

Unit 1 Study Guide: Engineering and Technology

Grade 5 Science

Use this guide a little each night. Students should try the example questions first, then read the explanations. Families can use the “**Why?**” **explanations** to help teach the ideas at home.

Lesson 1: Science, Math, Engineering, and Technology

1. Engineering

Engineering = using science and math to solve practical problems.

Engineers:

- design
- build
- improve
- test
- solve problems

Remember the Yellow House

Think about when we went to see the Yellow House being taken apart.

Science: helps us understand what is happening.

Example: What materials are there? Why do some materials break differently?

Engineering: helps us solve a problem.

Example: How can the area be changed safely or used for something new?

Math: helps us measure and compare.

Example: distance, area, amount of material, cost.

Technology: tools or processes people create to solve problems or meet needs.

Easy memory trick

Science = understand

Engineering = solve

Math = measure and compare

Technology = designed to meet a need

Example Question

Workers are preparing to rebuild where an old house was removed. Which task would most clearly require **math**?

- A. Studying why wood rots
- B. Measuring the size of the new foundation
- C. Observing which materials break easily
- D. Learning why rain damages wood

Correct answer: B

Why B is correct

Measuring the size of the foundation uses numbers and measurement.

Why the others are wrong

- A:** This is more science because it asks why something happens.
- C:** This is an observation about material behavior, which is more science.
- D:** This also asks for an explanation of a natural process, so it is science.

Parent question

Ask your child:

“Would this job help us understand something, measure something, or solve something?”

That question can help them decide whether science, math, or engineering is being used.

2. Technology

Technology = a product or process designed to solve a problem or meet a need.

Technology does **not** have to be electronic.

Examples:

- pencil
- chair
- bridge
- seat belt
- shovel
- phone

Important idea

A new tool can help scientists learn more.

A scientific discovery can also help engineers create new technology.

Example Question

Which is the best example of technology?

- A. Rain falling
- B. A bird building a nest
- C. A seat belt designed to protect people
- D. A mountain

Correct answer: C

Why C is correct

A seat belt was designed by people to solve a safety problem.

Why the others are wrong

A: Rain is natural.

B: A bird's nest is made by an animal, not designed as human technology.

D: A mountain is natural.

Lesson 2: The Design Process

3. The Design Process

The formal steps are:

Problem → Research → Brainstorm → Choose → Test → Improve → Communicate

Easier way to remember it

Find it → Learn → Think → Pick → Try → Fix → Share

That means:

Problem

What needs to be fixed?

Research

What information would help?

Brainstorm

Think of many possible ideas.

Choose

Pick a solution that seems best.

Test

Try it.

Improve

Fix problems you find.

Communicate

Share what happened.

Remember the Perfect Chair

We talked about designing a perfect chair.

One idea was:

“Make it soft by putting feathers on it.”

That sounds comfortable.

But then we found a problem:

Feathers may get dirty.

That does **not** mean the whole idea was bad.

An engineer could revise it:

- use a washable cushion
- use a removable cover
- try a different soft material

Big lesson

Engineers do not have to get it right the first time.

Test → find a problem → improve → test again

Example Question

A new backpack is tested. Students say it holds many books, but the straps hurt their shoulders.

What should the engineer do next?

- A. Sell the backpack immediately
- B. Ignore the strap problem
- C. Improve the straps and test the backpack again
- D. Stop using evidence

Correct answer: C

Why C is correct

Testing found a problem. Engineers use that evidence to improve the design and test again.

Why the others are wrong

A: The design still has a problem.

B: Ignoring evidence does not improve the design.

D: Evidence is what helps engineers decide what should change.

4. Criteria and Constraints

These two words are VERY important.

Criteria = WANTS

What should a successful solution do?

Examples:

- safe
- comfortable
- strong
- hold 5 books
- keep water off a trail

Constraints = LIMITS

What makes the job harder or limits the solution?

Examples:

- limited money
- limited materials
- limited time
- limited space

Memory trick

Criteria = what we WANT

Constraints = what gets in our WAY

Perfect Chair Example

Criterion: The chair should be comfortable.

Constraint: We only have certain materials.

Another criterion might be:

The chair should be easy to clean.

Example Question

A student must build a bridge that can hold three books. The student may only use 10 craft sticks.

Which is a **constraint**?

- A. The bridge must hold three books.
- B. The bridge should be strong.
- C. The student may only use 10 sticks.
- D. The bridge should work safely.

Correct answer: C

Why C is correct

The number of sticks limits what the student can use.

Why the others are wrong

- A:** Holding three books is something the solution must accomplish, so it is a criterion.
 - B:** Strength is a desired result.
 - D:** Safety is also something a good design should accomplish.
-

5. Research

Research = learning useful information before choosing a solution.

Good research should help answer the problem.

Perfect Chair Example

Problem:

The chair gets dirty easily.

Helpful research:

- washable fabrics
- stain-resistant materials
- removable covers

Not very helpful:

- history of chairs
- favorite chair colors

Easy rule

Good research should help solve the actual problem.

Example Question

A student wants to design a shirt that stays cool and is easy to clean.

Which research would be MOST useful?

- A. Famous clothing designers
- B. Fabrics that do not absorb much heat
- C. Favorite shirt colors
- D. History of buttons

Correct answer: B

Why B is correct

The student is trying to stay cool, so learning about materials that absorb less heat directly helps solve the problem.

Why the others are wrong

A: It does not directly help solve the problem.

C: Color preference is not the main problem.

D: Button history does not help make the shirt cooler or easier to clean.

6. Evidence

Evidence = information that supports an answer or decision.

Evidence can come from:

- observations
- measurements
- maps
- graphs
- tests
- research

Ask yourself:

“What information proves my answer?”

7. Variables and Fair Tests

Variable

A variable is something that changes in an investigation.

Fair Test

Change the thing you want to study. Keep the other important conditions the same.

Easy memory trick

In our experiment, our mountain, the amount of water, and the spot the water began falling stayed the **SAME**. Barriers and trails **CHANGED**.

Example

Students want to know which ball bounces highest.

They use:

- golf ball
- plastic ball
- rubber ball

They:

- drop every ball from the same height
- use the same floor

Changed variable:

type of ball

Kept the same:

- drop height
 - floor
-

Example Question

Students test three paper towel brands to see which absorbs the most water.

Which plan is the fairest?

- A. Use different-sized sheets and different amounts of water.
- B. Use the same-size sheet and same amount of water for every brand.
- C. Use one brand on a table and another on carpet.
- D. Let each student choose how much water to use.

Correct answer: B

Why B is correct

The paper towel brand changes, while the important testing conditions stay the same.

Why the others are wrong

A: Too many things are changing.

C: Changing the surface could affect the results.

D: Changing the amount of water makes the comparison unfair.

8. Repeated Tests

Repeated tests make results more reliable.

If something happens only once, it could have happened by chance.

Easy memory trick

More fair repeats = more reliable results

Example:

If one paper airplane flies far one time, does that prove it always works best?

No.

Test it several times.

Lesson 3: Technology and Society

9. Why Technology Changes

Technology changes as people's needs and wants change.

Designs may change for:

- safety
 - usefulness
 - efficiency
-

Remember Our Car Safety Examples

Older cars did not have the same safety features as newer cars.

Technology improved with things like:

- better seat belts
- airbags
- safer dashboard materials

Why did these changes happen?

People wanted safer cars.

Engineers learned more.

Laws and safety rules changed.

Example Question

Why were airbags added to cars?

- A. Society wanted safer cars.
- B. Engineers wanted cars to create traffic.
- C. Older cars could not move.
- D. People wanted cars to be more dangerous.

Correct answer: A

Why A is correct

People wanted safer transportation, so engineers improved car safety technology.

Why the others are wrong

B: Traffic may be an effect of many cars, but it is not why airbags were developed.

C: Older cars already moved.

D: The goal was to reduce danger, not increase it.

10. Positive and Negative Effects

Technology can have more than one effect.

Positive effect

A helpful result.

Negative effect

A harmful result.

Car example

Positive: Cars help people travel farther and faster.

Negative: Cars can cause traffic and pollution.

11. Expected and Unexpected Effects

Expected effect

A result people thought about ahead of time.

Unexpected effect

A result people did not plan for.

Important

Expected does NOT always mean positive.

Unexpected does NOT always mean negative.

They answer different questions.

Ask:

Positive or negative?

Was it helpful or harmful?

Expected or unexpected?

Did people plan for it?

Car Example

Cars make travel easier.

Positive? **Yes**

Expected? **Yes**

Many cars create traffic.

Positive or negative? **Negative**

Expected or unexpected? **It may be unexpected.**

Example Question

A city builds a new highway so people can travel more quickly. Later, many businesses move near the highway and the area becomes crowded.

Which part is most likely an **unexpected effect**?

- A. People can travel faster.
- B. The road was built for cars.
- C. The area becomes more crowded than planners expected.
- D. Engineers used materials to build the highway.

Correct answer: C

Why C is correct

The crowding happened as a result of the highway but was not the main planned result.

Why the others are wrong

A: Faster travel was the reason the highway was built.

B: That is simply a fact about the highway.

D: That describes construction, not an effect.

12. Tradeoffs

Tradeoff = giving up one thing to gain another.

Easy memory trick

Gain something → give something up

Remember: Pen vs. Pencil

Pen

Benefits

- many colors
- no sharpening

Tradeoff

- hard to erase

Pencil

Benefit

- erasable

Tradeoff

- needs sharpening

Important idea

Neither one is always better.

It depends on what matters most.

Example Question

Laptop A has a very large battery but weighs more.

Laptop B is lighter but has a smaller battery.

What is the tradeoff?

- A. Battery life versus weight
- B. Color versus screen size
- C. Price versus keyboard shape
- D. Internet speed versus sound

Correct answer: A

Why A is correct

The user gains longer battery life but gives up some lightness.

Why the others are wrong

B, C, and D: Those features were not part of the information given.

Good Science Writing

Do not stop at “because it worked.”

Good science writing explains **what happened and why it matters**.

Weak

Test 3 was better.

This does not explain why.

Better

Test 3 was better because less water crossed the trail.

Now there is evidence.

Strong

Test 3 was better because the barriers redirected water away from the trail, so the trail flooded less.

Now the answer includes:

- a claim
 - evidence
 - reasoning
-

Helpful Sentence Starters

Explaining an answer

I think _____ because _____.

Using evidence

My evidence is _____. This shows _____.

Criteria

The design meets the criterion because _____.

Constraint

A constraint is _____ because it limits _____.

Tradeoff

The benefit is _____, but the tradeoff is _____.

Practice Questions

Try these **without looking at the notes first**.

1.

A playground bench must safely hold four students. The class may only spend \$40.

Which is a **constraint**?

- A. Hold four students
 - B. Be safe
 - C. Cost no more than \$40
 - D. Be useful
-

2.

A student wants to know which type of soil holds the most water.

What should the student change?

- A. Type of soil
 - B. Amount of soil
 - C. Amount of water
 - D. Size of container
-

3.

Why should the student in Question 2 keep the amount of water the same?

- A. To make the test fair
 - B. To make the soil heavier
 - C. To create more variables
 - D. To make every result different
-

4.

A chair is very comfortable but its fabric stains easily.

What should an engineer do?

- A. Ignore the stain problem
 - B. Improve the fabric and test again
 - C. Stop collecting evidence
 - D. Use the exact same design forever
-

5.

Which is the best example of useful research for the chair problem?

- A. Famous chairs in history
 - B. Washable and stain-resistant fabrics
 - C. Favorite chair colors
 - D. Names of furniture stores
-

6.

A new bus produces less air pollution than an older bus.

What kind of effect is this?

- A. Positive
- B. Negative

- C. A constraint
 - D. A variable
-

7.

Phones allow people to communicate quickly, but they can also distract drivers.

What does this show?

- A. Technology can only have positive effects.
 - B. Technology can only have negative effects.
 - C. One technology can have both positive and negative effects.
 - D. Engineers should never improve technology.
-

8.

A student chooses a pen instead of a pencil.

Give **one benefit** and **one tradeoff**.

Benefit: _____

Tradeoff: _____

9.

A bridge must hold 10 pounds and can only use 20 sticks.

Criterion: _____

Constraint: _____

10.

Students test four chair cushions.

They use the same chair and same person each time, but change the cushion material.

What is the variable?

11.

Why should engineers test a design more than once?

12.

A car becomes safer because airbags are added.

Why did the technology most likely change?

13.

A new road helps people get to work faster, but later causes heavy traffic near the city.

Positive effect: _____

Negative effect: _____

Possible unexpected effect: _____

14.

A backpack can hold many books, but carrying it becomes very heavy.

Explain the tradeoff.

Practice Answer Help

1. C

Why: \$40 is a limit.

A, B, and D describe things the bench should accomplish.

2. A

The student is trying to compare soil types, so **type of soil** should change.

The other important conditions should stay the same.

3. A

Keeping the water amount the same makes the test fair.

If different soils received different amounts of water, students would not know whether the soil or water amount caused the result.

4. B

Testing found a weakness.

Engineers use that evidence to revise and retest a design.

5. B

Washable and stain-resistant materials directly help solve the problem.

The other choices do not help solve the stain problem.

6. A

Less pollution is a helpful result, so it is a positive effect.

7. C

The phone provides a benefit, but it can also create a problem.

Technology can have more than one effect.

8. Example

Benefit: A pen does not need sharpening.

Tradeoff: It is difficult to erase.

Other reasonable answers are possible.

9.

Criterion: Hold 10 pounds.

Constraint: Only 20 sticks may be used.

10.

Cushion material

That is the thing intentionally changed.

11. Example

Engineers repeat tests so their results are more reliable and they can see whether the design works consistently.

12. Example

The technology changed because people wanted safer cars.

13. Example

Positive: People get to work faster.

Negative: Heavy traffic develops.

Unexpected: The heavy traffic may not have been planned.

14. Example

The backpack can carry more books, but the tradeoff is that it becomes heavier to carry.

Family Guide: The “Why” Behind Unit 1

You do not need to be a science expert to help.

These are the main ideas behind the unit.

Why do engineers research first?

So they understand the problem before choosing a solution.

Why brainstorm more than one idea?

The first idea is not always the best one.

Comparing ideas can lead to a better solution.

Why do criteria matter?

Criteria tell us what a successful solution should do.

Criteria = goals

Why do constraints matter?

Constraints are real limits engineers must work around.

Examples:

- money
- time
- materials
- space

Constraints = limits

Why do engineers test?

Testing gives evidence.

It shows what worked and what needs improvement.

Why improve a design?

Finding a problem is useful.

Engineers use that information to make the next version better.

Why repeat tests?

One result could happen by chance.

Repeated tests make results more reliable.

Why keep most things the same in a fair test?

So students can tell what actually caused the difference.

Why does technology change?

People's needs and wants change.

Technology changes to meet those new needs and wants.

Why can useful technology still cause problems?

Solving one problem can sometimes create another problem.

Cars make travel easier, but many cars can also create traffic and pollution.

Why do tradeoffs happen?

A design usually cannot be best at everything.

Improving one feature may mean giving up something else.

Questions Parents Can Ask

These work for almost every problem in this unit:

What is the problem?

What does the solution need to do?

What limits the solution?

What information would help?

What evidence supports your answer?

What changed?

What stayed the same?

Was the test fair? Why?

What could be improved?

What did you gain, and what did you give up?

Night Before the Test

If You Remember Nothing Else...

1. **Science = understand.**
2. **Engineering = solve.**
3. **Technology = something designed to meet a need.**
4. **Math helps engineers measure and compare.**
5. **Criteria = wants/goals.**
6. **Constraints = limits.**
7. **Research before choosing a solution.**
8. **Problem → Research → Brainstorm → Choose → Test → Improve → Communicate**
9. **A fair test changes one important thing and keeps other conditions the same.**
10. **Repeated tests make results more reliable.**
11. **Technology changes when people's needs and wants change.**
12. **Technology can have positive, negative, expected, and unexpected effects.**

13. **Tradeoff = gain something, give something up.**
14. **Good science answers explain WHY.**