Wires Gauge and Characteristics

Electrical wiring in homes and businesses consist of wires with a circular cross-section. They come in a variety of sizes, often referred to as the wire **gauge**. The American Wire Gauge (AWG) is a standardized system for expressing the size of a round, solid, non-iron conducting wire. While most of the wires used in household circuits are 12-gauge and 14-gauge, wires of other sizes are used for hobby applications (e.g., train layouts, speaker wiring) and long-distance power transmission. The gauge of a wire indicates information about the diameter, cross-sectional area, and expected resistance. **Table 1** illustrates these relationships for several gauges.

Table 1

AWG	Diameter (mm)	Area (mm^2)	Copper Wire Resistance (Ω/m)
32	0.202	0.0320	0.538
28	0.321	0.0810	0.213
24	0.511	0.205	0.0842
22	0.644	0.326	0.0529
20	0.812	0.518	0.0333
18	1.02	0.823	0.0209
16	1.29	1.31	0.0132
14	1.63	2.08	0.00828
13	1.83	2.62	0.00657
12	2.05	3.31	0.00521
11	2.31	4.17	0.00413
10	2.59	5.26	0.00328
9	2.91	6.63	0.00260
8	3.26	8.37	0.00206
6	4.12	13.3	0.00130
5	4.62	16.8	0.00103
4	5.19	21.2	0.000815

The amount of current that can be safely *carried* by a wire is affected by the wire gauge. A variety of factors in addition to gauge affect this current-carrying capacity - referred to as **ampacity**. Such characteristics include the nature of the insulating material wrapped around the wire, the temperature of the surroundings, the number of nearby wires, etc. The National Electrical Code (NEC) provides guidelines for the safe installation of electrical wiring in the United States. **Table 2** lists ampacities for various gauge wires used in houses, business, and for power transmission. Ratings apply to wires having plastic insulation with temperature ratings of 60°C, 75°C and 90°C.

Table 2

AWG	Ampacity (A) at T =		
	60°C	75°C	90°C
14	20	20	25
12	25	25	30
10	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95

From http://www.usawire-cable.com/pdfs/NEC%20AMPACITIES.pdf

Questions:

1. Which of the listed wires is the narrowest wire?
   a. 8-gauge
   b. 12-gauge
   c. 14-gauge
   d. 20-gauge

2. What is the relationship between the gauge of a wire and the cross-sectional area of the wire?
   a. Increasing the gauge will increase the cross-sectional area of the wire.
   b. Increasing the gauge will decrease the cross-sectional area of the wire.
   c. The cross-sectional area of a wire is not related nor affected by the gauge.
   d. Decreasing the gauge first decreases the area and then increases the area.

3. Which of the listed wires has the smallest cross-sectional area?
   a. 8-gauge
   b. 12-gauge
   c. 14-gauge
   d. 20-gauge

4. The gauges listed in **Table 1** do not include all the possible gauges. What is the best estimate of the diameter and cross-sectional area of a 25-gauge wire?
   a. diameter = 0.321 mm area = 0.0810 mm^2
   b. diameter = 0.416 mm area = 0.143 mm^2
   c. diameter = 0.511 mm area = 0.205 mm^2
   d. diameter = 0.511 mm area = 0.205 mm^2

5. If a particular electronic application requires a wire with a low resistance, then it will need to be a wire that is _____.
   a. of high gauge and very wide
   b. of high gauge and very narrow
   c. of low gauge and very narrow
   d. of low gauge and very wide

6. How does wire resistance correlate with the cross-sectional area of a wire?
   a. The highest resistance wires have the greatest cross-sectional areas.
   b. The highest resistance wires have the smallest cross-sectional areas.
   c. There seems to be no correlation between the cross-sectional area and the resistance.
   d. Cross-sectional area seems to correlate with resistance; the relationship is not predictable.

7. Which gauge wire would have a cross-sectional area that is twice the cross-sectional area of a 16-gauge wire?
   a. An 8-gauge wire
   b. A 10-gauge wire
   c. A 13-gauge wire
   d. A 32-gauge wire

8. What change in the gauge of a wire would cause the diameter of a wire to double?
   a. A doubling of the gauge.
   b. A *halving* of the gauge.
   c. A decrease by 2.
   d. A decrease by 6.

9. What change in the gauge of a wire would cause the cross-sectional area of a wire to double?
   a. A doubling of the gauge.
   b. A decrease by 2.
   c. A decrease by 3.
   d. A decrease by 6.

10. Which gauge wire would have a resistance that is twice the resistance of a 19-gauge wire?
   a. A 9.5-gauge wire
   b. A 16-gauge wire
   c. A 22-gauge wire
   d. A 38-gauge wire

11. Which of the listed wires has the greatest ampacity?
   a. 4-gauge
   b. 8-gauge
   c. 12-gauge
   d. 14-gauge

12. Which of the following set of conditions would result in the greatest current-carrying capacity for a wire?
   a. A large gauge wire surrounded by insulation with a high-temperature rating.
   b. A large gauge wire surrounded by insulation with a low-temperature rating.
   c. A small gauge wire surrounded by insulation with a high-temperature rating.
   d. A small gauge wire surrounded by insulation with a low-temperature rating.

13. Which of the following wire characteristics identified in **Table 1** and **Table 2** are consistent with one another?
   a. High gauge, large cross-sectional area, high resistance, high ampacity
   b. High gauge, large cross-sectional area, high resistance, low ampacity
   c. Low gauge, large cross-sectional area, low resistance, high ampacity
   d. Low gauge, large cross-sectional area, high resistance, low ampacity