


## Progression toolkit: Energy transfer, conservation and dissipation

Learning focus	Energy is conserved, so that the total amount of energy in all stores before a transfer is the same as after the transfer, plus any work done on the system. Some energy is always transferred to thermal stores, and this energy is generally less useful.				
As students' conceptual understanding progresses they can:	<div>CONCEPTUAL PROGRESSION</div>				
	Describe how energy can be transferred from one store to another.	Describe how the amount of energy in each store changes as energy is transferred.	Explain why, in any transfer, some energy is transferred to a thermal store.	Use the principle of conservation of energy and energy calculations to determine the amount of energy in different stores.	Calculate missing variables using the principle of conservation of energy and energy calculations. <div>B</div>
Diagnostic questions	Dropping the ball	Diving	Downhill	Rollercoaster	Falling
			Trolleys and springs	Trampoline	
	Toy cannon	Adding weight	Rolling ball		
Response activities	Surprise!		Pendulum		

Key:

**B** Bridge to later stages of learning


Dropping the ball	Toy cannon	Diving	Adding weight	Downhill																														
<p><b>BEST</b> TEACHER NOTES</p> <p><b>Dropping the ball</b></p> <p>A student holds a tennis ball and then drops it.</p>  <p>These statements about energy stores. For each statement, add a tick (✓) in the column to show what you think.</p> <table border="1"> <thead> <tr> <th>Statements about energy stores</th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A When the ball is being held, there is no energy in the gravitational store.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B As the ball falls, energy is transferred from the elastic store to the gravitational store.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C As the ball falls, energy is transferred from the gravitational store to the kinetic store.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>D As the ball falls, energy in the gravitational store is used up.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>E As the ball falls, energy is created in the kinetic store.</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Statements about energy stores	I am sure this is right	I think this is right	I think this is wrong	I am sure this is wrong	A When the ball is being held, there is no energy in the gravitational store.					B As the ball falls, energy is transferred from the elastic store to the gravitational store.					C As the ball falls, energy is transferred from the gravitational store to the kinetic store.					D As the ball falls, energy in the gravitational store is used up.					E As the ball falls, energy is created in the kinetic store.					<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Toy cannon</b></p> <p>A toy cannon fires a small ball.</p> <p>Inside the barrel a spring is compressed. When the spring is released, it pushes the ball out.</p>  <p>1. The ball is fired vertically.</p> <p>What energy transfer takes place between the moment the spring is released and the moment the ball reaches its maximum height?</p> <p>A elastic store → kinetic store <input type="checkbox"/></p> <p>B elastic store → kinetic store + gravitational store <input type="checkbox"/></p> <p>C elastic store → gravitational store <input type="checkbox"/></p> <p>D elastic store → gravitational store <input type="checkbox"/></p> <p>2. The ball is fired horizontally.</p> <p>What energy transfer takes place between the moment the spring is released and the moment the ball just leaves the spring?</p> <p>A elastic store → kinetic store <input type="checkbox"/></p> <p>B elastic store → kinetic store + gravitational store <input type="checkbox"/></p> <p>C elastic store → gravitational store <input type="checkbox"/></p> <p>D elastic store → gravitational store <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Diving</b></p> <p>Competes dive into the sea to catch fish. They can feel the water at 20 cm to 10 cm to 20 cm.</p>  <p>At the start of the dive, a person is stationary.</p> <p>Which bar charts best represent the energy at each end of its dive?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Adding weight</b></p> <p>Two weights are hanging on the end of a spring. Another weight is being held, ready to add to the spring.</p>  <p>When the third weight is added, the spring stretches.</p> <p>Which of these bar charts best represent the energy before and after the third weight is added?</p> <p>A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/></p>	<p><b>BEST</b> TEACHER NOTES</p> <p><b>Downhill</b></p> <p>The force of gravity causes a toy car to roll down a slope.</p>  <p>a. Which energy transfers best represent what happens as the car rolls down the slope?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A Gravitational store → Kinetic store <input type="checkbox"/></p> <p>B Kinetic store → Thermal store <input type="checkbox"/></p> <p>C Gravitational store → Kinetic store + Thermal store <input type="checkbox"/></p> <p>b. What is the best reason for your answer to part a?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A The force of gravity makes the car move faster. <input type="checkbox"/></p> <p>B Friction transfers some energy from the kinetic store into the thermal store. <input type="checkbox"/></p> <p>C The acceleration of the car transfers some energy from the kinetic store into the thermal store. <input type="checkbox"/></p> <p>D Friction uses up some but not all of the energy in the kinetic store. <input type="checkbox"/></p>
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<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Trolleys and springs</b></p> <p>A trolley is attached between two stretched springs. It is pushed to one side and released. The trolley moves backwards and forwards with vigour!</p>  <p>Eventually the trolley comes to a stop.</p> <p>a. Which statement describes the situation now?</p> <p>A The energy in the kinetic store is zero. The energy in the elastic store is zero. <input type="checkbox"/></p> <p>B The energy in the kinetic store is zero. The energy in the elastic store is a maximum, but not zero. <input type="checkbox"/></p> <p>C The energy in the kinetic store is a minimum, but is not zero. The energy in the elastic store is zero. <input type="checkbox"/></p> <p>D The energy in the kinetic store is a minimum, but is not zero. The energy in the elastic store is a maximum, but not zero. <input type="checkbox"/></p> <p>b. What is the best explanation for your answer?</p> <p>A The energy in the kinetic store has been transferred to the elastic store. <input type="checkbox"/></p> <p>B The maximum amount of energy that was in the kinetic store has been transferred into the thermal store. <input type="checkbox"/></p> <p>C All the energy in the kinetic store and the elastic store has been transferred into the thermal store. <input type="checkbox"/></p> <p>D The energy in the kinetic store has run out. <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Rollercoaster</b></p> <p>A rollercoaster is held stationary at the start of a ride. It is then released.</p>  <p>1. Imagine there is no friction.</p> <p>At which point does the roller coaster stop again for the first time?</p> <p>Put a tick (✓) next to the best answer.</p> <p>A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/></p> <p>2. Using the rollercoaster to the next moment 100 kJ of energy into the gravitational store.</p> <p>At which point is there 100 kJ of energy in the kinetic store?</p> <p>Put a tick (✓) next to the best answer.</p> <p>A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Trampoline</b></p> <p>A heavy ball is dropped from a height of 8 m above a trampoline.</p>  <p>When the ball is dropped, there are 80 J of energy in the gravitational store.</p> <p>How much energy is there in the kinetic store at the moment the ball hits the trampoline?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A less than 80 joules. <input type="checkbox"/></p> <p>B exactly 80 joules. <input type="checkbox"/></p> <p>C more than 80 joules. <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Rolling ball</b></p> <p>A steel ball is released from the left-hand side of a bowl.</p>  <p>1. The ball will roll forwards and backwards and finally stop at the bottom of the bowl.</p> <p>What is the best reason for this?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A The energy gets smaller and smaller. When the ball stops, there is no energy. <input type="checkbox"/></p> <p>B The ball uses up all its energy and comes to a stop. <input type="checkbox"/></p> <p>C Friction does work on the ball. Energy in the thermal store increases. <input type="checkbox"/></p> <p>D Gravity pulls down on the ball and slows it down. <input type="checkbox"/></p> <p>E Energy in the kinetic store is transferred to a gravitational store until the ball stops. <input type="checkbox"/></p>	<p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Falling</b></p> <p>A student drops a cricket ball from a height of 2.8 m. The energy in the kinetic store is 10 J when it reaches the ground.</p>  <p>a. Which equation(s) need to be used to calculate the amount of energy in the kinetic store when the ball hits the ground?</p> <p>Put a tick (✓) in the box next to the best answer.</p> <p>A Just <math>E = mgh</math>. <input type="checkbox"/></p> <p>B Just <math>E = \frac{1}{2}mv^2</math>. <input type="checkbox"/></p> <p>C Both <math>E = mgh</math> and <math>E = \frac{1}{2}mv^2</math>. <input type="checkbox"/></p> <p>b. The equation <math>E = \frac{1}{2}mv^2</math> can be used to calculate the speed at which the ball hits the ground. How does the equation need to be rearranged?</p> <p>A <math>v = \sqrt{\frac{2E}{m}}</math> <input type="checkbox"/> B <math>v = \sqrt{\frac{E}{2m}}</math> <input type="checkbox"/></p> <p>C <math>v = \left(\frac{2E}{m}\right)^2</math> <input type="checkbox"/> D <math>v = \frac{m}{\sqrt{2E}}</math> <input type="checkbox"/></p>																														
Two-tier multiple choice	Simple multiple choice	Simple multiple choice	Two-tier multiple choice	Simple multiple choice																														

### Surprise!

**BEST**  
STUDENT WORKSHEET

**Surprise!**

Observe this jump-up toy because they spring up unexpectedly.  
The toy is pushed down to squash the spring.  
A suction cup sticks to the toy.  
A short time later it releases and the toy jumps into the air.



Some students are discussing a jump-up toy.

**Yan May:** At its maximum height all the energy is in the gravitational store.

**Ashley:** It has no energy before the suction cup releases.

**Maria:** The toy speeds up for just the first few moments after it lifts off.

**Bobby:** As it goes up energy is lost from the kinetic store.

**Abdul:** Energy from the elastic store is transferred to the kinetic store.

To answer:

- Who do you agree with?  
Answer your reasons.
- Who is wrong about the jump-up toy?  
What would you say to help them?


Developed by the University of York Science Education Group, the Salter's Institute and the Institute of Physics.  
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### Pendulum

**BEST**  
STUDENT WORKSHEET

**Pendulum**

A pendulum is made of a hanging weight.  
Lifting the weight to one side and releasing it causes the pendulum to swing forwards and backwards.



What happens after the pendulum is set swinging?  
Pick one statement in each row to explain how the amount of energy changes.

1. As the pendulum swings down, the energy in the gravitational store increases.	As the pendulum swings down, the energy in the gravitational store increases.
2. ...and the energy in the kinetic store decreases.	...and the energy in the kinetic store increases.
3. Air resistance and frictional cause energy to be transferred into the thermal store.	Air resistance and frictional cause energy to be transferred into the kinetic store.
4. The pendulum swings up and reaches a lower height than it started from.	The pendulum swings up and reaches the same height that it started from.
5. ...because it gains energy from the gravitational store as it swings down all the way.	...because energy is conserved, and the energy in the gravitational store is the same as at the start.
6. The pendulum stops because the kinetic energy has run out.	The pendulum stops because the energy has been transferred into thermal stores.

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Talking heads

Explanation story