

Balancing Forces: Investigating Floating Trains

Problem students work to solve

How is it possible for a train to float?

Chapter 1 Question

Why does the train rise?

Investigation Question

What makes an object start to move? (1.2, 1.3, 1.4)

Evidence sources and reflection opportunities

- Investigate by making blocks move (1.2)
- Read *Forces All Around* (1.3)
- View *Domino* video (1.4)
- Create and analyze chain reactions (1.4)

Key concepts

- A force acts between two objects. (1.3)
- When an object starts moving or stops moving, that is evidence that a force has acted on it. (1.3)

Application of key concepts to problem

- Discuss why the train starts to move (1.4)
- Write a scientific explanation about the floating train (1.4)

Explanation that students can make to answer the Chapter 1 Question

The train rises because a force acts on it. The train started to move and when an object changes how it is moving, that means a force acted on it.

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How is it possible for a train to float?

Chapter 2 Question

Why does the train rise without anything touching it?

Investigation Questions

How can a force act without objects touching? (2.1, 2.2)

Evidence sources and reflection opportunities

- Discover non-touching forces with magnets (2.1)
- Discuss evidence about non-touching forces (2.1)
- Make digital diagrams (models) of forces (2.1)
- Investigate which objects magnetic forces act on (2.2)
- Read about forces in *Handbook of Forces* (2.2)

Key concepts

- Some forces happen between objects that are touching. Other forces happen between objects that aren't touching. (2.1)
- Non-touching forces can act between magnets and some, but not all, other objects. (2.2)

Application of key concepts to problem

- Think-Pair-Share about the floating train (2.5)
- Make a model of the train rising (2.5)
- Write a scientific explanation about why the train rises without anything touching it (2.5)

Explanation that students can make to answer the Chapter 2 Question

The train rises because of a magnetic repelling force. There must be a magnet in the train and in the track.

In what ways can magnetic forces make an object move? (2.3, 2.4)

- Investigate magnetic forces with magnets (2.3)
- Read about magnets in *Handbook of Forces* (2.3)
- Read *What My Sister Taught Me About Magnets* (2.4)
- Discuss forces using unit vocabulary (2.5)

- Magnets can attract or repel other magnets. (2.4)
- Magnets can attract some metal objects. (2.4)

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How is it possible for a train to float?

Chapter 3 Question

Why does the train fall?

Investigation Question

What makes an object fall? (3.1, 3.2)

Evidence sources and reflection opportunities

- Observe effects of gravity (3.1)
- Revisit *Forces All Around* (3.1)
- Make a digital diagram (model) showing gravity (3.1.)
- Read about gravity in *Handbook of Forces* (3.2)
- Create and analyze chain reactions (3.3)
- Discuss gravity using unit vocabulary (3.3)

Key concepts

- An object falls because Earth pulls the object toward it with the force of gravity. (3.2)

Application of key concepts to problem

- Discuss and model what makes the train fall back to the tracks (3.4)
- Write a scientific explanation describing why the train falls to the track (3.4)

Explanation that students can make to answer the Chapter 3 Question

The train falls because of the force of gravity. Gravity acts between the train and Earth. Gravity attracts the train to Earth.

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How is it possible for a train to float?

Chapter 4 Question

Why does the train float, even though gravity is acting on it?

Investigation Question

Why would an object not move even though a force is acting on it? (4.1, 4.2, 4.3)

Evidence sources and reflection opportunities

- Observe one way to keep an object from falling (4.1)
- Investigate both magnetic force and another force acting on an object (4.1)
- Discuss and write about two forces exerted on an object at the same time (4.1)
- Make a paperclip float (4.2)
- Read more about forces in *Handbook of Forces* (4.2)
- Read *Explaining a Bridge* (4.3)
- Diagram the floating paper clip (4.4)

Key concepts

- Two forces can be exerted on an object at the same time. (4.1)
- When two forces are exerted on an object in opposite directions, the forces can be balanced. (4.3)

Application of key concepts to problem

- Create physical models and discuss why the train floats (4.4)
- Write a scientific explanation about why the train floats (4.4)

Explanation that students can make to answer the Chapter 4 Question

The train floats because there are balanced forces acting on it. There is a repelling magnetic force between the track and the train. There is an attracting force of gravity between the train and Earth. These two forces are the same strength and opposite directions so they are balanced. (There are also balanced forces when the train is resting on the track: gravity pulls the train down and a touching force from the track pushes it up.)

Balancing Forces: Investigating Floating Trains

Problem students work to solve

How is it possible for a train to float?

Chapter 5 Question

Why does the train change from floating to falling?

Investigation Question

What can make forces not be balanced anymore? (5.1, 5.2)

Evidence sources and reflection opportunities

- Investigate unbalanced forces with a floating paper clip (5.1)
- Analyze data about unbalanced forces (5.1)
- Plan and conduct investigations about distance, magnetic force, and balanced and unbalanced forces (5.1)
- Read *Hoverboard* (5.2)
- Observe an electromagnet demonstration (5.3)
- Read about electromagnets in *Handbook of Forces* (5.3)

Key concepts

- If forces exerted on an object are balanced, and then a force changes, the forces become unbalanced, which can cause the object to start moving. (5.2)

Application of key concepts to problem

- Discuss and model the floating train (5.4)
- Diagram the floating train (5.4)
- Write a scientific explanation about the floating train. (5.5)

Explanation that students can make to answer the Chapter 5 Question

The train stops floating and falls back down because the magnetic force between the track and the train stops. It can stop because the magnet is an electromagnet and gets turned off. This makes the forces unbalanced.