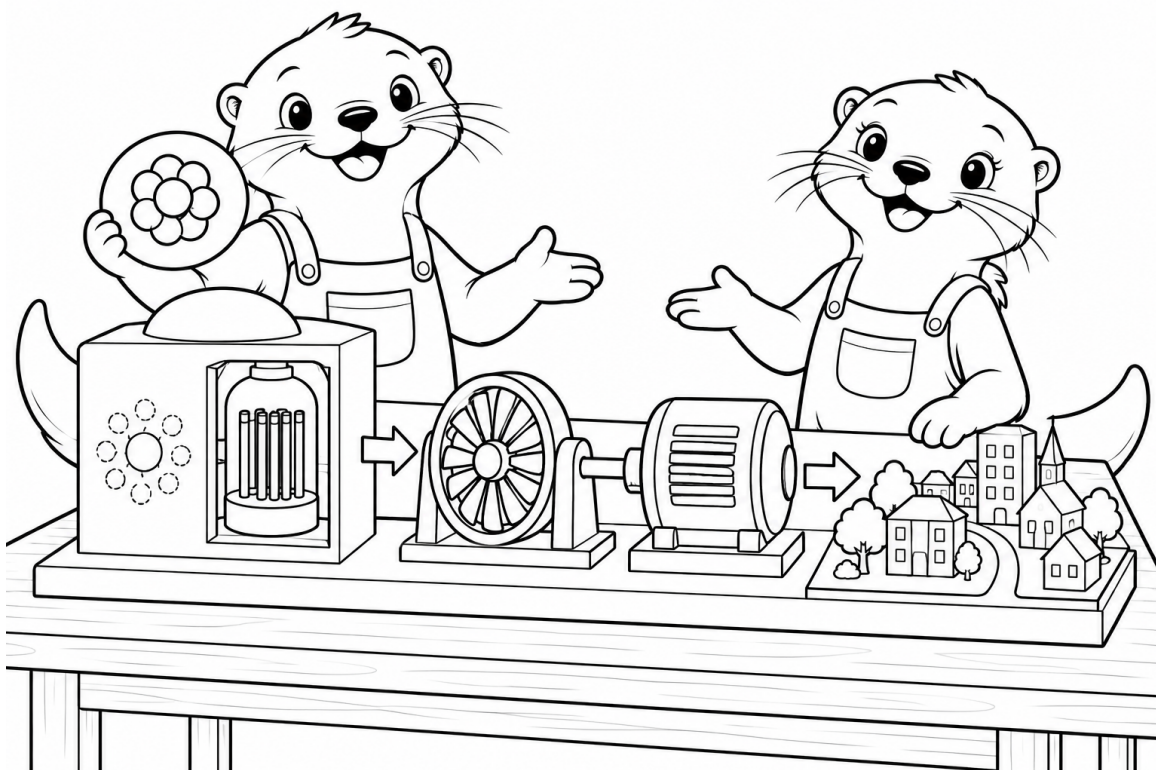


Atoms to Electricity

A paper museum of tiny particles, moving heat, and a town that lights up.



20 activities / ages 8-11 with a grown-up

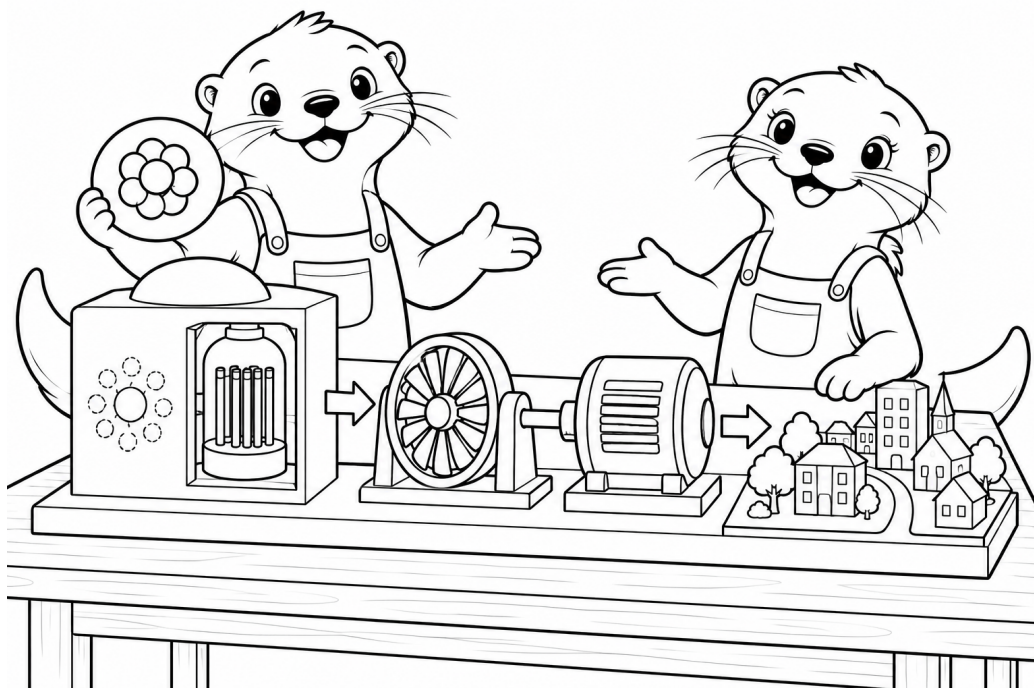
Help the otter engineers build a museum. Count particles, trace three separate water journeys, make a power-station model, and explain where electricity comes from.

You need: pencils or crayons, child scissors, a glue stick, 3 spare sheets of paper, and a ruler. Print single-sided at Actual Size or 100%.

Paper models only. The friendly cover is an imaginative toy scene, not a working diagram. It omits pipes and other equipment. Guide: page 22. Answers and sources: pages 23-24.

The museum needs you

Color the otter scene. Then sketch one exhibit for each kind of energy below.



HEAT



MOVEMENT



ELECTRICITY



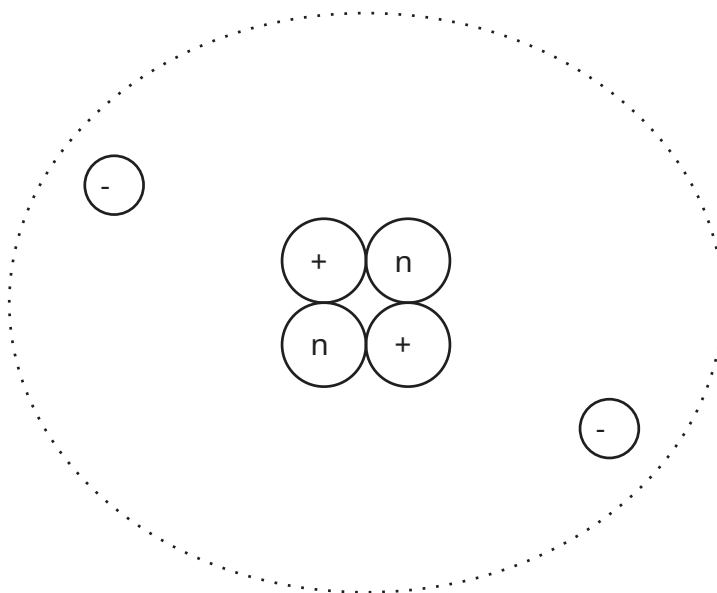
This is a museum story, not equipment to build. Real power stations use several connected processes. Your drawings can show a warm object, turning wheel, and glowing lamp.

Meet the atom parts

Trace a line from each label to an example. Color both protons one color and both neutrons another.

PROTON: positive (+)

NEUTRON: no charge (n)



ELECTRON: negative (-)

The center is the nucleus. Draw a ring around the four particles in the nucleus, not around the whole atom.

This helium-4 model has ____ protons and ____ neutrons.

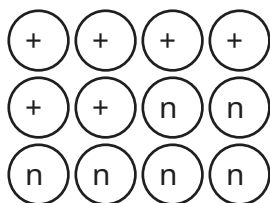
A neutral atom has equal numbers of protons and electrons.

Diagram is not to scale. Dotted edge = a region where electrons may be found, not a path. Electrons do not travel on the neat planet-like tracks often drawn in cartoons. [8,9]

Proton passports

An element is identified by its proton count. Match each nucleus to its passport. Ignore neutrons for this job.

A



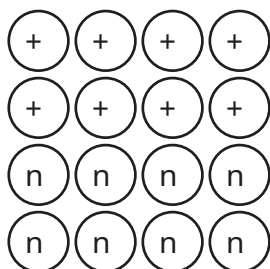
Protons: ____

B



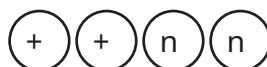
Protons: ____

C



Protons: ____

D



Protons: ____

H

Hydrogen: 1

He

Helium: 2

C

Carbon: 6

O

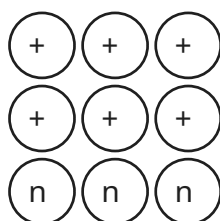
Oxygen: 8

Write a nucleus letter beside each passport: Hydrogen ____ Helium ____ Carbon ____ Oxygen ____ . The + circles are protons; n circles are neutrons. [1]

Repair the isotope gallery

These are all carbon. Keep six protons in every nucleus. Add the missing neutrons as circles marked n.

Carbon-12

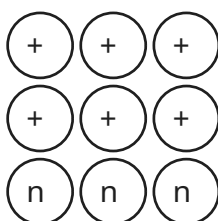


6 protons

12 particles total

Add ____ neutrons.

Carbon-13

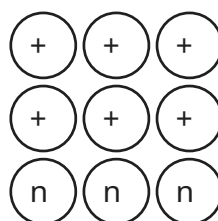


6 protons

13 particles total

Add ____ neutrons.

Carbon-14



6 protons

14 particles total

Add ____ neutrons.

What stays the same? What changes?

Isotopes are versions of one element with different neutron counts. The number in carbon-13 counts protons + neutrons. Some isotopes are stable; others are radioactive. [1]

Find the missing neutrons

One possible fission pathway is shown. Complete the count. Draw each missing free neutron as a circle marked n.

BEFORE

Uranium-235 nucleus

92 protons + 143 neutrons

+ 1 incoming neutron



AFTER: two nuclei

Barium-141: 56p + 85n

Krypton-92: 36p + 56n

Also after: free neutrons + energy released

Draw the missing neutrons here:

Count protons before: 92 After: $56 + 36 = \underline{\quad}$

Count all p + n before: $235 + 1 = \underline{\quad}$

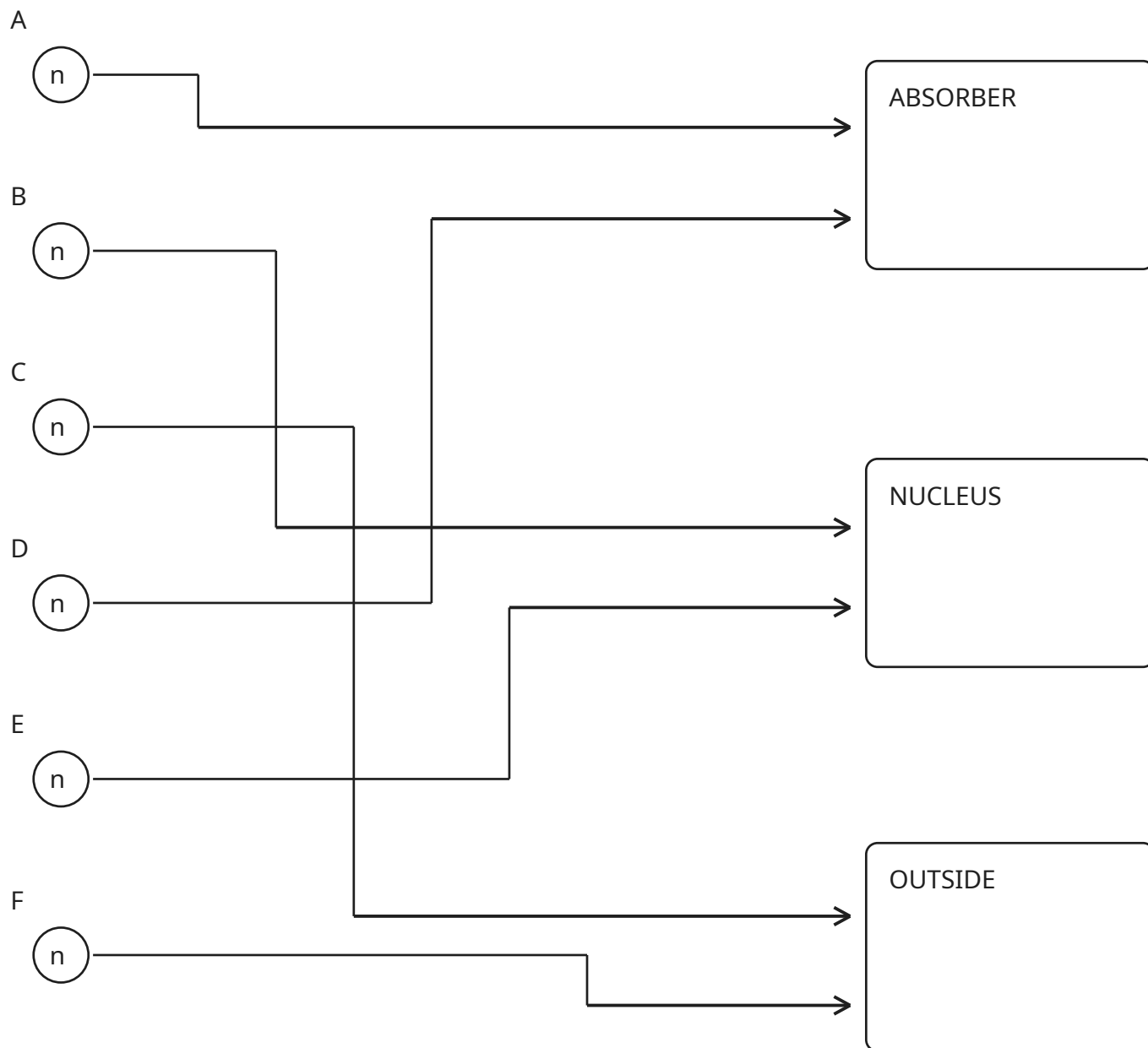
After: $141 + 92 + \underline{\quad}$ free neutrons = 236

Check: Did you include the incoming neutron?

This is one possible split, not the only one. These nuclei later decay. Particle count balances; a small mass difference supplies released energy. Circles are symbols, not scaled nuclei. [2]

Follow a neutron

Trace each route from A-F; go straight at crossings. Mark a square at an absorber, a circle at a nucleus, or a triangle outside.

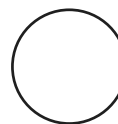
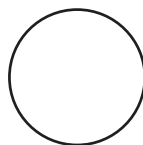
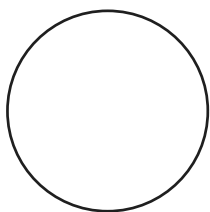


In this drawing: absorbed __; reaches a nucleus __; leaves the model __. Not every neutron causes another fission.

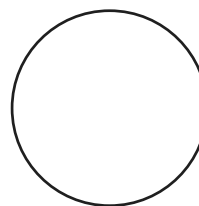
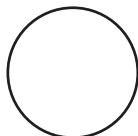
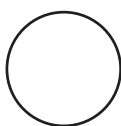
Control rods contain materials that absorb neutrons. This is a route puzzle, not a reactor layout or probability model. Stopping a chain reaction does not remove decay heat; cooling is still needed. [4,5]

Split or join?

Write FISSION or FUSION under each sketch. Add arrows to show whether nuclei split apart or join together.



Name: _____



Name: _____

Match each clue to a sketch:

The Sun is powered by it. ____ Today's nuclear power plants use it. ____

Both processes can release energy. The sketches show the idea only: they do not specify isotopes, exact particle numbers, or every reaction product. [3]

The six-scene energy story

Cut out the six cards. Put them in order on spare paper. Add arrows and a caption explaining one connection.

D GENERATOR



The turning turbine drives a generator.

B STEAM



Heat makes steam in a separate water circuit.

F TOWN



Electrical energy powers useful devices.

A REACTOR HEAT



Fission releases energy; the reactor becomes hot.

E GRID



Cables and transformers connect users and generators.

C TURBINE



Steam moves through the turbine and turns it.

This story follows a pressurized water reactor (PWR). Other reactor designs differ. Electricity does not come straight from a splitting nucleus: several energy transfers connect the steps. [4,6]

Energy changes its form

Use H = thermal energy, M = movement, E = electrical energy, L = light. Fill the two end badges for each device.

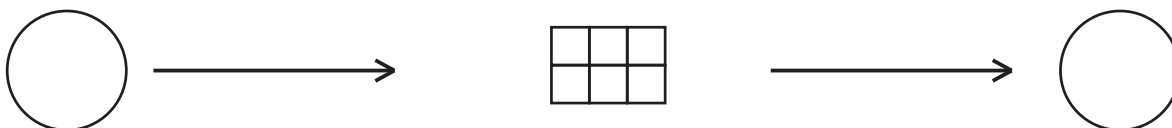
Steam turbine



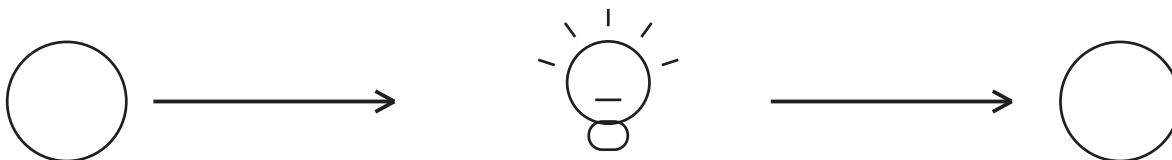
Generator



Solar PV panel



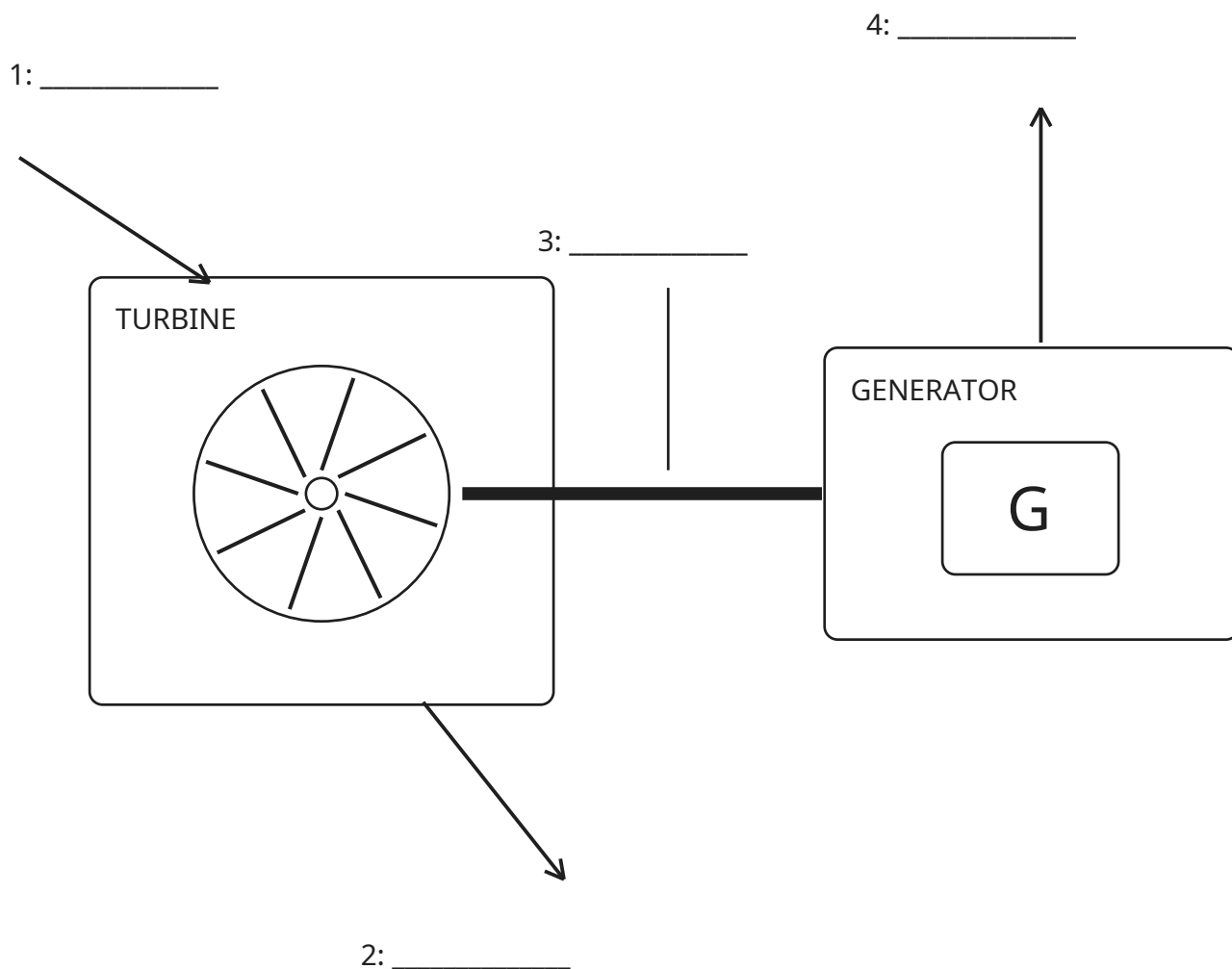
Lamp



Each row highlights a useful change. Real devices also transfer energy to their surroundings, often as heat. A turbine is turned by moving steam; the steam carries thermal energy. [4,6]

The turning-shaft detective

Follow the arrows. Label steam in, steam out, turning shaft, and electricity. Then give the turbine and generator different patterns.



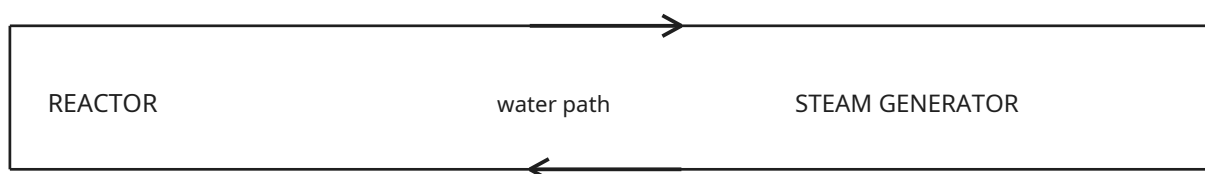
Circle the part that turns because steam pushes its blades. Draw a star on the part that changes movement into electrical energy.

Steam passes through the turbine. The turbine drives the generator through a shaft. This simplified view omits housings, magnets, coils, and many other parts. [4,6]

Three separate water journeys

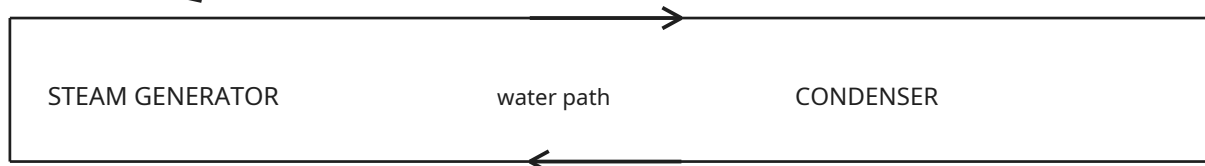
Trace each closed rectangle with a different color or pattern. Put a small arrow on every side, following the arrows already shown.

1. PRIMARY WATER



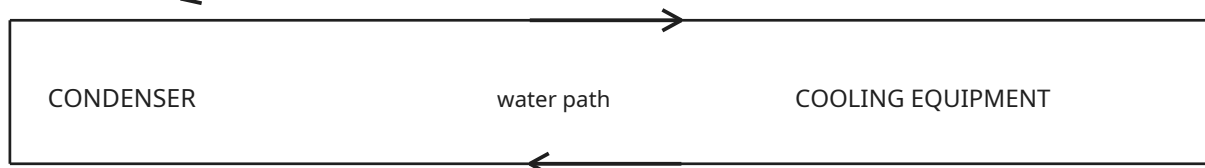
HEAT ONLY

2. WATER / STEAM



HEAT ONLY

3. COOLING WATER

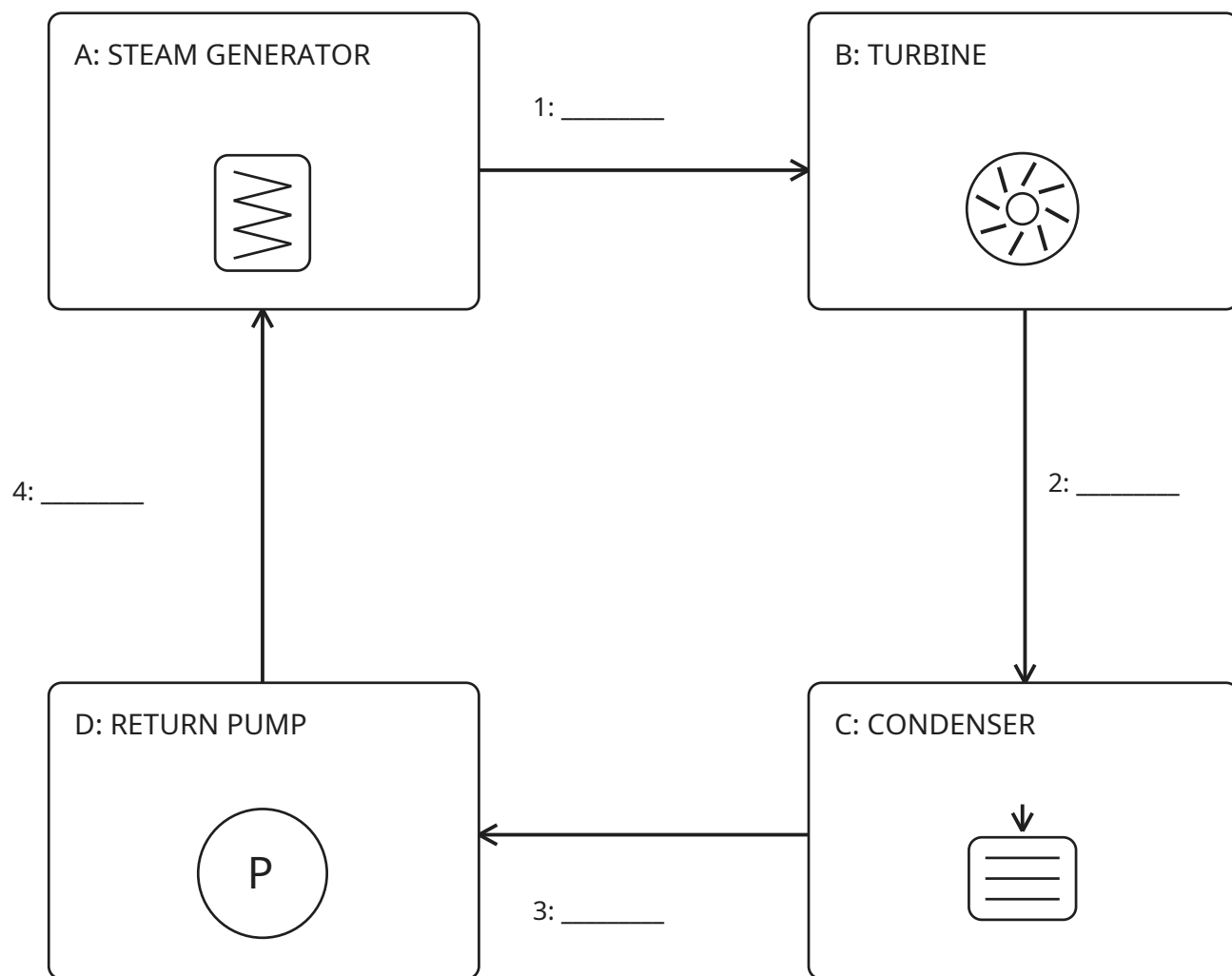


The same steam generator touches circuits 1 and 2 through separate sides. The same condenser touches circuits 2 and 3. Their waters do not mix.

A simplified PWR with recirculating cooling. Circuit 2 also passes through a turbine (next page). Heat can cross a metal barrier while water stays in its own circuit. Not a construction diagram. [4,7]

Steam becomes water again

Complete the secondary-circuit loop. Write WATER or STEAM on each blank. Draw two heat arrows: heat enters at A and leaves at C.



At A, liquid changes to gas: _____

At C, gas changes to liquid: _____

Word bank: boiling / condensing. A receives heat from primary water. C sends heat to separate cooling water. A return pump moves liquid back; it is not the generator. [4,7]

Build a power-station exhibit

Use the six cards from the next page. Test each position before gluing. Draw the connections listed below with different line styles.

A: releases heat

CONNECTION KEY

Wavy = heat
Solid arrow = steam
Dashed arrow = water
Double line = shaft

B: makes steam

D: makes electricity

A to B: heat
B to C: steam
C to D: shaft
C to E: steam
E to B: water
E to F: heat

C: steam turns it

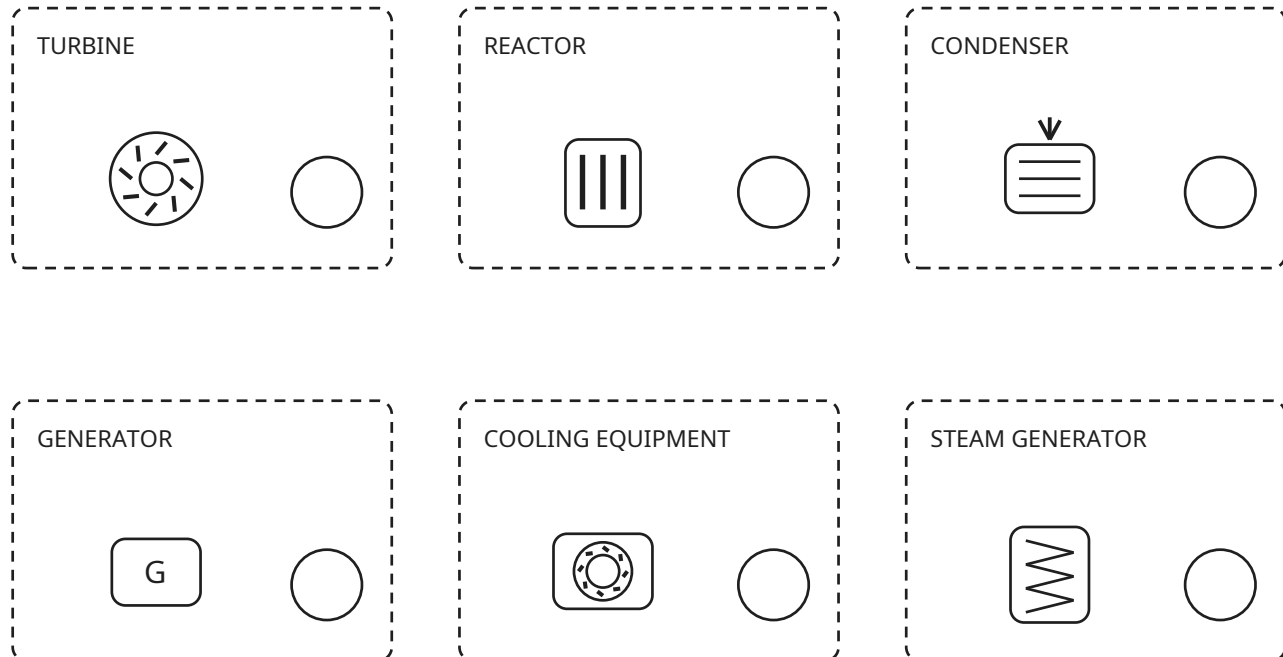
F: removes heat

E: steam to water

Draw around the card spaces or continue on spare paper. This exhibit follows energy transfers; it is not a pipe plan. The three separate circuits are on activity 11. The generator connects to the grid. [4,7]

Make the machine cards

Add a tiny heat, movement, or electricity symbol to each card. Cut on the dashed lines. Use these on the previous exhibit mat.



DESIGN ONE MORE EXHIBIT CARD

Draw a device in the town. Label the energy entering it and one useful change it makes. Your new card belongs after the grid.

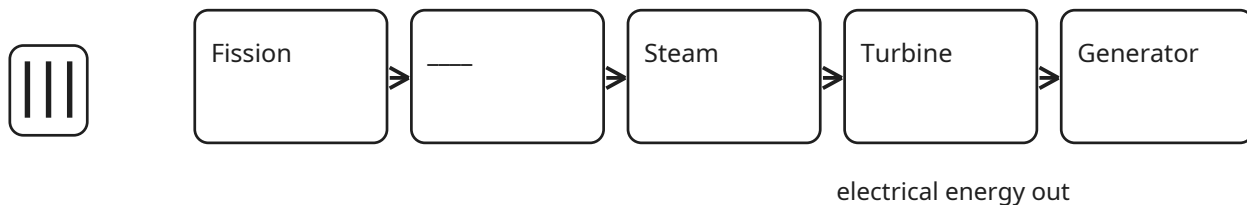


Card symbols may include H = heat, M = movement, E = electricity. Several symbols may fit one machine. The six printed cards are sized to fit the six spaces on activity 13 at 100% print scale.

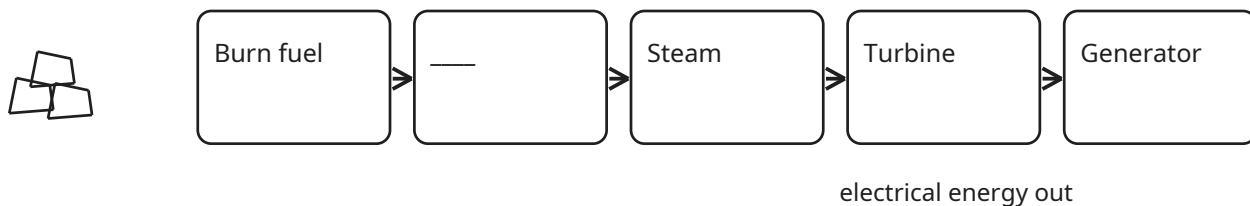
Four routes to electricity

Fill each blank from the word bank. Color the two routes that use steam. Solar PV means a photovoltaic panel.

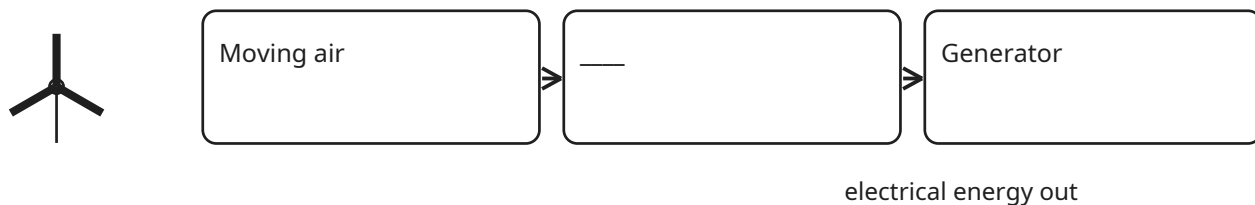
NUCLEAR



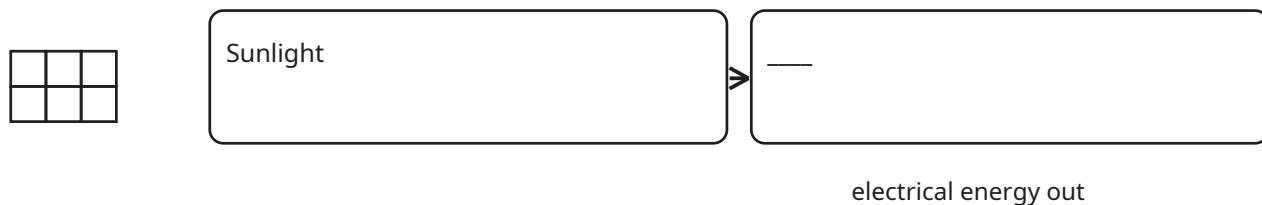
COAL (steam plant)



WIND



SOLAR PV



Word bank (reuse allowed): heat / turning turbine / electrical energy. A PV panel makes electricity without a steam turbine. Solar-thermal plants are different from PV. These are common example routes. [6]

Where do twelve tokens go?

These are invented energy models, not measurements of real plants. For each model, shade E tokens for electrical energy and H tokens for heat sent out.

Model A: 12 energy tokens enter

4 electrical + 8 heat = ____ total

Use two patterns, not only color. Write E or H inside each token.

Model B: 12 energy tokens enter

6 electrical + 6 heat = ____ total

Use two patterns, not only color. Write E or H inside each token.

Which model sends out more electrical energy? ____

How many more electrical tokens? ____

Did any energy tokens vanish? Explain to your partner.

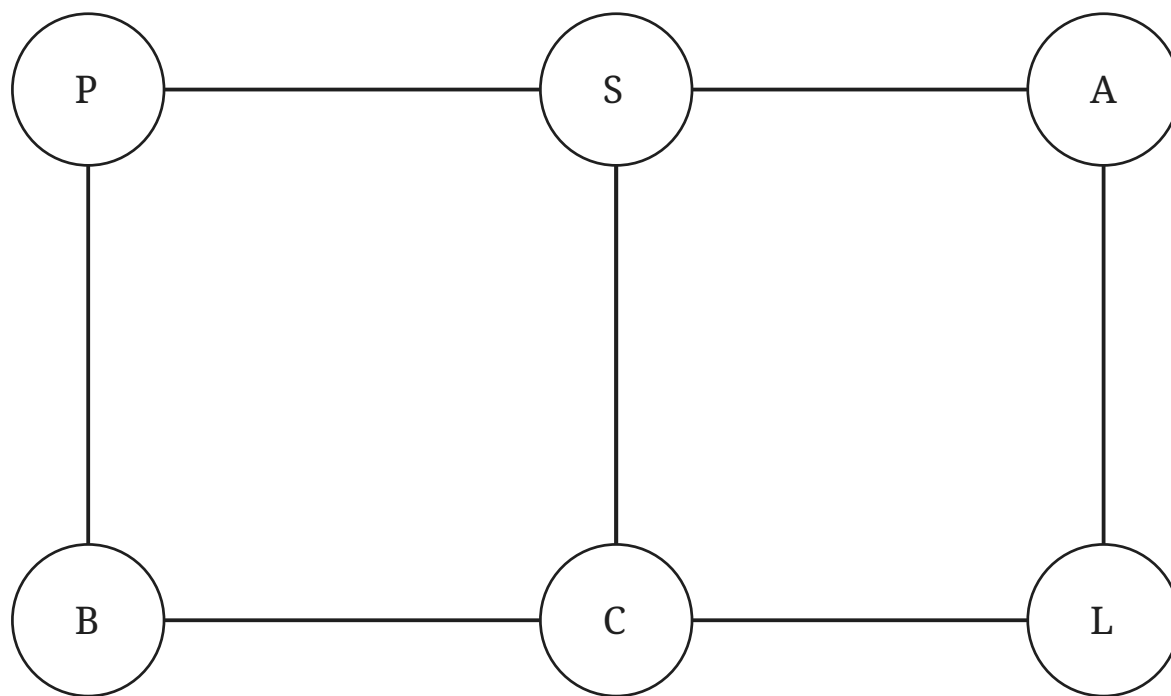
The tokens model energy accounting: 12 in = 12 out in each case. They do not show a real efficiency or how a reactor is operated. Real energy transfers include more forms and pathways.

Connect the town

Trace two different routes from the plant to the library. Every route must pass through the substation. Use only the printed connecting lines.

PLANT

SUBSTATION



LIBRARY

Route one letters: _____

Route two letters: _____

If the A-L line is unavailable, can the library still be connected? Cross that line with a pencil and trace a route that remains.

A connectivity puzzle, not an electrical circuit calculation. Real grids use transformers, protection equipment, and many connected generators. Electricity flow is not a parcel that follows one chosen route. [6]

The label inspector

Each museum label has one wrong idea. Cross out the incorrect words, then sketch or write a clearer replacement.

A Electrons sit inside the nucleus.

B A generator turns steam into water.

C Stopping fission removes all reactor heat.

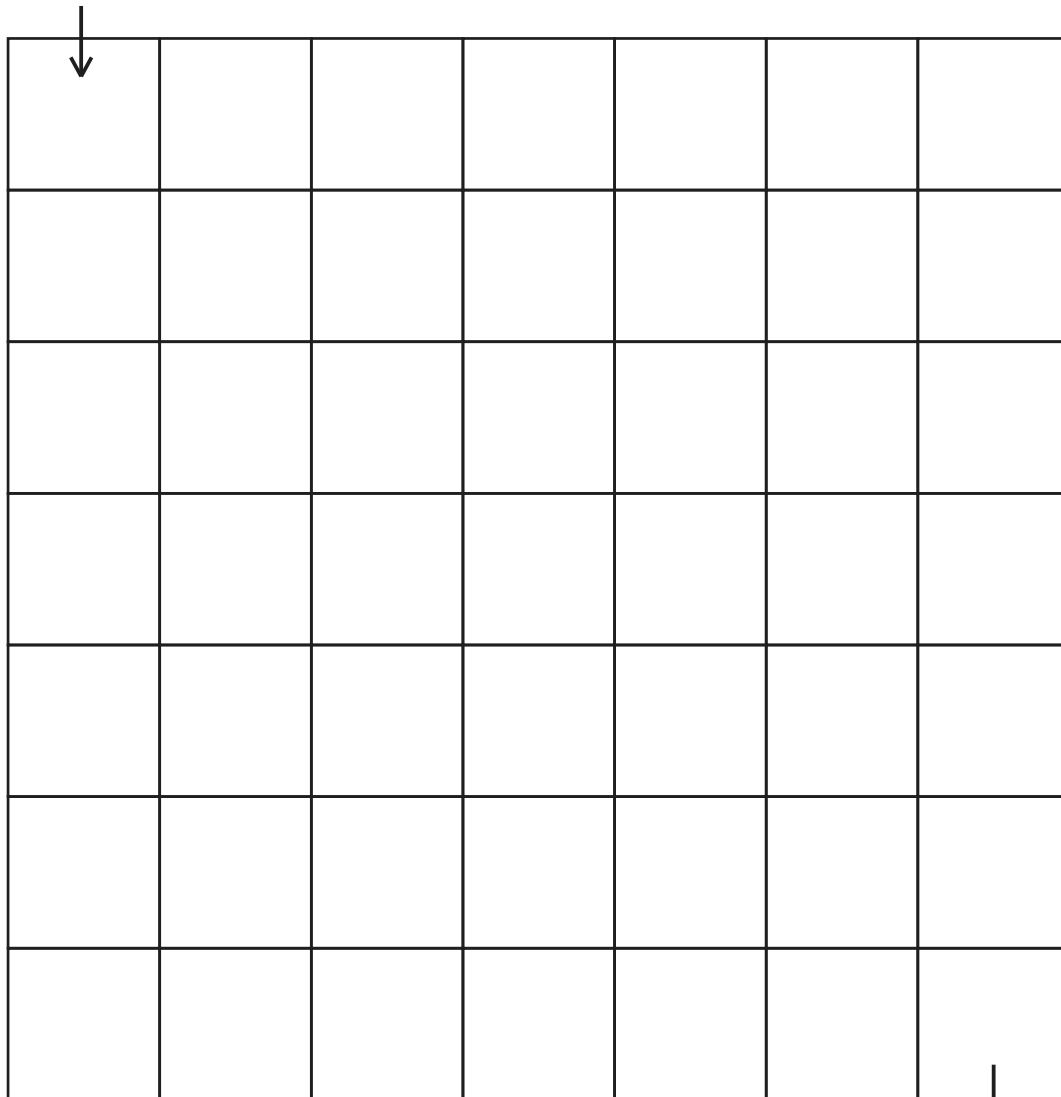
D All electricity sources need a steam turbine.

Use the earlier exhibits as evidence. For C, remember decay heat: radioactive fission products keep releasing energy after shutdown, so cooling remains necessary. [4,5,6]

Plan a tiny science museum

On the grid, outline three exhibit rooms. Keep the marked entrance and exit connected by a walking route. Then add an exhibit to each room.

ENTRANCE



EXIT

- A: atom or isotope exhibit
- B: energy-change exhibit
- C: water-circuit or grid exhibit

Use A, B, and C to label the rooms. Draw a dotted walking route from the top-left square to the bottom-right square. Add at least one arrow that helps a visitor understand science, not just where to walk.

Your pocket power museum

Cut around the outside rectangle. Fold on the three dotted vertical lines, alternating forward and back. Complete the four exhibit panels.

1. TINY PARTS	2. HEAT TO MOTION	3. ELECTRICITY	4. ASK A VISITOR
Draw and label a nucleus and an electron region.	Draw steam turning a turbine. Show the shaft.	Connect the generator to a useful town device.	Write a question. Add a small picture that helps explain it.

Show your museum to someone. Ask them to point to one energy change and one place where water stays separate from other water.

One thing my visitor understood: _____

Fold gently with a ruler and a grown-up if needed. This is a complete paper exhibit. No electricity, heat source, chemicals, radioactive materials, or real machine parts are used.

Grown-up field guide

Read the small model notes together. Children can explain with drawings, pointing, dictation, or writing.

Start with curiosity

Activities 1-4 introduce particles. Use +, n, and - as symbols. The electron region is not an orbit or a hard wall. Counting diagrams are enlarged models, not pictures of real atoms.

Make the tricky distinction

Fission splits a nucleus; fusion joins light nuclei. The counted example in activity 5 is one possible immediate outcome. It balances protons and nucleons, not exact mass. Later radioactive decays are outside that puzzle.

Three water circuits

For activities 11-12, trace each water path before adding heat arrows. A heat exchanger transfers energy through a separating surface. The primary water does not join the steam or cooling water. The simplified PWR model omits many components.

A calm, accurate conversation

Power stations need trained people, cooling, monitoring, and multiple protective systems. Radioactive waste requires careful management. Stopping fission does not stop decay heat. Discuss questions without calling any energy source impact-free or risk-free.

Pacing and accessibility

Try 2-4 activities at a sitting. Pre-cut cards if needed; children can match them without glue. At 100% print size, 140 x 96 model-unit cards fit 146 x 104 spaces. Keep activities 13-14 single-sided for cutting.

Listen for understanding

Ask: What identifies an element? Where does steam go after the turbine? What crosses between the separate circuits? Which electricity route skips a turbine? End with the child teaching one museum exhibit to you.

All core tasks are paper-only. These activities are an introduction to civilian electricity generation, not operational guidance. Sources and answer notes follow.

Answer notes / activities 1-10

Accept clear drawings and spoken reasoning. Open-ended work has many good answers.

1-2 Museum energy; atom parts

1: Examples include a warm surface, turning wheel, and lit lamp. 2: Two + protons, two n neutrons, two - electrons. Ring the four central particles only.

3-4 Identity and isotopes

3: A carbon (6p), B hydrogen (1p), C oxygen (8p), D helium (2p). Passports: H B; He D; C A; O C. 4: Add 3, 4, and 5 neutrons, giving totals of 6, 7, and 8. Proton count stays six.

5 Balanced particle count

Draw 3 free neutrons. Protons: $56 + 36 = 92$. Nucleons: $235 + 1 = 236$; $141 + 92 + 3 = 236$. Neutrons: $143 + 1 = 85 + 56 + 3 = 144$. The incoming neutron matters.

6-7 Neutron routes; split or join

6: A and D absorber; B and E nucleus; C and F outside. Two of each. Following a route does not guarantee a fission. 7: Top fission, arrows outward; bottom fusion, arrows joining. Sun: fusion. Nuclear power stations today: fission.

8-9 Energy story; conversions

8: A, B, C, D, E, F. Fission heat makes steam; steam turns the turbine; the turbine drives the generator; the grid connects users. 9: Turbine H to M; generator M to E; PV L to E; lamp E to L. Other outputs include heat.

10 Shaft detective

1 steam in; 2 steam out; 3 turning shaft; 4 electricity. Circle turbine; star generator. Steam passes through the turbine, while the shaft drives the generator.

READ MORE / PRIMARY SOURCES

[1] DOE: Isotopes

[2] University of Texas: Nuclear Power

[3] DOE: Fission and Fusion

[4] DOE: How a Nuclear Reactor Works

[8] NRC: What Is an Atom?

[9] DOE: Electrons

Source titles are clickable in the PDF. Sources checked October 2026.

Answer notes / activities 11-20

The invented token models and museum plans are teaching tools, not real operating data.

11-12 Water journeys

11: Trace three separate closed paths. Heat crosses at the steam generator and condenser, not water. 12: 1 steam; 2 steam; 3 water; 4 water. A boiling; C condensing. Heat enters A from primary water and leaves C for cooling water.

13-15 Exhibit and source routes

13: A reactor; B steam generator; C turbine; D generator; E condenser; F cooling equipment. 14: Example extra card: lamp, electrical energy to light and heat. 15: Nuclear heat; coal heat; wind turning turbine; solar PV electrical energy. Color nuclear and coal.

16-17 Accounting and connections

16: A has 4 E + 8 H = 12; B has 6 E + 6 H = 12. B has 2 more E tokens; none vanish. 17: Examples P-S-A-L and P-S-C-L. After A-L is crossed out, P-S-C-L still works. Other connected routes via S are valid.

18 Repair the labels

A: Electrons are outside the nucleus. B: A condenser turns steam into liquid water; a generator converts movement to electricity. C: Decay heat remains after fission stops. D: Wind and solar PV do not need steam turbines.

19-20 A museum to share

19: Three labelled rooms, an entrance-to-exit walking route, and an explanatory science arrow. Many plans work. 20: Four folded panels with a nucleus/electron region, steam/turbine/shaft, generator/town connection, and a visitor question.

READ MORE / PRIMARY SOURCES

[5] NRC: Reactor Concepts (decay heat; control rods)

[6] EIA: Electricity generation and the grid

[7] NRC: Pressurized Water Reactors

Source titles are clickable in the PDF. Sources checked October 2026.

Science notes: nuclear fission produces radioactive products; used fuel needs managed storage. Real plants and grids have environmental impacts. This introduction does not compare their overall risks or emissions.