

Chemical Engineering and Society: Mastery Check

Learning target: I can show that I understand where synthetic materials come from, how their structure gives them useful properties, what they cost and give to society, and how engineers revise criteria when a solution causes new problems.

Retrieval and mastery check

About 40 min

Individual

MS-PS1-3 · assesses

MS-ETS1-1 · practice

independent practice

writing

Name _____

Date _____

Period _____

Directions

Part A has twelve retrieval items; answer every one, even if you must make your best guess. Show calculations for numeric items. Part B is a short synthesis; write in complete sentences and use the chapter's vocabulary. You may not use notes, but you may ask for your W1 sheet for Part B, because the synthesis asks you to revise your first explanation.

You will need: This worksheet, Pencil, Calculator (optional), Completed W1 sheet for Part B (optional)

Part A: Retrieval (12 items)

- Which of these is a natural resource rather than a synthetic material?
 - ☐ A. A nylon rope
 - ☐ B. Crude oil pumped from underground
 - ☐ C. A PLA cup
 - ☐ D. Sucralose
- Which statement gives the accurate meaning of **synthetic material**?
 - ☐ A. A material that is fake or an imitation of a real one
 - ☐ B. A material made in a laboratory out of nothing
 - ☐ C. A material people produce from natural resources through chemical processes
 - ☐ D. A material that can never be found in nature
- True or false: Petroleum took only a few hundred years to form underground from dead plants and animals.
 - ☐ True ☐ False Explain your thinking:

4. Corn starch is broken into glucose; then yeast carry out a chemical process called _____ that turns the glucose into ethanol and the gas _____.

5. Sucralose and table sugar have almost the same molecular shape, but sucralose has three chlorine atoms where sugar has oxygen-hydrogen groups. Use this to explain why sucralose tastes sweet yet gives the body no energy.

6. In the original method, treating one cancer patient with paclitaxel took the bark of about 6 mature Pacific yew trees (a historical estimate), and the trees take roughly a century to mature. How many trees would it have taken to treat 250 patients? Then explain in one sentence why the bark was being used as a nonrenewable resource even though trees are living things.

7. A material is described as **biodegradable**. Which statement is accurate?

- ☐ A. It will break down quickly wherever it is thrown away.
- ☐ B. Living things can break it down, but how fast depends on heat, moisture and oxygen.
- ☐ C. It was made from plants.
- ☐ D. It cannot be recycled.

8. Label each statement as a **criterion** or a **constraint**: (a) 'The bag must hold 2 kg of apples for 10 minutes without tearing.' (b) 'The team may spend no more than \$4 on materials.'

9. Why did engineers add 'breaks down quickly after use' to the criteria for plastic containers?

- ☐ A. Plastics stopped being strong enough for containers.
- ☐ B. Evidence showed that single-use plastics were filling landfills for years and harming wildlife.
- ☐ C. Petroleum became too expensive to use for plastics.
- ☐ D. Customers asked for containers that leak less.

- 10.** A reusable cup takes 12 MJ of energy to make and 0.1 MJ per wash. A single-use cup takes 0.5 MJ to make. After how many uses has the reusable cup used the same total energy as that many single-use cups? Show your work.

- 11.** Give one benefit and one cost of using corn ethanol instead of gasoline. Your cost may not be 'it is a chemical.'

- 12.** Draw a four-box flow for any synthetic material from this chapter other than ethanol: natural resource → chemical process (name what happens) → synthetic material → one effect on people or the environment. Label every box.

Part B: Synthesis

- 13.** Return to the two jackets from the start of the chapter: one leather, one faux leather made of polyurethane on polyester. Rewrite your first explanation of why a company would make the faux jacket. Your new explanation must (1) trace the faux jacket to its natural resource and name the kind of process that made it, (2) give one benefit and one cost of each jacket for people or the environment, (3) use at least four of these terms correctly: natural resource, synthetic material, polymer, nonrenewable, renewable, biodegradable, trade-off, and (4) end with one sentence about what information you would still need before calling either jacket the better choice.

If you are stuck

For any 'which is natural' question, ask whether people chemically changed it into a new substance; if they only dug it up, pumped it or harvested it, it is a natural resource. For criterion versus constraint, ask whether the sentence says what the design must do (criterion) or sets a limit it must stay inside (constraint). For the break-even calculation, each use of the reusable cup saves the cost of a single-use cup but adds a wash; divide the making energy by the saving per use. For Part B, build your paragraph in the order of the four numbered requirements.

One material, two stories

Pick one synthetic material from the chapter and write two short paragraphs about it: one as an honest advertisement that uses only true statements, and one as an honest warning that also uses only true statements. Then write two sentences on what a reader would need to add to either paragraph to get a fair picture, and why a scientist would refuse to call the material simply 'good' or 'bad.'