1. Assume that at Pine Valley Furniture each product (described by Product No., Description, and Cost) is comprised of at least three components (described by Component No., Description, and Unit of Measure) and components are used to make one or many products (i.e., must be used in at least one product). In addition, assume that components are used to make other components and that raw materials are also considered to be components. In both cases of components being used to make other components, we need to keep track of how many components go into making something else. Draw an E-R diagram for this situation and place minimum and maximum cardinalities on the diagram.

This is a version of a bill-of-materials structure in which components are different entities from products, but raw materials are considered components. The exercise also indicates a minimum cardinality of three for the number of components composing a product, but no such restriction is placed on components as part of other components. Microsoft Visio was used to prepare this answer.

2. A software training program is divided into training modules, and each module is described by module name and the approximate practice time. Each module sometimes has prerequisite modules. Model this situation of training programs and modules with an E-R diagram.

This exercise defines two entities—TRAINING PROGRAM and TRAINING MODULE—with a one-to-many relationship (Composed of) between them, and a unary optional (because some modules do not have a prerequisite, and some modules are not a prerequisite to other modules) many-to-many relationship (Is Prerequisite for) on the TRAINING MODULE entity.
3. Each semester, each student must be assigned an adviser who counsels students about degree requirements and helps students register for classes. Students must register for classes with the help of an adviser, but if their assigned adviser is not available, they may register with any adviser. We must keep track of students, their assigned adviser, and with whom the student registered for the current term. Represent this situation of students and advisers with an E-R diagram.

This exercise defines two entities—ADVISOR and STUDENT—and two relationships—Is Assigned Advisor and Registers—between ADVISOR and STUDENT. An advisor is assigned to zero to many students, and a student is assigned to exactly one advisor; an advisor registers zero to many students, and a student is registered by exactly one advisor. An important rule in the exercise is that the data model covers only “the current term,” so no historical records need to be kept. As an alternative, it is also possible to create a data model with the above two entities and a ROLE associative entity in between, where ROLE has an attribute of ROLE PLAYED (which could take on values of “Advises,” “Advises and Registers,” and “Registers”). Then, we would create a relationship between the entities through the associative entity such that an advisor is associated with zero to many students, and a student is associated with one or two advisors. The problem with this alternative is clarifying on only the data model what combination of ROLE PLAYED values are permitted for a given student.
4. Study the E-R diagram of Figure 7–20. Based on this E-R diagram, answer the following questions:

   a. How many PROJECTs can an employee work on?
   b. What is the degree of the Includes relationship?
   c. Are there any associative entities on this diagram? If so, name them.
   d. How else could the attribute Skill be modeled?
   e. Is it possible to attach any attributes to the Includes relationship?
   f. Could TASK be modeled as an associative entity?

An employee can work on one-to-many projects; the Includes relationship is a binary relationship. No associative entities are directly shown by the associative entity symbol. The only many-to-many relationship, Works On, has no attributes, so it does not need to be shown as an associative entity. The SKILL attribute could also be modeled as an attributive or weak entity. It is not possible for the Includes relationship to have attributes because it is a one-to-many relationship. Only one-to-one and many-to-many relationships are allowed to have attributes. TASK could be modeled as an associative entity because it falls at the intersection of mandatory binary relationships between PROJECT, TOOL, and CITY, depending on the meaning of task. As currently modeled, TASK is something done on a project with a tool at a city, so it is not an independent concept. TASK can be modeled as an entity because it has its own primary key independent of the keys of PROJECT, CITY, and TOOL. Some semantic information would be lost if TASK were modeled as an associative entity (e.g., the minimum cardinalities related to task on the Includes, Done at, and Used on relationships).
5. The real estate database contains an entity called PROPERTY, which is a property for sale by the agency. Each time a potential property buyer makes a purchase offer on a property, the agency records the date, offering price, and name of the person making the offer.
   
a. Represent the PROPERTY entity and its purchase offer attributes using the notation for multivalued attributes.
   
b. Represent the PROPERTY entity and its purchase offer attributes using two entity types.
   
c. Finally, assume the agency decides to also keep data about buyers and potential buyers, including their name, address, and phone number. Augment your answer to part b to accommodate this new entity type.

Suggested answers are provided below. Microsoft Visio was used to create the answers for this exercise.

Problem and Exercise 9, Part a

Problem and Exercise 9, Part b

Problem and Exercise 9, Part c
6. Draw an ERD for the following Scenario:

A Laboratory has several chemists who work on one or more projects. Chemists also may use certain kinds of equipment on each project.

Attributes of CHEMIST includes EMPLOYEE_ID (identifier), Name, Phone_No. Attribute of PROJECT include Project_ID (identifier), and Start_Date.

Attributes of EQUIPMENT include Serial_No and Cost.

The organization wishes to record Assign_Date, which is the date when a given equipment was assigned to a particular chemist working on a specific project.

A chemist must be assigned at least to one project and one equipment item. Any given equipment item need not be assigned, and a given project need not be assigned either a chemist or an equipment item.