Fields Move Carts

Model forces and energy changes in two-object field interactions.

HS-PS3-5 "Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each statement that tells how a force arrow should point, and circle each statement that describes an energy form increasing or decreasing. These marks help you trace the field interaction in each model.

Two Models, One Pattern

1. Consider a system with only two objects: a small north pole of one bar magnet and a small north pole of a second bar magnet. Place them on low-friction carts facing each other. A model can show each magnet, arrows for the magnetic force on each cart, and magnetic field lines in the space between them. The arrows point away from the other magnet because like poles repel. The force arrows have equal size and opposite directions. If the carts are free to move, both carts accelerate apart. The model focuses on interactions, not on every detail inside the magnets.

2. At first, hold the carts close together. This arrangement has more magnetic potential energy than the arrangement in which the like poles are farther apart. Release the carts, and the magnetic force does positive work on each moving cart. As separation increases, the system's magnetic potential energy decreases while the carts' kinetic energy increases. Energy is not created by the motion. The decrease in energy associated with the magnetic field and the objects' arrangement accounts for the increase in the carts' kinetic energy. A complete model tracks both the force and these linked energy changes.

3. Models can also represent attraction. Imagine a positively charged bead and a negatively charged bead on separate low-friction tracks. Electric field arrows can show the field in the region between the beads, while force arrows on the beads point toward each other. When released from rest, each bead moves toward the other, so its kinetic energy increases. As their separation decreases, the electric potential energy of the two-object system decreases. The field is part of the system model, so the energy change is described as a transfer from electric potential energy to kinetic energy. A diagram alone is stronger when labels explain what each arrow and energy change means.

2 ANSWER WITH EVIDENCE

Use the passage

1. For the two north poles on carts, what direction should each magnetic force arrow point, and how should the two arrows compare in size?

2. Compare the magnetic potential energy when the like poles are close together with the potential energy when they are farther apart.

3. After the like poles are released, describe the linked changes in separation, magnetic potential energy, and kinetic energy.

4. In the charged-bead model, how do the force arrows and energy changes show an attractive electric interaction?

3 YOUR TURN

Your own words

Create a labeled model of two negatively charged spheres on low-friction tracks that begin close together and are released. Show both force arrows and the electric-field region, then write exactly two sentences explaining the motion and the linked energy changes.

ANSWER KEY

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HIGH SCHOOL · HS-PS3-5

PART 1 · READ AND MARK

Underline each statement that tells how a force arrow should point, and circle each statement that describes an energy form increasing or decreasing. These marks help you trace the field interaction in each model. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For the two north poles on carts, what direction should each magnetic force arrow point, and how should the two arrows compare in size?	**Each force arrow points away from the other magnet. The arrows are equal in size and opposite in direction.**
2	Compare the magnetic potential energy when the like poles are close together with the potential energy when they are farther apart.	**The system has more magnetic potential energy when the like poles are close together and less when they are farther apart.**
3	After the like poles are released, describe the linked changes in separation, magnetic potential energy, and kinetic energy.	**The separation increases, magnetic potential energy decreases, and the carts' kinetic energy increases.**
4	In the charged-bead model, how do the force arrows and energy changes show an attractive electric interaction?	**The force arrows point toward each other. As the beads move closer, electric potential energy decreases and each bead's kinetic energy increases.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Model: [negative sphere] ← force arrow dashed electric-field region force arrow → [negative sphere], initially close. Because both spheres are negative, they repel, so each force arrow points away from the other sphere. As the distance between them increases, electric potential energy decreases and kinetic energy increases by the same amount in an isolated system.

Accept equivalent labeled diagrams that show two objects only, equal and opposite repulsive force arrows, and an electric-field region. The explanation should connect increasing separation to decreasing electric potential energy and increasing kinetic energy.