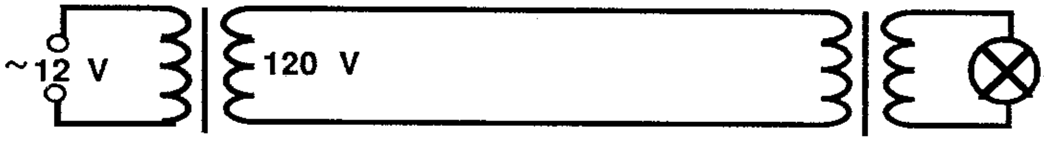
What would the **readings** on the meters be when the switch **'S'** was closed ? (Assume the transformer is 100 % efficient).

Power transmission

1. A 24 W lamp is to be lit from a 12 V a.c. supply with two long wires connecting the lamp to the supply. The wires have a total resistance of 1 Ω.

(a) If the supply delivers 24 W to the wires and lamp, calculate the **current** in the wires and the **power** lost in the wires.

(b) The system is now changed so that the power supply voltage is increased by a step-up transformer to 120 V and, as before, 24 W of power is delivered to the resistance wires and lamp. At the other end of the wires, the output of a step-down transformer is connected to the 12 V lamp.

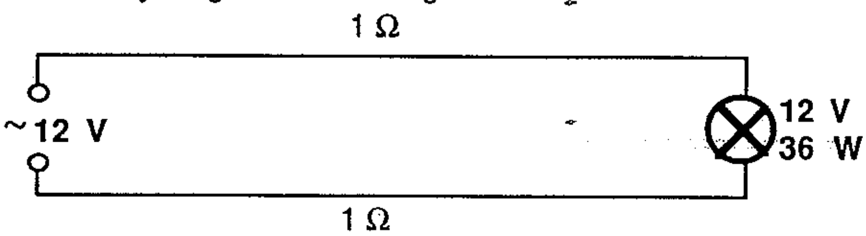


Calculate the **current** in the wires and the **power lost** in the wires.

2. Electricity is generated in power stations at 11 kV. It is then stepped-up, by transformers, to 132 kV or 400 kV to be transmitted cross-country on the grid. What is the **advantage** of transmitting the power at such high voltages ?

3. 50 kW of power is to be transmitted through long cables to a small hamlet. The cables have a total resistance of 0.5 Ω. Calculate the **power lost** in the cables if the power is delivered to the cables at (a) 250 V a.c. and, after being stepped-up by a transformer, at (b) 250 kV a.c.

4. A 12 V 36 W lamp is to be lit from a 12 V a.c. supply but the connecting wires are very long and have a significant resistance of 2 Ω.



Assuming that the lamp's resistance is constant, calculate

(a) the **current** delivered to the wires by the power supply,
(b) the **heat** generated every second in the wires,
(c) the **potential difference** across the lamp and
(d) the **power** delivered to the lamp.
(e) Explain how *two* identical transformers, each able to change the input voltage by a factor of ten, could be added to the circuit to enable almost **all** of the **power** from the supply to reach the lamp.