1. When measuring resistance or continuity you must first
   a. Turn off the power
   b. Turn on the power to the circuit
   c. Reset the circuit breaker
   d. Break circuit an put meter in series with the circuit

2. The voltage in a series circuit is
   a. always positive
   b. the same throughout the circuit
   c. is divided equally over all the loads
   d. equal to the sum of the voltage drop

3. What is the unit of measurement for current?
   a. Volts
   b. Amps
   c. Watts
   d. Ohms

4. What is the unit of measurements for resistance?
   a. Volts
   b. Amps
   c. Watts
   d. Ohms

5. What device can step up or step down voltage?
   a. relay
   b. generator
   c. transient
   d. transformer

6. What type of circuit is used in home wiring?
   a. Wye delta
   b. Series
   c. 3-phase
   d. parallel

7. What device does not use electromagnetic forces?
   a. Switch
   b. Solenoid valve
   c. 3 phase motor
   d. relay

8. What is the common electrical service used in homes in the U.S.?
   a. 120/208 3 phase 60 Hz
   b. 220 v 1 phase 50 Hz
   c. 277/460v 3 phase 60 Hz
   d. 120/208 1 phase 60 Hz

9. Current will always
   a. Alternate
   b. Be the same
   c. Take the path of least resistance
   d. Arc across an open circuit

10. Safety limit switches in HVAC equipment are typically wired
    a. Shorted to ground
    b. In series
    c. Across the load
    d. In parallel

11. What is another name for a 3-phase 4-wire system?
    a. delta
    b. wye
    c. series
    d. inductive

12. What happens to the resistance of a wire when the temperature increases?
    a. increases
    b. decreases
    c. stays the same
    d. goes to zero ohms

13. Of the following, what wire size is the largest in diameter?
    a. 18 awg
    b. 10 awg
    c. 24 awg
    d. 4 awg

14. What type of load will always have its voltage and current in phase?
    a. motor load
    b. capacitor load
    c. resistive load
    d. inductive load

15. What is the unit of measurement for inductors?
    a. farads
    b. ohms
    c. mhos
    d. henry

16. In a reactive circuit, which of the following is greatest?
    a. true power
    b. reactive power
    c. apparent power
    d. wattless power

17. What is the power factor when the reactive power is 0 (no reactance)?
    a. 1.0
    b. 0.0
    c. 0.80
    d. 0.50

18. What electrical value is used to measure the total opposition (reactive and non reactive) to current flow in an ac circuit?
    a. VARS
    b. Impedance
    c. Inductive Reactance
    d. Capacitive Reactance

19. How are capacitors used to help industrial and commercial facilities?
    a. they are used to store energy to use at night
    b. they are used to offset the inductive reactance
    c. they are used to reduce the peak demand load
    d. they are used to help cool large motors

20. Capactive and inductive reactance is dependent upon what?
    a. resistance
    b. frequency
    c. voltage
    d. current

21. What is the voltage drop for a condensing unit drawing 12 amps at 208v 1-phase with #12 copper conductors? The condensing unit is 75' from the panel. K value for copper is 10.4, cm for #12 wire is 6,530.

22. What wire size will carry 68 amps using copper wire type THW? Connection temperatures are rated for 75°C.

23. What standard breaker size should be used for the circuit in problem 22?

24. What is the reactance of a circuit with one inductor with an inductance of 0.75Henry? Frequency is 1000 Hz.

25. What is the reactance of a circuit with three 20 microfarad capacitors in parallel? Frequency is 60 Hz.

Formulas

Area

Rectangle A= Length x Width
Circle A = Π x Radius^2
Triangle A = ½ Base x Height
Π = 3.14
Right Triangle $C^2 = A^2 + B^2$

Volume

Rect. Box V=Length x Width x Height
Sphere V = 4/3 x Π x Radius^3

Temperature

°C = 5/9 (°F – 32)
°F = (°C x 9/5) + 32
Micro = 1 x 10^{-6}

Electricity

Resistance of Conductors R = (2 x K x L) / cm for a single phase system
$X_L = 2 \times \Pi \times F \times L$

$$X_C = \frac{1}{(2 \times \Pi \times F \times C)}$$

$$Z_{Total} = \sqrt{X_L^{\ 2} + X_C^{\ 2}}$$

Standard Breaker Sizes

15	40	80	175	350	700
20	45	90	200	400	800
25	50	100	225	450	1000
30	60	125	250	500	1200
35	70	150	300	600	1600

Table 310-16. Allowable Ampacities of Insulated Conductors Rated 0–2000 Volts, 60° to 90°C (140° to 194°F) Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size	Temperature Rating of Conductor. See Table 310-13.						Size
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
AWG kcmil	TYPES TW†, UF†	TYPES FEPW†, RH†, RHW†, THHW†, THW†, THWN†, XHHW†, USE†, ZW†	TYPES TBS, SA,SIS, FEP†, FEPB†, ML, RHH†, RHW-2, THHN†, THHW†, THW-2, THWN-2, USE-2, XHH, XHHW†, XHHW-2, ZW-2	TYPES TW†, UF†	TYPES RH†, RHW†, THHN†, THW†, THWN†, XHHW†, USE†	TYPES TBS, SA,SIS, THHN†, THHW†, THW-2, THWN-2, RHH†, RHW-2, USE-2, XHH, XHHW†, XHHW-2, ZW-2	AWG kcmil
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18	....	....	14	....	....	....	....
16	....	....	18	....	....	....	....
14	20†	20†	25†	....	....	....	....
12	25†	25†	30†	20†	20†	25†	12
10	30	35†	40†	25	30†	35†	10
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	190	230	255	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	355	420	475	285	340	385	600
700	385	460	520	310	375	420	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	450	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	520	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	560	665	750	470	560	630	2000

CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. °C
21–25	1.06	1.05	1.04	1.06	1.05	1.04	70–77
26–30	1.00	1.00	2.00	1.00	1.00	1.00	78–86
31–35	.91	.94	.96	.91	.94	.96	87–95
36–40	.82	.88	.91	.82	.88	.91	96–104
41–45	.71	.82	.87	.71	.82	.87	105–113
46–50	.58	.75	.82	.58	.75	.82	114–122
51–55	.41	.67	.76	.41	.67	.76	123–131
56–60	....	.58	.75	....	.58	.71	132–140
61–70	....	.33	.58	....	.33	.58	141–158
71–80	....	....	.41	....	....	.41	159–176

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

FIGURE 6-4 (Reprinted with permission from NFPA 70-1996, *National Electrical Code®*, Copyright© 1995, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the official position of the National Fire Protection Association, which is represented by the standard in its entirety.)

Answers

1. A
2. D
3. B
4. D
5. D
6. D
7. A
8. D
9. C
10. B
11. B
12. A
13. D
14. C
15. D
16. C
17. A
18. B
19. B
20. B
21. 2.87 V
22. #4 AWG
23. 80 AMP
24. 4,710 OHMS
25. 44.23 OHMS