Chapter 2: The Process of Design

TRUE/FALSE

1. Polya's four problem-solving steps are not sequential.

   ANS: F PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

2. Innovation can start at the problem-defining phase.

   ANS: T PTS: 1 REF: Design Process

3. A design brief encourages thinking about only one aspect of a problem before attempting a solution.

   ANS: F PTS: 1 REF: Design Process

4. A proposal is a full-scale working model of a design intended to have complete, or almost complete, form, fit, and function of the intended design.

   ANS: F PTS: 1 REF: Design Process

5. Clearly defining limitations accurately describes, and effectively solves, problems.

   ANS: T PTS: 1 REF: Design Limitations

MULTIPLE CHOICE

1. A(n) ____ process lets the designer jump backward and forward to more effectively develop a solution.
   a. ordered
   b. sequential
   c. Polya
   d. nonsequential

   ANS: D PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

2. Throughout the design process, managing project ____ will drive the team's most important decisions.
   a. profit
   b. iteration
   c. risk
   d. order

   ANS: C PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

3. The ____ Robotics Competition gives high school students real-world experience working with professional engineers to develop a robot.
   a. FIRST
   b. DARPA
   c. Polya
   d. IBot

   ANS: A PTS: 1 REF: Design Process

4. Once the problem is well-defined, the design team collaborates. This is a process called ____.
   a. evaluation
   b. brainstorming
   c. generation
   d. constraint

   ANS: B PTS: 1 REF: Design Process

5. ____ are principles or standards by which something may be judged or decided.

a. Constraints
b. Criteria
c. Assessments
d. Necessities

ANS: B PTS: 1 REF: Design Process

6. ____ is an evaluation technique that requires analyzing benefits and risks, understanding the trade-offs, and then determining the best action to take to ensure that the desired positive outcomes outweigh any negative outcomes.

a. Assessment
b. Iteration
c. Order
d. Brainstorming

ANS: A PTS: 1 REF: Design Process

7. The documentation, called a design proposal, can consist of ____ design (CAD) drawings.

a. conventional architectural
b. computer-actuated
c. computer-aided
d. conventional assessment

ANS: C PTS: 1 REF: Design Process

8. There are two general categories of production: (i) mass production and (ii) ____ production.

a. computer
b. sequential
c. refined
d. custom

ANS: D PTS: 1 REF: Design Process

9. ____ lasers are at the heart of fiber-optics.

a. Semiconductor
b. Carbon dioxide
c. Metal
d. Water-based

ANS: A PTS: 1 REF: Design Process

10. Having a project budget of $1,575 or only being given a one-half bottle of glue would typically be referred to as a ____.

a. specification
b. criterion
c. constraint
d. requirement

ANS: C PTS: 1 REF: Design Limitations

COMPLETION

1. ____________________ is the act of repeating a set of procedures until a specified condition is met.

ANS: Iteration

PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

2. The DARPA Grand Challenge is a prize competition for ____________________ (driverless and completely self-controlled) vehicles.

ANS: autonomous

PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

3. A design ____________________ is a written plan that identifies a problem to be solved and its criteria and constraints.

   ANS: brief

   PTS: 1 REF: Design Process

4. The design ____________________ should include documents that specify all (i) materials, (ii) dimensions, and (iii) processes used in the construction.

   ANS: proposal

   PTS: 1 REF: Design Process

5. ____________________ of a design, or design project, can also be referred to as criteria, constraints, specifications, or requirements.

   ANS: Limitations

   PTS: 1 REF: Design Limitations

SHORT ANSWER

1. What are Polya’s steps to problem solving?

   ANS:
   One of the most famous writers on problem solving was George Polya, a mathematician dedicated to improving mathematics education. In 1945, he wrote the book How to Solve It to summarize his work on problem solving. Polya’s four steps to problem solving are:
   1. Understand the problem
   2. Make a plan
   3. Carry out the plan
   4. Look back on the plan; how could it have been better?

   PTS: 1 REF: Polya's Four Steps to Effective Problem Solving

2. What role does the leader of a brainstorming session have?

   ANS:
   The responsibilities of the leader may include setting up the time and place of the meeting, ensuring attendance, and constructing an agenda for the team to follow. An agenda creates order in the meeting and begins the brainstorming process by validating each topic to be discussed.

   PTS: 1 REF: Design Process

3. What is the importance of an engineering notebook?

   ANS:

An engineering notebook is a very important tool. Your notebook is the source for collecting important information, making it valuable to the designer and the whole project team. An engineering notebook also serves as clear evidence of exact dates of innovative, and potentially patentable, ideas. Engineering notebooks, used frequently in industry, represent legally recognized “hardcopy” evidence of innovation, which can be a deciding factor for both granting a patent and successfully defending a patent.

PTS: 1 REF: Design Process

4. What are some of the most important considerations for the test and evaluation phase?

ANS:
A few recommendations follow:

Make a list of those attributes that are important to test.

Design a set of experiments that address the above list. In this set of experiments consider testing in two types of conditions: (i) under controlled conditions and (ii) in a working environment.

Gather and record your test data. Analyze your data and compare it to the criteria and specification for the design.

Conclude by writing a complete summary of your testing. The summary should identify those major areas of concern that may be the focus of any redesign work.

PTS: 1 REF: Design Process

5. Construct a list that a design team can consult to ensure that they accounted for all of the important limitations for a project.

ANS:
Possible Limitations:
1. Resources
2. Human resources
3. Materials and equipment
4. Time
5. Economic factors (all costs, such as materials, labor, fees, etc.)
6. Physical factors
7. Aesthetics
8. Marketability
9. Reliability
10. Manufacturability
11. Safety (human, animal, and environmental in general)
12. Ethics

PTS: 1 REF: Design Limitations