Science 122
Transformers

Physics – Principles and Processes
Merrill – Red Text

## Practice Problems

*In all problems, effective currents and voltages are indicated.*

**9.** A step-down transformer has 7500 turns on its primary and 125 turns on its secondary. The voltage across the primary is 7200 V.
- **a.** What voltage is across the secondary?
- **b.** The current in the secondary is 36 A. What current flows in the primary?

**10.** The secondary of a step-down transformer has 500 turns. The primary has 15 000 turns.
- **a.** The *EMF* of the primary is 3600 V. What is the *EMF* of the secondary?
- **b.** The current in the primary is 3.0 A. What current flows in the secondary?

**11.** An ideal step-up transformer's primary circuit has 500 turns. Its secondary circuit has 15 000 turns. The primary is connected to an AC generator having an *EMF* of 120 V.
- **a.** Calculate the *EMF* of the secondary.
- **b.** Find the current in the primary if the current in the secondary is 3.0 A.
- **c.** What power is drawn by the primary? What power is supplied by the secondary?

**12.** A step-up transformer has 300 turns on its primary and 90 000 ($9.000 \times 10^4$) turns on its secondary. The *EMF* of the generator to which the primary is attached is 60.0 V.
- **a.** What is the *EMF* in the secondary?
- **b.** The current flowing in the secondary is 0.50 A. What current flows in the primary?

**16.** A portable computer requires an effective voltage of 9.0 volts from the 120 -V line.
- **a.** If the primary of the transformer has 475 turns, how many does the secondary have?
- **b.** A 125-mA current flows through the computer. What current flows through the transformer's primary?

**17.** In a hydroelectric plant, electricity is generated at 1200 V. It is transmitted at 240 000 V.
- **a.** What is the ratio of the turns on the primary to the turns on the secondary of a transformer connected to one of the generators?
- **b.** One of the plant generators can deliver 40.0 A to the primary of its transformer. What current is flowing in the secondary?

**18.** A hair dryer uses 10 A at 120 V. It is used with a transformer in England, where the line voltage is 240 V.
- **a.** What should be the ratio of the turns of the transformer?
- **b.** What current will it draw from the 240-V line?

Solutions

#9. a) 120V
b) 0.600A

#10. a) 120V
b) 90A

#11. a) $3.60 \times 10^3$ V
b) 90A
c) $1.1 \times 10^4$ W

#12. a) $1.80 \times 10^4$ V
b) $1.5 \times 10^2$ A

#16. a) 36
b) 9.5 mA

#17. a) 1:200
b) 0.200A

#18. a) 2:1
b) 5.0A

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Practice Prob

Step-down

9. $N_p = 7500$
$N_s = 125$
$V_p = 7200V$
$V_s = ?$

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

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

$V_s = \frac{(7200)(125)}{7500} = \boxed{120V}$

b) $I_s = 36A$
$I_p = ?$

$\frac{I_p}{I_s} = \frac{N_s}{N_p}$

$I_p = \frac{I_s N_s}{N_p} = \frac{(36)(125)}{7500} = 0.600A$

10. Step-down

$N_s = 500$
$N_p = 15\,000$

a) $V_p = 3600V$
$V_s = ?$

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

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

$V_s = \frac{(500)(3600)}{15\,000} = 120V$

b) $I_p = 3.0A$
$I_s = ?$

$\frac{I_s}{I_p} = \frac{N_p}{N_s}$

$I_s = \frac{I_p N_p}{N_s}$

$I_s = \frac{(3.0)(15\,000)}{500}$

$I_s = 90A$

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#11. Step-up

$N_p = 500$
$N_s = 15000$
$V_p = 120\,V$

a) $V_s = ?$

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

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

$$V_s = \frac{(120)(15000)}{500}$$

$$\boxed{V_s = 3.60 \times 10^3\,V}$$

b) $I_s = 3.0\,A$
$I_p = ?$

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

$$I_p = \frac{I_s N_s}{N_p}$$

$$I_p = \frac{(3.0)(15000)}{500} = \boxed{90\,A}$$

c) $P_p = V_p I_p$

$$P_s = P_p = (120)(90) = \boxed{1.1 \times 10^4\,W}$$

#12. Step-up

$N_p = 300$
$N_s = 90000$
$V_p = 60.0\,V$

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

$$V_s = \frac{V_p N_s}{N_p} = \frac{(60.0)(90000)}{300} = \boxed{1.80 \times 10^4\,V}$$

b) $I_s = 0.150\,A$
$I_p = ?$

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

$$I_p = \frac{I_s N_s}{N_p} = \frac{(0.150)(90000)}{300} = \boxed{1.50 \times 10^2\,A}$$

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Step ↓
120V – 9.0

16. $V_s = 9.0\,V$
$V_p = 120\,V$ – line

a) $N_p = 475$
$N_s = ?$

~~$\frac{N_s}{N_p} = \frac{V_s}{V_p}$~~
~~$N_s = \frac{N_p V_p}{V_s}$~~
~~$N_s = \frac{(475)(120)}{9.0} = 6.3 \times 10^{4}$~~

$\frac{N_s}{N_p} = \frac{V_s}{V_p}$
$N_s = \frac{N_p V_s}{V_p} = \frac{(475)(9.0)}{120} = 36$

b) $I_s = 125\,mA = 125 \times 10^{-3}\,A$ (Computed)
$I_p = ?$

$\frac{I_p}{I_s} = \frac{N_s}{N_p}$
$I_p = \frac{I_s N_s}{N_p}$
$I_p = \frac{(125 \times 10^{-3})(36)}{475}$
$I_p = 9.5 \times 10^{-3}\,A$ or $9.5\,mA$

17. $V_p = 1200\,V$ (generated)
$V_s = 240\,000\,V$ (transmitted)

a) $\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{1200}{240\,000} = \frac{1}{200}$

$N_p : N_s \Rightarrow 1:200$

b) $I_p = 40.0\,A$
$I_s = ?$

$\frac{I_s}{I_p} = \frac{V_p}{V_s}$
$I_s = \frac{I_p V_p}{V_s} = \frac{(40.0)(1200)}{240\,000} = 0.200\,A$

#18 $V_p = 240\,V$ - household $\quad I_s = 10\,A$

$V_s = 120\,V$

a) $\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{240}{120} = \frac{2}{1}$

b) $I_p = ?$

$$\frac{I_p}{I_s} = \frac{V_s}{V_p}$$

$$I_p = I_s \frac{V_s}{V_p}$$

$$I_p = \frac{(10A)(120)}{240} = 5.0\,A$$