LESSON MAKER PRO

Energy Balance Lab

Use energy flows and component changes to solve for an unknown change.

HIGH SCHOOL · HS-PS3-1

HS-PS3-1 "Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known..."

NAME _____ DATE _____

TRACK THE WHOLE SYSTEM

Choose a system boundary, then treat energy entering the system as positive and energy leaving as negative. The changes in energy of all components add up to the net energy flow across the boundary. A positive change means a component gains energy, and a negative change means it loses energy. Include Earth when gravitational potential energy is treated as stored inside a near-Earth system.

WORKED EXAMPLE

A two-component system receives 36 J of energy. Component B gains 14 J. Find the change in energy of component A.

1. Write the model: x + 14 J = +36 J.
2. Subtract 14 J from both sides.
3. x = +22 J.

Answer: Component A gains 22 J.

PRACTICE 6 problems

1 A two-component system receives 18 J of energy. Component B gains 7 J. What is the change in energy of component A?

ANSWER _____

2 A two-component system releases 25 J of energy. Component A loses 9 J. What is the change in energy of component B?

ANSWER _____

3 A three-component system receives 40 J of energy. Component A gains 15 J, and component B loses 8 J. What is the change in energy of component C?

ANSWER _____

4 No energy crosses the boundary of a system. Its kinetic energy decreases by 12 J, and its gravitational energy increases by 5 J. What is the change in its thermal energy?

ANSWER _____

5 A system releases 28 J of energy. Its kinetic energy increases by 6 J. What is the change in its thermal energy?

ANSWER _____

6 A system receives 21 J of energy. Its thermal energy increases by 9 J. Write an equation with x for the change in kinetic energy, then find x.

ANSWER _____

_____

APPLY IT Show your work

1 At a skate park, consider the skateboarder with board, the ramp, and Earth as one system. No energy crosses the system boundary. The system's gravitational energy decreases by 48 J while its kinetic energy increases by 31 J. What is the change in thermal energy caused by friction?

WORK SPACE

ANSWER _____

2 A student rides an elevator at school. Treat the elevator, student, and Earth as one system. The motor transfers 240 J of energy into the system. The system's gravitational energy increases by 190 J, and its kinetic energy decreases by 8 J as the elevator slows. What is the change in thermal energy?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A skateboarder with board, the ramp, and Earth form a system that releases 27 J of energy to the surroundings. The system's gravitational energy decreases by 45 J, and its kinetic energy increases by 10 J. Find the change in thermal energy. Then explain, in two sentences, why the energy flow and each component change have the signs you used.

WORK SPACE AND ANSWER

ANSWER KEY

Energy Balance Lab

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A two-component system receives 18 J of energy. Component B gains 7 J. What is the change in energy of component A?	**+11 J**
2	A two-component system releases 25 J of energy. Component A loses 9 J. What is the change in energy of component B?	**-16 J**
3	A three-component system receives 40 J of energy. Component A gains 15 J, and component B loses 8 J. What is the change in energy of component C?	**+33 J**
4	No energy crosses the boundary of a system. Its kinetic energy decreases by 12 J, and its gravitational energy increases by 5 J. What is the change in its thermal energy?	**+7 J**
5	A system releases 28 J of energy. Its kinetic energy increases by 6 J. What is the change in its thermal energy?	**-34 J**
6	A system receives 21 J of energy. Its thermal energy increases by 9 J. Write an equation with x for the change in kinetic energy, then find x.	**x + 9 J = +21 J; x = +12 J**

PART 2 · APPLY IT

1. **+17 J** Use 0 J for the net energy flow: -48 J + 31 J + x = 0 J. Solving gives x = +17 J.
2. **+58 J** Set the component changes equal to the energy entering: 190 J - 8 J + x = 240 J. Solving gives x = +58 J.

CHALLENGE

The thermal energy changes by +8 J. The energy flow is negative because 27 J leaves the system, the gravitational change is negative because that energy decreases, and the kinetic and thermal changes are positive because those energies increase.

Accept equivalent equations that use positive energy entering and negative energy leaving. Require units of J and correct signs on all energy changes. Treat rider-plus-board as one component, the ramp as another, and Earth as the third. Gravitational potential energy is associated with the Earth–rider interaction. All original numerical answers and signs are unchanged.