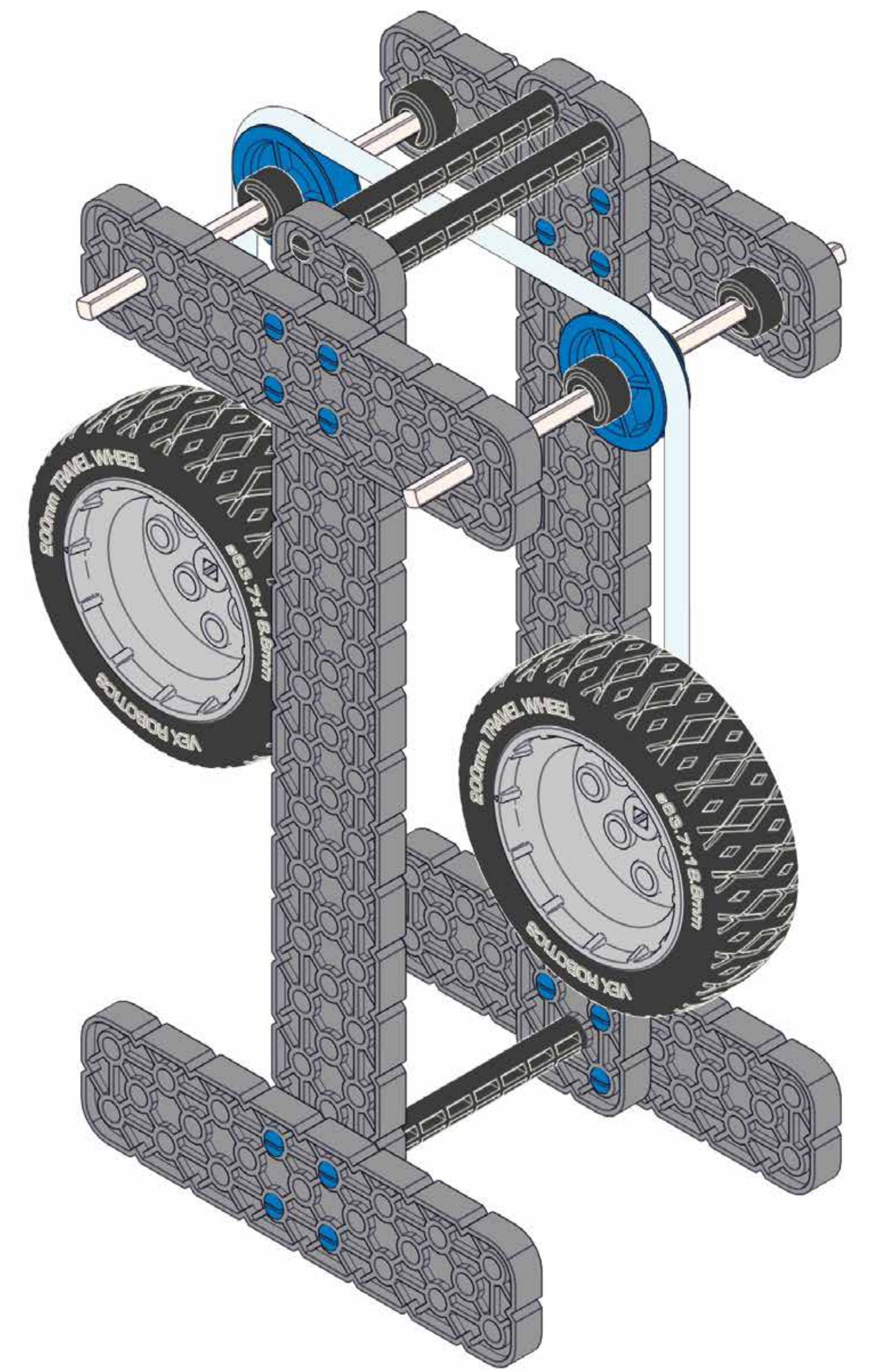
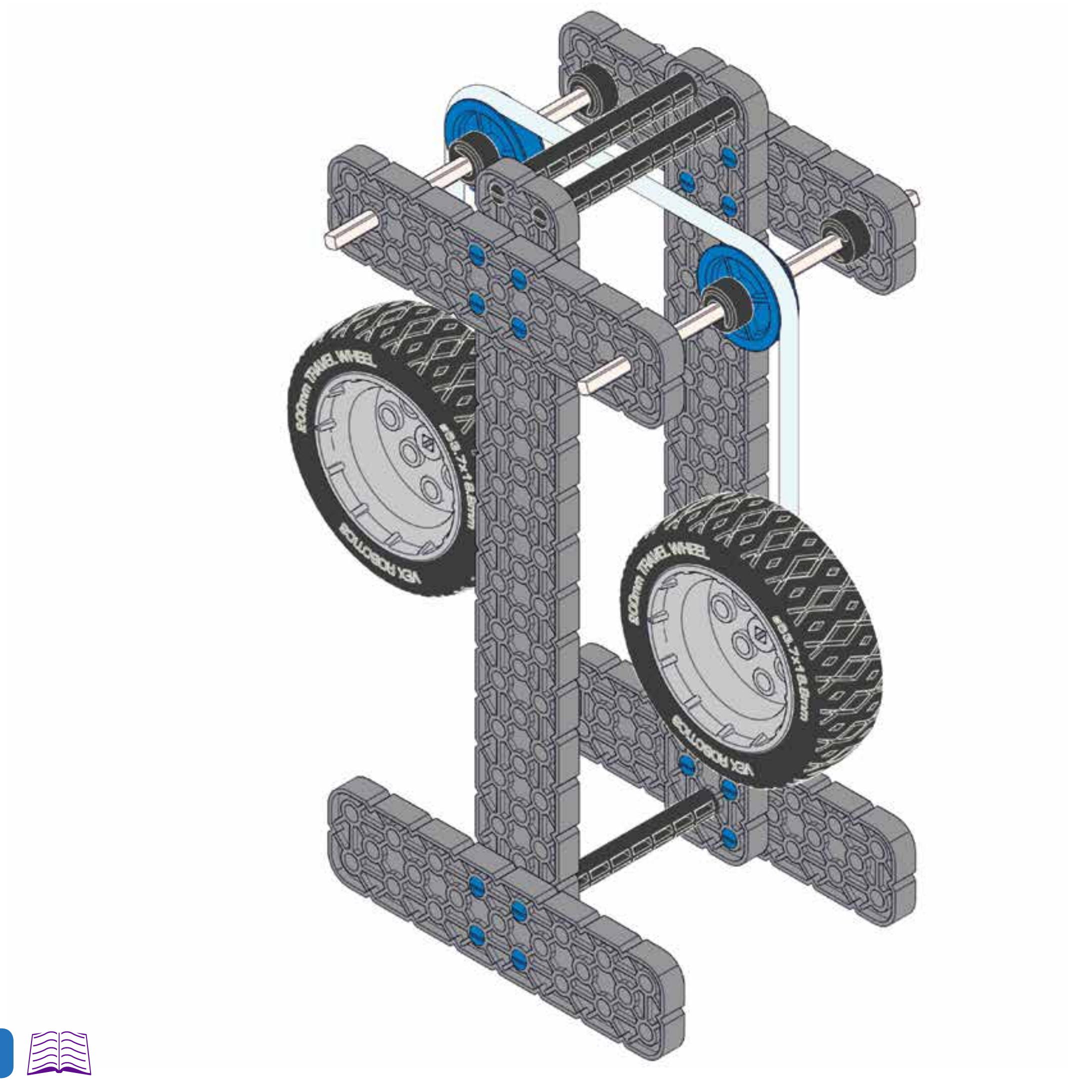
D

Simple Machines & Motion





D.1

Simple Machines & Motion

Unit Overview:

In this unit you will learn about the six types of simple machines, a seventh machine called a pendulum, and all of the scientific concepts and terms that go along with these machines. Simple machines are the basis for all mechanical systems, no matter how complex they may become.

Unit Content:

- Six Types of Simple Machines: Wheel & Axle, Inclined Plane, Wedge, Lever, Pulley, and Screw
- Simple Motion: The Pendulum
- Key Terms: Work, Force, Fulcrum, Simple Harmonic Motion

Unit Activities:

- Matching Exercise
- Sample Simple Machines build with assembly instructions
- Completion of Build and Idea Book Page for Machine Design and/or Robot Design

Note: Separate copies and/or printouts of activities may be used for student work. Please see your teacher BEFORE writing in this guide. Visit www.vexiq.com/curriculum to download and print PDFs of all exercises!

D.2

Simple Machines & Motion

This unit focuses on the most basic building blocks of design, simple machines, and motion. The basic knowledge of simple machines and motion allows students to better understand how things work, provides a foundation for designing mechanisms, and is the first step in learning the principles of mechanical design.

Simple Machines

Simple Machines are tools used to make work easier. In science, **work** is defined as a force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. A **force** is any push or pull that causes an object to change its position (movement), direction, or shape.


Inclined Plane


Lever


Wedge


Screw


Pulley


Wheel and Axle

D.3

The Six Types of Simple Machines:

Wheel & Axle - Makes work easier by moving objects across distances. The wheel (or round end) turns with the axle (or cylindrical post) causing movement. On a wagon, for example, a container rests on top of the axle.

Inclined Plane - A flat surface (or plane) that is slanted, or inclined, so it can help move objects across distances. A common inclined plane is a ramp.

Wedge - Instead of using the smooth side of the inclined plane to make work easier, you can also use the pointed edges to do other kinds of work. When you use the edge to push things apart, this movable inclined plane is called a wedge. An ax blade is one example of a wedge.

Lever - Any tool that pries something loose is a lever. Levers can also lift objects. A lever is an arm that “pivots” (or turns) against a **fulcrum** (the point or support on which a lever pivots). Think of the claw end of a hammer that you use to pry nails loose; it’s a lever. A see-saw is also a lever.

D.3 cont.

Pulley - Instead of an axle, a wheel could also rotate a rope, cord, or belt. This variation of the wheel and axle is the pulley. In a pulley, a cord wraps around a wheel. As the wheel rotates, the cord moves in either direction. Attach a hook to the cord, and now you can use the wheel's rotation to raise and lower objects, making work easier. On a flagpole, for example, a rope is attached to a pulley to raise and lower the flag more easily.

Screw - When you wrap an inclined plane around a cylinder, its sharp edge becomes another simple tool: a screw. If you put a metal screw beside a ramp, it may be hard to see similarities, but a screw is actually just another kind of inclined plane. One example of how a screw helps you do work is that it can be easily turned to move itself through a solid space like a block of wood.

D.4

Simple Motion: The Pendulum

Simple Motion (more fully known as Simple Harmonic Motion) is what happens when an object moves in a non-complex periodic way. This means that:

- The object experiences a force that moves it
- The movement occurs, reaching some maximum value
- The object returns to its "original" conditions
- The process repeats

Let's take the example of a pendulum and consider what happens. A pendulum is defined as a body suspended from a fixed point so that it can swing back and forth under the influence of gravity as a force.

When a pendulum is started, it swings (accelerates) down under the influence of gravity. Gravity is the attraction between two masses, such as the earth and an object on its surface. At the bottom of its arc, the pendulum then swings up on the other side. It continues to move up (and decelerate) until it stops. The pendulum then begins to swing back down, reaching some maximum velocity at the bottom of its arc before swinging back up to where it began. The pendulum has gone through one complete cycle of its motion, and because it is a repetitive cycle, it can be said to be simple harmonic motion. Friction (the force that resists motion through the rubbing of one object against another) will eventually stop the pendulum, but not before several cycles have passed.

D.5

Simple Machines & Motion Matching Exercise

Student Name(s): ______________________________

Teacher/Class: ______________________________ Date: ____________

Part I Instructions:

Match terms from the word bank to the correct definition by writing terms on the correct line. Each term is only used once.

Part I Word Bank:

Force	Friction	Gravity	Pendulum
Simple Harmonic Motion	Simple Machines	Work	

________________ are tools used to make work easier.

________________ is a force acting on an object to move it across a distance.

A ______________ is any push or pull that causes an object to change its position, direction, or shape.

________________ is what happens when an object is in motion in a non-complex periodic way.

A ______________ is a body suspended from a fixed point so that it can swing back and forth under the influence of gravity.

________________ is the attraction between two masses, such as the earth and an object on its surface.

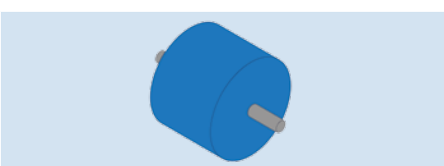
________________ is the force that resists motion through the rubbing of one object against another.

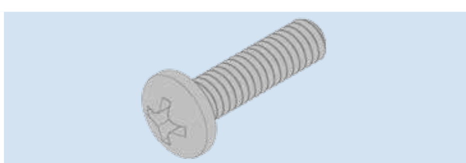
Part II Instructions:

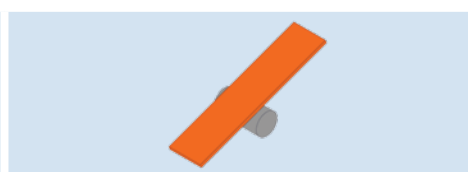
Match terms from the word bank and label correctly below each picture.

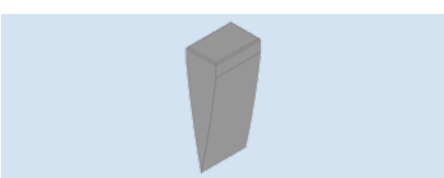
Part II Word Bank:

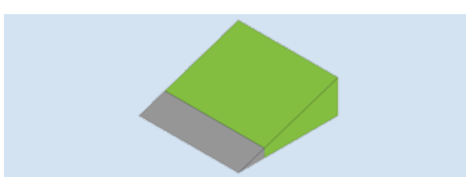
Inclined Plane	Lever	Pulley	Screw	Wedge	Wheel & Axle

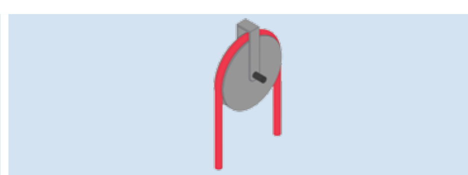










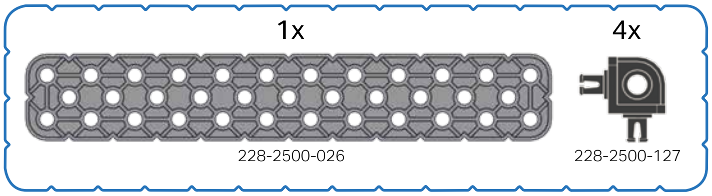


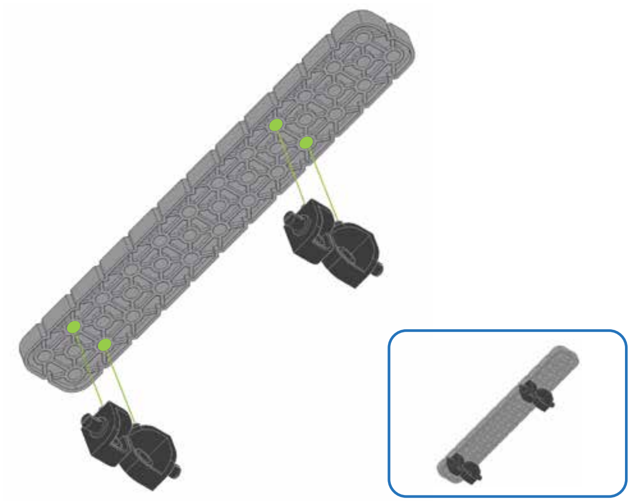
D.6

Simple Machines & Motion Sample Assemblies

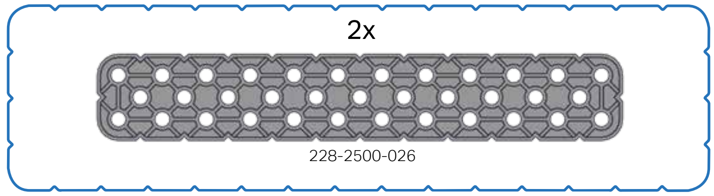
Inclined Plane Assembly

1

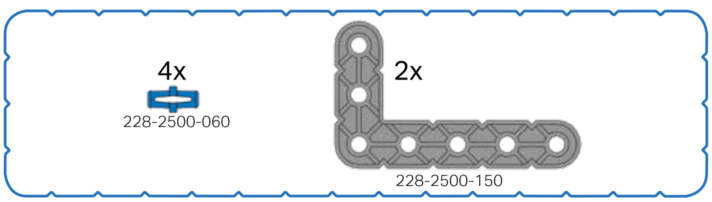


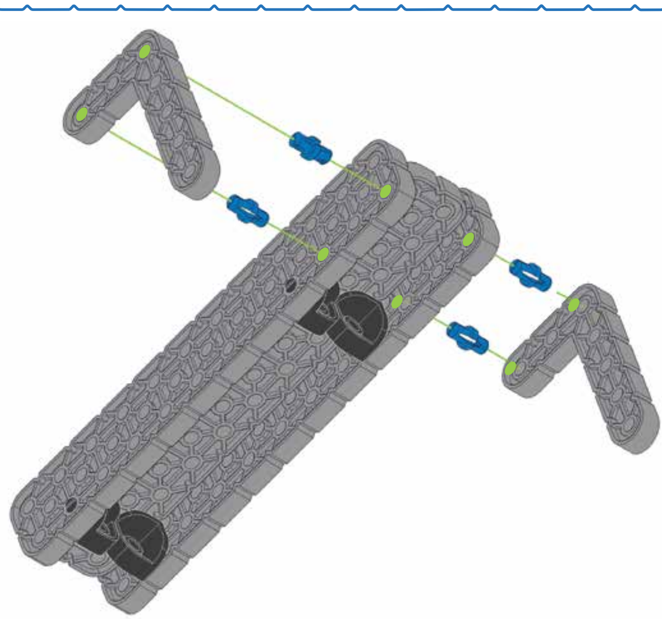


2



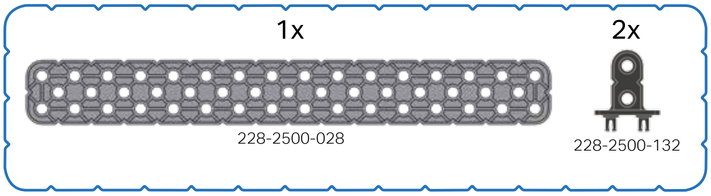
3

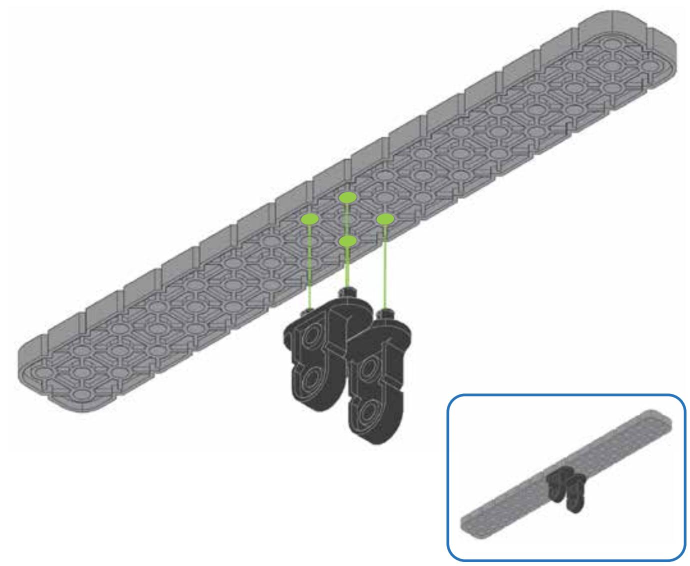




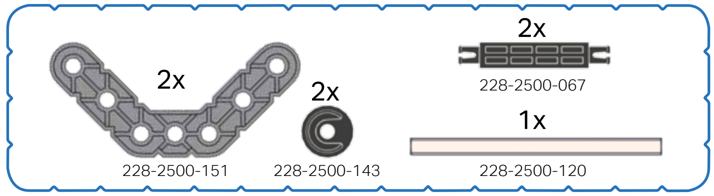
D.6 cont. Lever Assembly

1

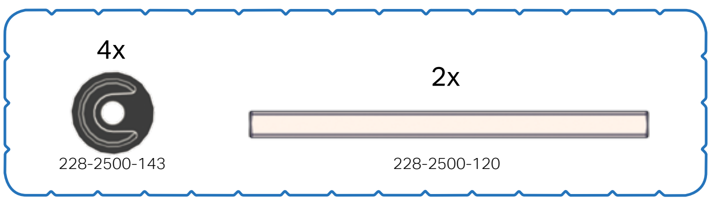


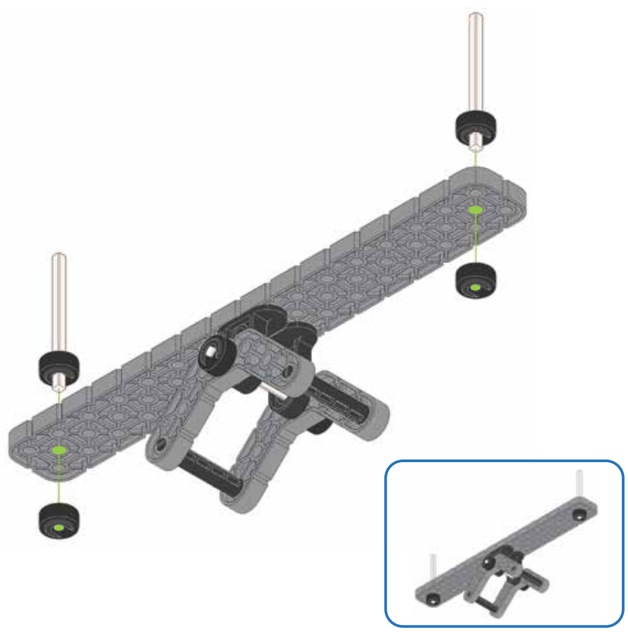


2

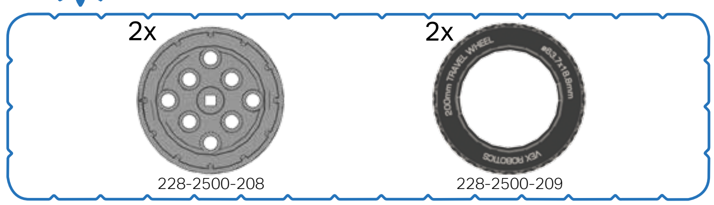


3



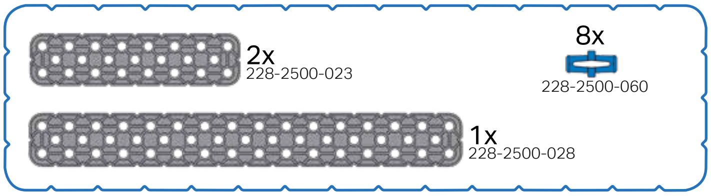


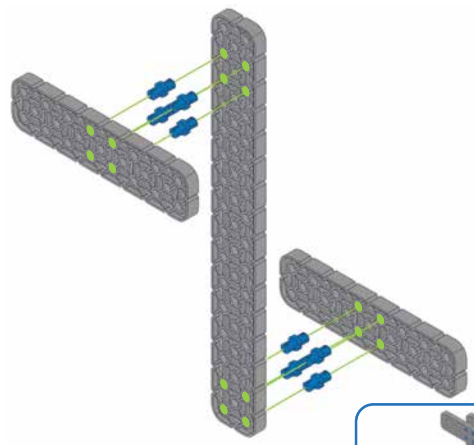
4



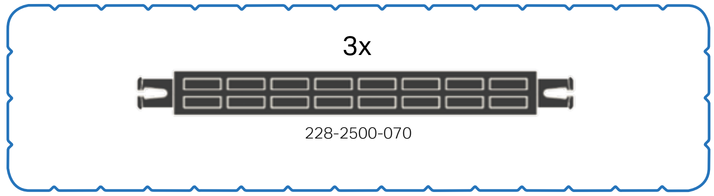
D.6 cont.
Pulley Assembly

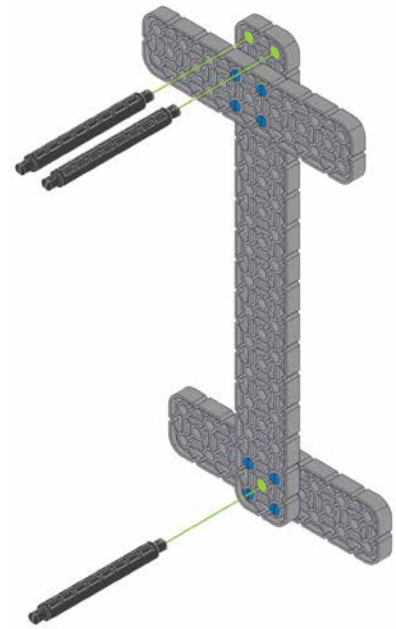
1



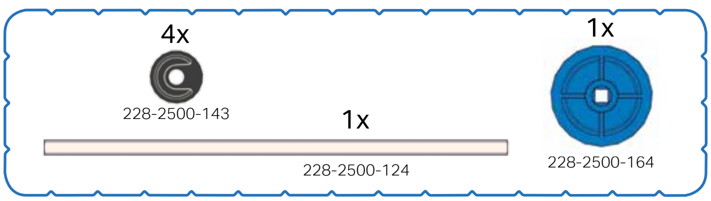


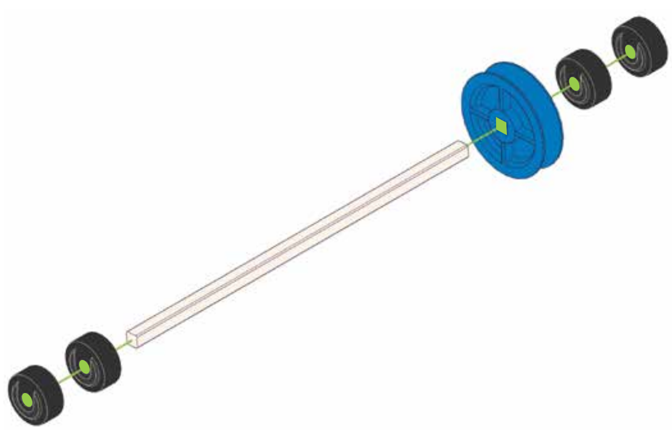
2



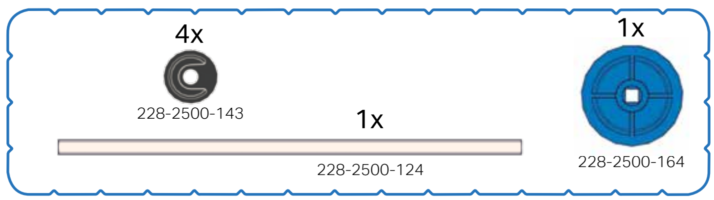


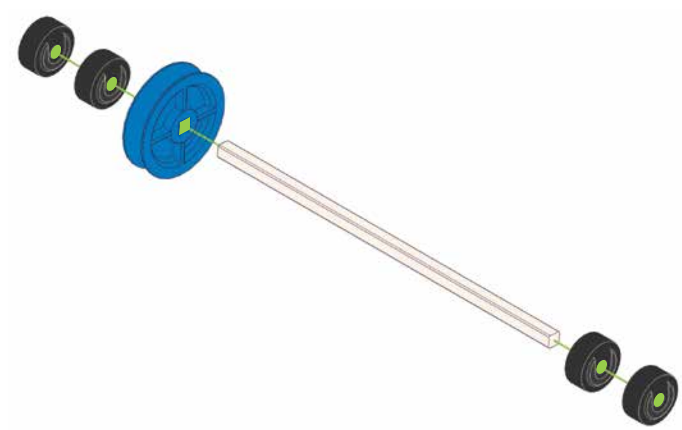
3





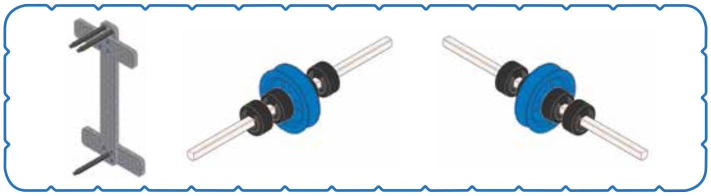
4

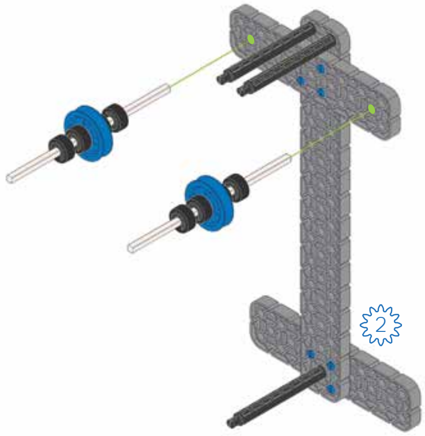




D.6 cont.

5

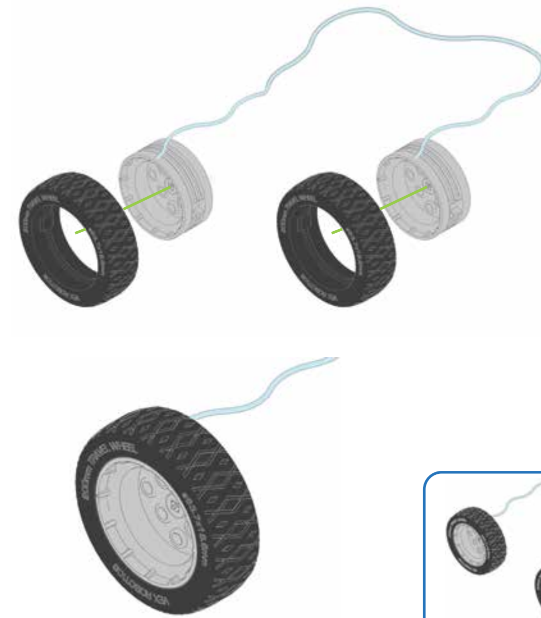




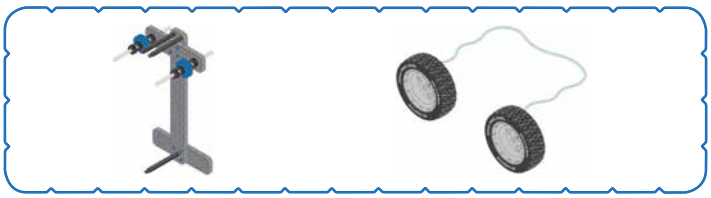
2

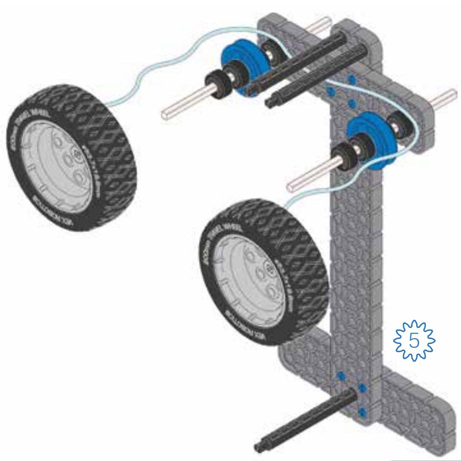
6

2x
228-2500-208
2x
228-2500-209
1x
304.8mm
(12") String
(not included)



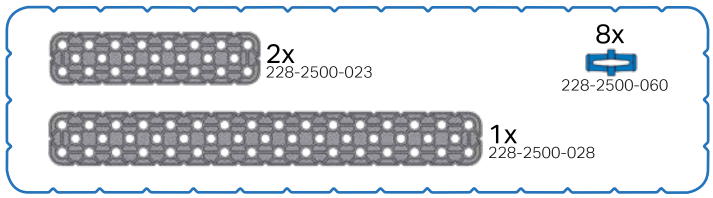
7



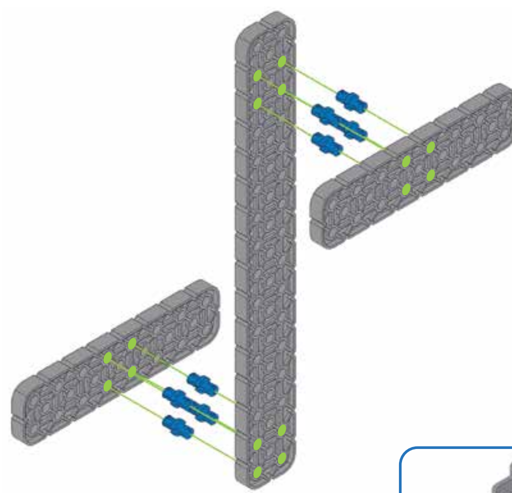


5

8

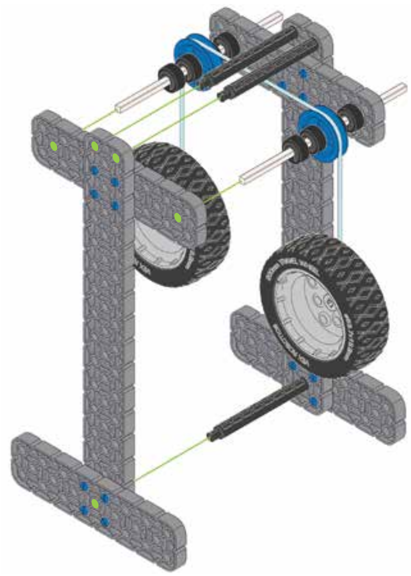


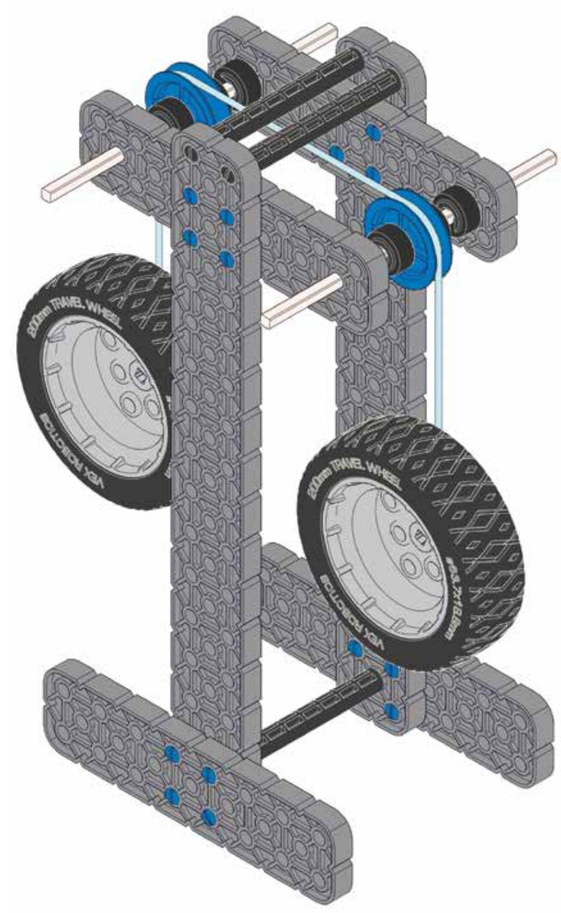
2x
228-2500-023
8x
228-2500-060
1x
228-2500-028



D.6 cont.

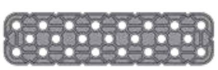
9



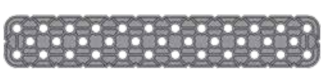


Pendulum Assembly

1



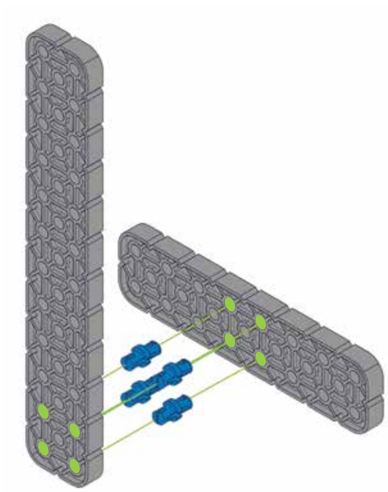
1x
228-2500-023

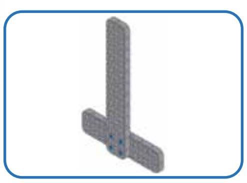


1x
228-2500-026

4x

228-2500-060

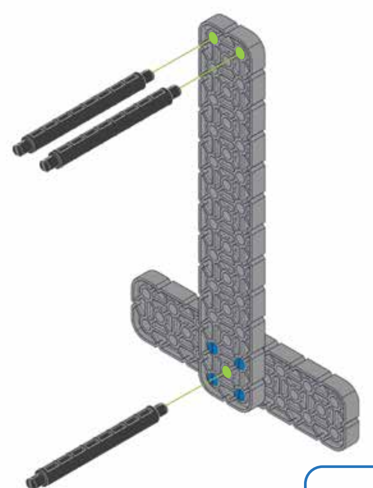




2

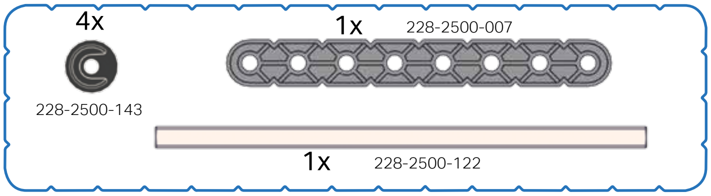
3x

228-2500-070



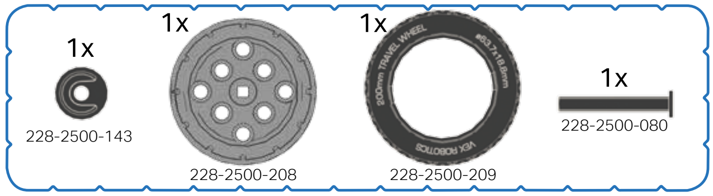
D.6 cont.

3



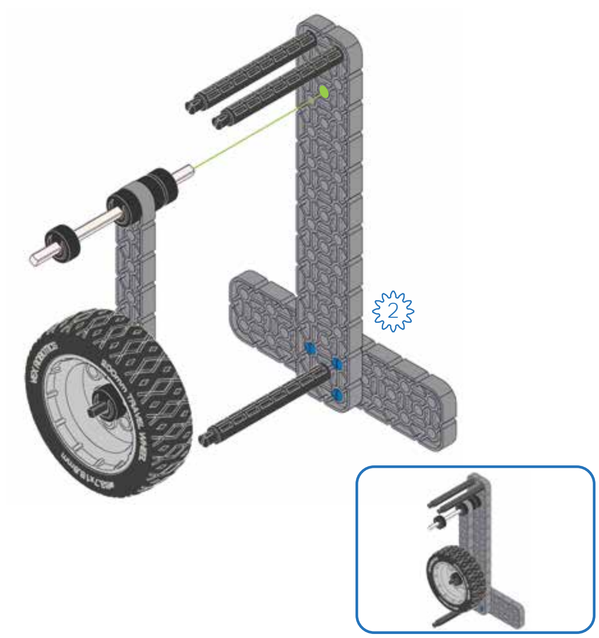
4x
228-2500-143
1x
228-2500-007
1x
228-2500-122

4



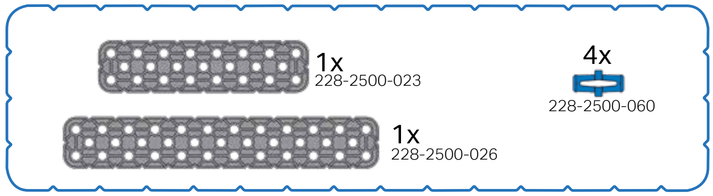
1x
228-2500-143
1x
228-2500-208
1x
228-2500-209
1x
228-2500-080

5

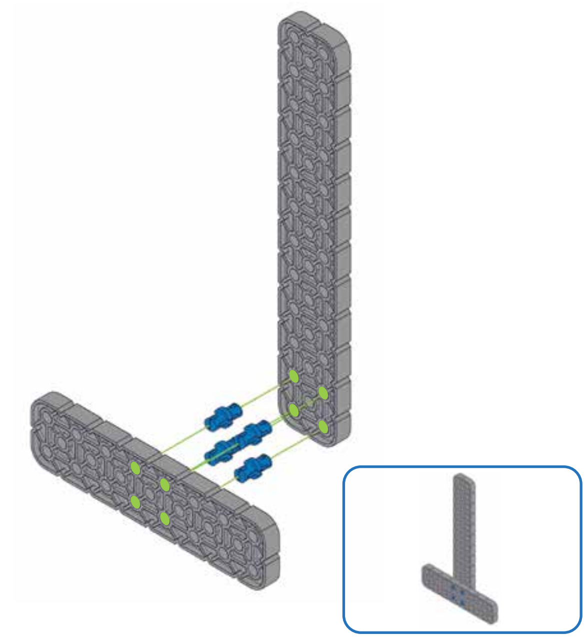


2

6

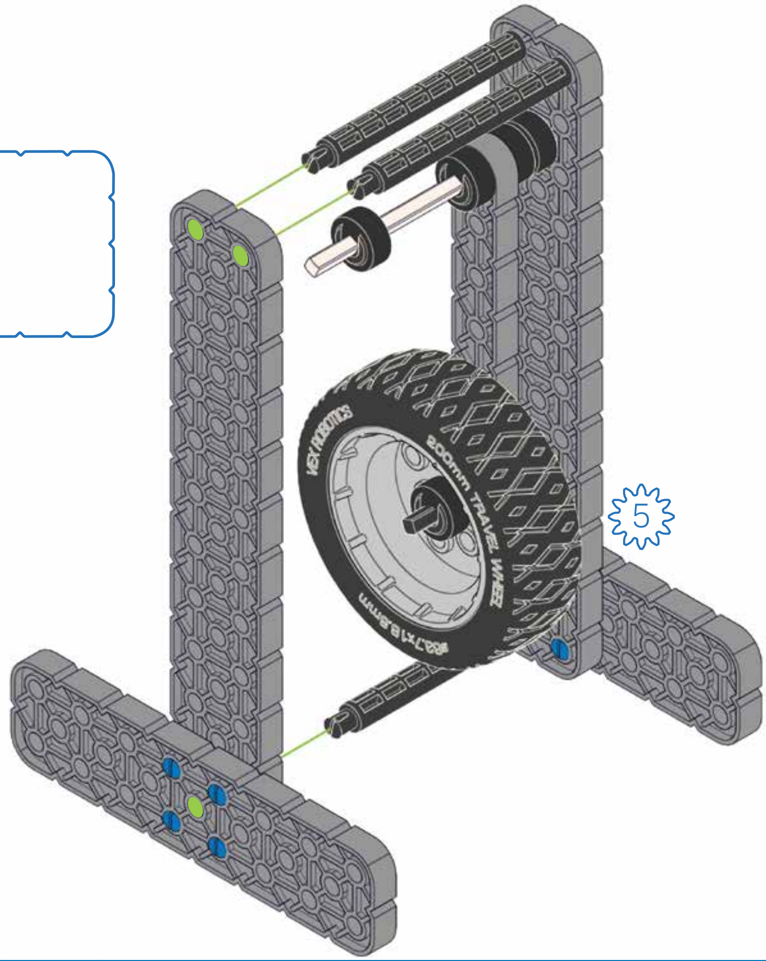


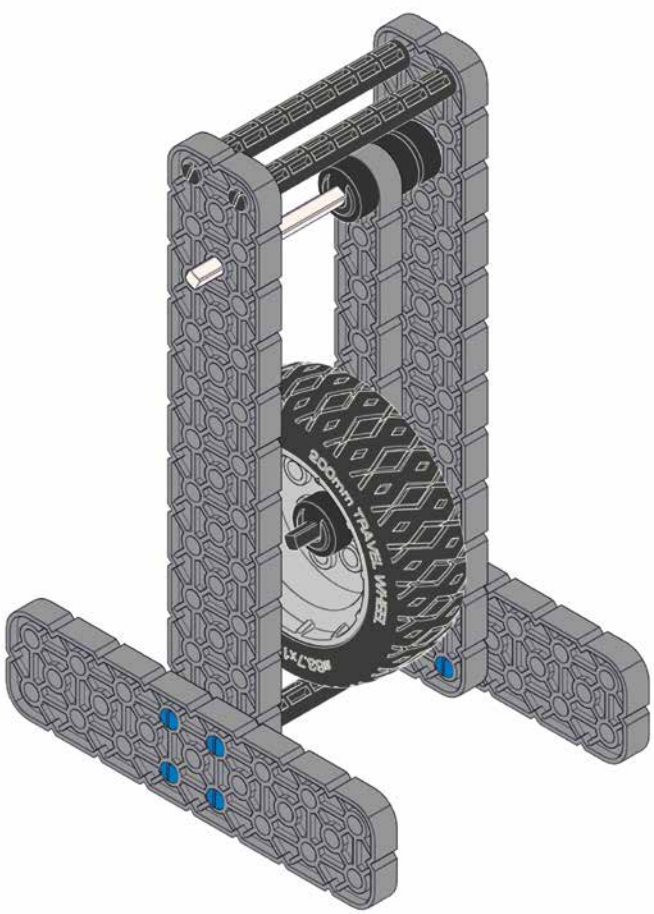
1x
228-2500-023
1x
228-2500-026
4x
228-2500-060



D.6 cont.

7



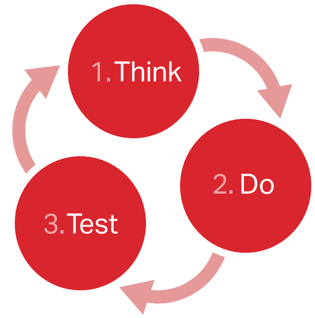


D.7

Simple Machines & Motion Idea Book Page Exercise: Machine Design

Student Name(s): ____

Teacher/Class: ____________________ Date: _________ Page #: _____



Instructions:

After you have completed building the Simple Machines & Motion Sample Assemblies your teacher may ask you to design a simple machine or pendulum of your own. Following your teacher's instructions, use this Idea Book Exercise page to document your design.

1. "THINK" - Here is where your "idea" or "problem" is written/drawn:

____

____

Draw your idea and/or problem here, too, if it helps you to describe it. What might your solution look like?

2. "DO" – Here is where you list your task or tasks that your "THINK" step created:

____

____

____

____

3. "TEST" – After your "DO" step is done, test your design. Write down your observations:

____

____

Does your simple machine/pendulum function like you expected? YES NO

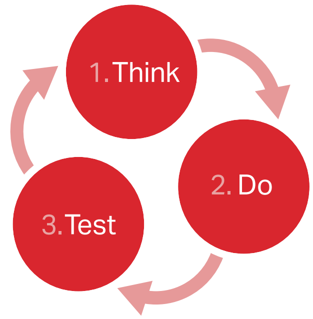
If you answered "YES" - Congratulations! You may now move on to repeat this task with a new simple machine/pendulum or move on to other lessons.

If you answered "NO" - Use your observations above to determine what problem exists, then use another copy of this page to help solve that problem. Keep repeating this "THINK-DO-TEST" process, until your robot completes the task.

Problems ARE NOT failures. They are an expected part of the design process!

D.7 cont.

Simple Machines & Motion Idea Book Page Exercise: Robot Design



Student Name(s): ____

Teacher/Class: ____________________ Date: _________ Page #: _____

Instructions:

Starting with the Clawbot IQ Robot Base, add one simple machine or pendulum so the result is a teleoperated robot that moves a tennis ball, cube, or similar round object from a floor or table top onto a 1-inch to 2-inch high platform (a book will suffice for this exercise). Your teacher may assign which simple machine/ pendulum you are to use or you may get to pick.

1. "THINK" - Here is where your "idea" or "problem" is written/drawn:

____

____

Draw your idea and/or problem here, too, if it helps you to describe it. What might your solution look like?

2. "DO" – Here is where you list your task or tasks that your "THINK" step created:

____

____

____

____

3. "TEST" – After your "DO" step is done, test your design. Write down your observations:

____

____

Does your simple machine/pendulum function like you expected? YES NO

If you answered "YES" - Congratulations! You may now move on to repeat this task with a new simple machine/pendulum or move on to other lessons.

If you answered "NO" - Use your observations above to determine what problem exists, then use another copy of this page to help solve that problem. Keep repeating this "THINK-DO-TEST" process, until your robot completes the task.

Problems ARE NOT failures. They are an expected part of the design process!