Where Energy Goes

Track a cart's energy through a ramp and spring

P.3.b "Create mathematical and graphical representations to depict the transformation of energy from one form to another, including kinetic energy, gravitational potential energy, elastic potential energy, and work due to friction."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentences that explain energy transformations. Circle the words that tell you how to set up an energy graph.

A Cart Meets a Spring

1. A cart rolls from a low platform down a track toward a spring fixed to a wall. The cart starts from rest, and the spring starts uncompressed. Treat the cart, Earth, spring, and track as one energy system. Use the track's lowest point as the zero level for gravitational potential energy.

2. At the start, the cart's energy is gravitational potential energy. As it descends, gravity increases its kinetic energy, while friction transfers some mechanical energy into thermal energy in the cart and track. When the cart compresses the spring, its kinetic energy can become elastic potential energy. The table records energy amounts at four moments.

ENERGY DURING THE CART'S RUN

Moment	Gravitational (J)	Kinetic (J)	Elastic (J)	Transferred by friction (J)
Start	100	0	0	0
Bottom, before spring	0	80	0	20
Maximum compression	0	0	60	40
After spring release	0	45	0	55

3. Each row accounts for the same starting energy. The last column shows the cumulative energy transferred by friction, not energy stored in the spring. For a graph, place each moment along the horizontal axis and energy in joules on the vertical axis. Work done by friction on the moving cart is negative; the transferred amount shown here is positive.

2 ANSWER WITH EVIDENCE

Use the passage

1. Write an energy equation for the cart's trip from the start to the bottom, before it reaches the spring. What is the work done by friction on the cart during this trip?

2. From the bottom to maximum spring compression, how much additional energy does friction transfer? Write an equation showing where the cart's 80 J of kinetic energy goes.

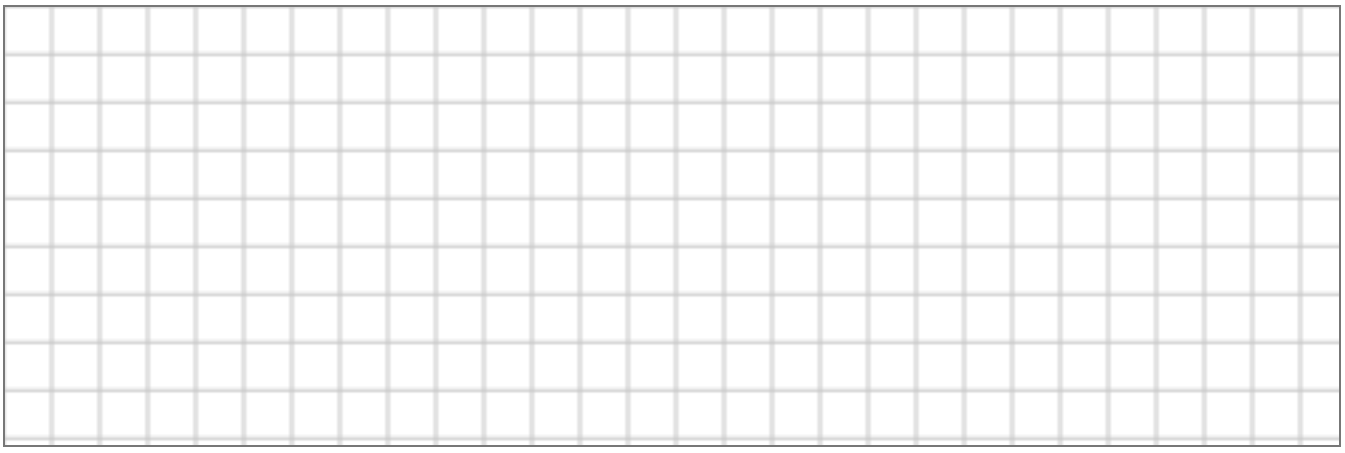
3. On a graph with moment on the horizontal axis and energy on the vertical axis, what two points would show elastic potential energy at maximum compression and after spring release?

4. Write an equation showing how the energy stored in the compressed spring changes by the time the cart leaves the spring.

3 YOUR TURN

Your own words

Invent a three-stage run in which a raised cart starts with 120 J of gravitational potential energy, rolls toward a spring, and compresses it. On the grid, graph gravitational, kinetic, and elastic potential energy and cumulative energy transferred by friction at the start, before spring contact, and at maximum compression; show friction transferring energy during both moves, and write an equation for the final energy balance.



Where Energy Goes

PART 1 · READ AND MARK

Underline the sentences that explain energy transformations. Circle the words that tell you how to set up an energy graph. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Write an energy equation for the cart's trip from the start to the bottom, before it reaches the spring. What is the work done by friction on the cart during this trip?	**100 J = 80 J + 20 J. Friction does −20 J of work on the cart.**
2	From the bottom to maximum spring compression, how much additional energy does friction transfer? Write an equation showing where the cart's 80 J of kinetic energy goes.	**Friction transfers another 20 J. The energy equation is 80 J = 60 J elastic potential energy + 20 J transferred by friction.**
3	On a graph with moment on the horizontal axis and energy on the vertical axis, what two points would show elastic potential energy at maximum compression and after spring release?	**(Maximum compression, 60 J) and (after spring release, 0 J).**
4	Write an equation showing how the energy stored in the compressed spring changes by the time the cart leaves the spring.	**60 J elastic potential energy = 45 J kinetic energy + 15 J transferred by friction.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Horizontal axis: Start, Before contact, Maximum compression. Vertical axis: energy (J). Gravitational: 120, 0, 0. Kinetic: 0, 90, 0. Elastic: 0, 0, 70. Transferred by friction: 0, 30, 50. Final balance: 120 J = 70 J + 50 J.

Accept other nonnegative values if each stage totals 120 J, friction's cumulative value increases during both moves, and the plotted series and final equation agree. For question 1, distinguish friction's negative work on the cart from the positive amount of energy transferred.