Chapter 2 Fuses, Disconnect Switches, and Circuit Breakers

1. **Protective Factors.** Point out the two important factors involving disconnecting and protection.

2. **Fuse Construction and Operation.** Show the general construction of a one-time fuse. (See Textbook Figure 2-2.) Point out the three types of fuses: one-time, time-delay, and current-limiting. Discuss the applications where time-delay and current-limiting fuses are used.

3. **Fuse Types.** Show the physical changes in fuse design. Point out that they must be used with a fuse block designed to accept them. (See Textbook Figure 2-4.)

4. **Let-thru Current and I^2t.**
   a. Limiting action
   b. I^2t *vs.* Ip and total clearing time
   c. I^2t and characteristic of fuse

   Be sure to devote sufficient time to discussing I^2t as a measure of the degree of current limitation provided by fuses. This is extremely important in selecting fuses. Use the diagrams provided to emphasize the importance. (See Textbook Figures 2-7, 2-8, 2-9, 2-10.)

   Be sure the student knows how to read a graph showing melting time-current data *vs.* time graphs for a given fuse. (See Textbook Figure 2-6.)

5. **Voltage and Frequency Surges**
   a. From lightning
   b. From switching

   Be sure the student knows how a lightning arrester operates. Also be sure the student understands the relative damage caused by a direct hit, induction on the line, and surges caused by switching.

6. **Circuit Breaker Types.** Point out the four different types of circuit breakers, their uses, and how they differ in operating characteristics.

7. **Programmable Motor Protection.** Discuss some of the protective features.

8. **Electrical Metering and Voltage Protection.** Discuss some of the protective features.

9. **Selecting Protective Devices.** Discuss the important factors to consider when selecting protective devices. Point out why they are important. Discuss the importance of impedance in a transformer when calculating the interrupting capacity of a protective device. Go through several examples using various values of transformer kVA, voltage, and impedance. Be sure the student understands that impedance is the current-limiting characteristic of a transformer.

ACHIEVEMENT REVIEW ANSWERS

1. a. Means of disconnecting electrical energy from the circuits.
   b. Protection against sustained overloads and short-circuit current.

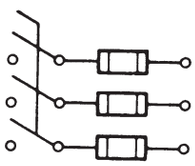
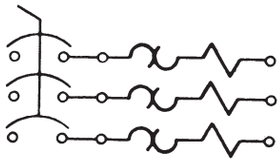
2. Where a heavy load can exist for a short period of time. An example is motor starting.

3. a. Nonautomatic (circuit interrupter)
   b. Thermal
   c. Magnetic
   d. Thermal magnetic

4. To clear a circuit in case of short circuit.

5. a. Size
   b. If a time lag is required
   c. Interrupting capacity
   d. Ambient temperature
   e. Voltage rating
   f. Number of poles
   g. Mounting, operator, and if an enclosure is required

6. Yes. One, three, and four poles are also available.

7. a. 
   b. 
   c. 
   d. 

8. The highest current at rated voltage that the fuse can interrupt.

9. Effective heat transfer (b)

10. It parallels the characteristics of conductors, motors, transformers, and other electrical apparatus (c)

11. Ip (peak let-thru current) and I^2t (*t* is the total clearing time) are two measures of the degree of current limitations provided by a fuse.

12. I^2t values of a fuse are derived from oscillograms of fuses operating within their current-limiting range and are calculated.

13. The highest overvoltage will be present when there is a ground fault in the system.

14. A lightning arrester will limit the crest of the surge by breaking down and conducting to ground.

15. Normal full load current $= \dfrac{15000}{480} = 31.25$ amps

$$= \frac{31.25}{0.04} = 781 \text{ amps}$$

The circuit breaker or fuse would have a minimum interrupting capacity of 781 amps at 480 volts. You would use an 800-amp circuit breaker or fuse, as it is the next larger commercial size.