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| Unit 6  Energy |

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| 6.0 – Forms of Energy |

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| Form of Energy | What is it? | Where does it come from? | Where is it used? |
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| 6.1 – Energy Transformations |

1. Go to PHET – Energy Forms and Changes
2. State the energy transformations taking place in each situation given.

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| **Turbine moved by medium water flow from faucet with a water heater system** | **Solar panel in medium cloud cover with a regular light bulb system** |
| **Turbine moved by steam from medium heat kettle with a water heater system** | **Turbine moved by cyclist pedaling at medium speed with a fluorescent light bulb system** |

Key Points:

* Number of transformation “steps” depend on the initial and final state of energy system we choose to consider.
* “Energy cannot be created or destroyed; it can only be changed from one form to another.” -- Albert Einstein

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| 6.2 – Energy Bar Graphs |



Go to and explore the Phet Simulation called “Energy Skate Park Basics: Intro”.

1. Why is the skater’s motion perpetual?

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Consider a skater moving back and forth along a frictionless ramp as shown in Frames 1 – 4 below.

1. Write the “four” step energy transformation taking place (one for each frame).

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1. Draw an energy bar chart for various positions given.

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| Frame 1 | Frame 2 |
| Frame 3 | Frame 4 |

1. In the table below, write down whether each quantity increases, decreases, or stays the same.

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| Skater’s Movement |  | Potential Energy | Kinetic Energy |
| Up the hill | v |  |  |
| Down the hill | v |  |  |

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| **Practice**:State the “3 step” energy transformation taking place in each situation given.   |  |  | | --- | --- | | 1. An arrow is shot from a bow and stops in the center of its target.   \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ | 1. An object rests on a coiled spring, and is then launched upwards.   \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ | | 1. A piece of clay is dropped and sticks to the floor.   \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ | 1. A pole vaulter runs, plants her pole, and vaults up over a bar.   \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ → \_\_\_\_\_\_\_\_\_\_ | |

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| 6.3 – Equations for Kinetic and Potential Energy |

1. Go online to search for the equations for kinetic and potential energy. State what each variable represents and what unit they need to be in.

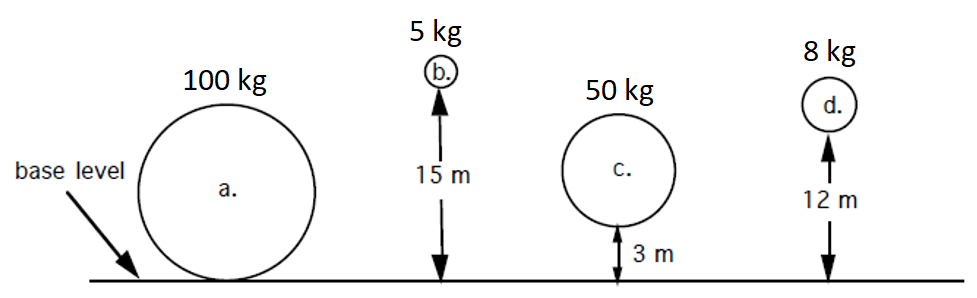
Equation for potential energy:

Equation for kinetic energy:

1. Which object in the figure below has the most kinetic energy? Show your work.

Machine generated alternative text:
-30 m/s 
5. 
Which object to the right has the 
most kinetic energy? 
v +20 m/s 
10 Kg 
v 
v +3 m/s 
1 OO Kg 
v 
+1 m/s 
d. 
500 Kg 

1. Which object has the most potential energy relative to the base level indicated?



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| 6.4 – Friction |

1. Open two PhET simulations: (1) PhET Friction Thermodynamics Sim AND (2) PhET Energy Skate Park Basics: Intro Sim
2. In the microscopic model boxes, draw and describe themotion of the skater’s molecules at her two different positions. ***Hint:*** *Think about molecules in the friction simulation.*
3. In the macroscopic model boxes, draw and describe the energy of the skater at the two positions.

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| Microscopic Model | Microscopic Model |
| Macroscopic Model | Macroscopic Model |



***FRICTION SUMMARY:***

What happens to the particles when two surfaces are rubbed together?

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* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ something is moving, the more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ it will create!
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy gets converted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy.
* In other words, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gets converted to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

What are some real life examples where you can observe friction?

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| 6.5 – Total Energy in a System |

1. Open **Phet Energy Skate Park: Basics**, and look at the skateboarder on a frictionless ramp (be sure the Energy Bar Graph is open).
2. Investigate the meaning of “total energy” from the bar graph. In the table below, describe what the KE, PE, and TE are.

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| When skater is at top of ramp | When skater is at bottom of ramp | When skater is half way down the ramp |
| KE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  PE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  ETOT = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | KE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  PE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  ETOT = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | KE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  PE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  ETOT  = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. What happens when the element of friction is introduced? Where does all of the energy go?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Define “total energy” of the system based on your observations.

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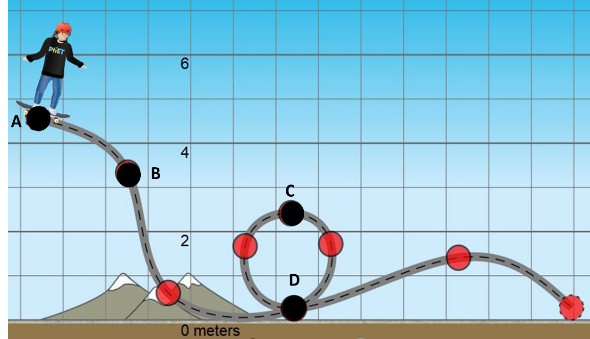
1. Find a way to increase the “total energy.” What did you do to increase the total energy?

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1. Use trends in the table from #2 above to write a “rule” about the changes in energy, including total energy, of the system as the skater moves along the track. Use your own words.

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1. Use your experience with the skater system to complete the energy bar graphs for each position below.



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| Position A | Position B | Position C | Position D |
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1. Based on your observations of total energy at different times and positions, write an equation to show the relationship between the total energy at A and at C. Use the diagrams in #7.

What does the above equation mean? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Use your observations about the relationship between total energy and the different forms of energy (KE, PE, Eth) to build a general equation for the total energy (Etot) in the system.

Etot =

What does the above equation mean? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Example**:Use your energy equations to complete the missing information in the table below:   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | System | Etot at A | KE at A | PE at A | Eth at A | Etot at B | KE at B | PE at B | Eth at B | |  | 16 J | 0 J | 16 J | 0 J |  |  | 0 J | 2 J | |  |  |  | 1.1 J | 0.3 J | 24 J | 6.3 J |  | 0.7 J | |  |  | 14.5 J | 1 J | 0.5 J |  | 4.5 J |  | 0.9 J | |

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| **Critical Thinking**: In the figures below, balls are travelling in different directions. The balls have the same size and shape, but they have different masses and are traveling at different velocities as shown. Rank the kinetic energy of the balls.      Explain your reasoning: |

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| 6.6 – Temperature, Thermal Energy, and Heat |

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| Thermal Energy | Temperature | Heat |
| An energy *of the system* due to the \_\_\_\_\_\_\_\_\_\_ of its atoms and molecules. It is the total kinetic energy of moving atoms and it is a form of energy. | A variable that quantifies the ‘hotness’ or “coldness” of a system. It is the average kinetic energy of all the molecules in a substance, or the thermal energy per molecule. | The energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between a system and the environment as a consequence of a temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between them. Heat is not a property of the system. Instead, heat is the **amount of energy that moves between the system and the environment** during a thermal interaction. |

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| **Consider This:** How do the temperatures and thermal energy compare for each of the set ups below?   |  |  |  |  | | --- | --- | --- | --- | |  |  |  |  | | Temperature |  |  |  | | Eth |  |  |  | |

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| **Consider This:** Touch your table top. Write an estimate for its temperature: \_\_\_\_\_\_\_\_\_\_\_\_ Touch the table’s metal leg. Write an estimate for its temperature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Are the temperatures of the table top and the table leg the same? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

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| **Consider This:** A sparkler is a safe toy for kids as the sparks don’t burn the skin upon contact. In fact, they are quite cool to the touch. In actuality, each spark is 1600°C. Explain why a 1600°C spark doesn’t burn your skin.  Image result for sparkler |

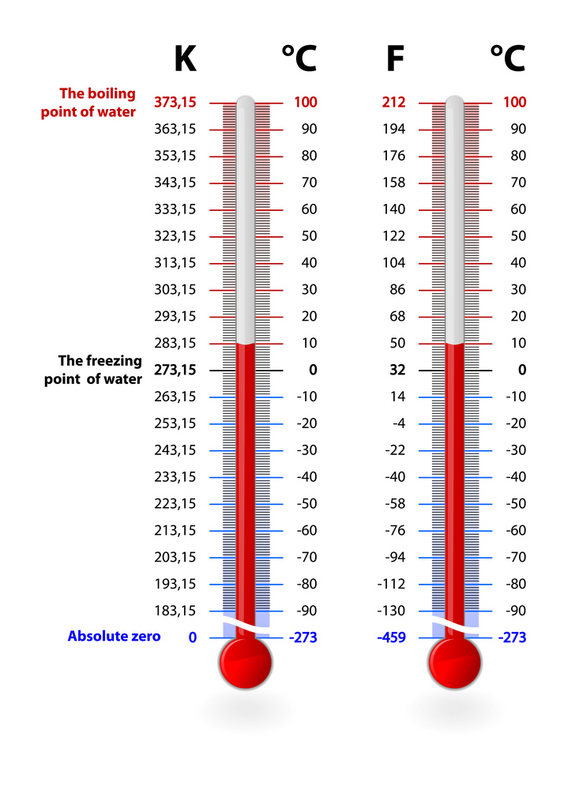
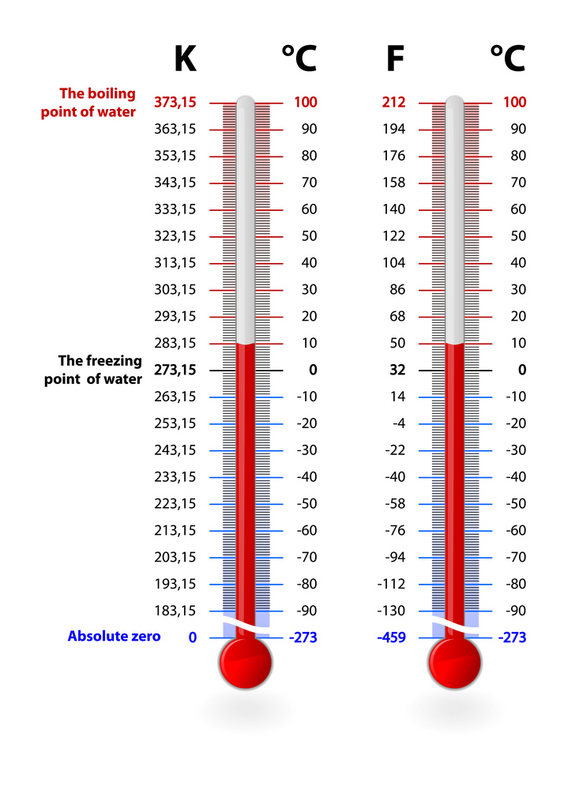
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| **Consider This:** An oven at 400°C is much cooler when compared with a sparkler, yet when you accidentally touch the side of the oven while getting your dinner out, it burns quite a bit. Explain why an oven at 400°C burns you significantly more than a sparkler at 1600°C.  Image result for oven inside |
| 6.7 – Temperature Scales | |

Temperature scales

* The Celsius scale defines 0 as the point at which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and 100 the point at which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The Kelvin scale defines 0 as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the temperature at which

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

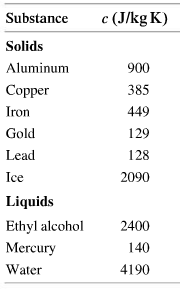
* The size of one unit of degree Celsius is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as one unit of degree Kelvin
* Degrees in Kelvin = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Example:** Convert the following.   |  |  |  | | --- | --- | --- | | 1. What is 25°C in Kelvin? | 1. What is 0 K in °C? | 1. What is -32°C in Kelvin? | |

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| 6.8 – Specific Heat Capacity |

**Specific Heat** is the amount of energy that raises the temperature of 1 kg of a substance by 1 K. You can think of specific heat as *thermal inertia.* The higher the specific heat (*inertia*), the more energy (*force*) needed to change the temperature (*velocity*).



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| **Example:** A 70.0 kg student catches the flu, and his body temperature increases from 37°C to 39°C. How much energy is required to raise his body’s temperature? The specific heat of a person is 3400 J/kg K. |

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| **Consider This**: Consider the following scenarios and discuss with a partner.   1. You take a freshly baked apple pie out of the oven that was set at 350°F. What temperature is the pie crust? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ What temperature is the pie filling? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Which one burns your tongue more? How come?      1. You find a glass jar with a metal screw top lid difficult to open. Your granny runs the hot water tap over the jar to help you open it. Why might she do that? |
| 6.9 – Energy Changes in Chemical Reactions | |

**Chemical potential energy:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In a chemical reaction, there is BOTH bond breaking AND bond making

* bond breaking: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* bond making: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Change in enthalpy (H)** is the heat consumed or released by a system under constant pressure

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| Endothermic | Exothermic | |
| |  |  | | --- | --- | |  |  |  * E bond breaking \_\_\_\_\_ E bond making * energy is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * E of products \_\_\_\_\_ E of reactants * ΔH = Hproduct – Hreactant = ­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * on a graph   HCl + 50kJ → H+ + Cl-   |  | | --- | |  |   ΔH = | |  |  | | --- | --- | |  |  |  * E bond breaking \_\_\_\_\_ E bond making * energy is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * E of products \_\_\_\_\_ E of reactants * ΔH = Hproduct – Hreactant = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * on a graph   H+ + Cl- → HCl + 50kJ   |  | | --- | |  |   ΔH = | |
| 6.10 – First Law of Thermodynamics | | |

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| **Mini Activity**: Let’s explore the two variables in the first law of thermodynamics. You will need 2 x 250 mL beakers, a thermometre, and a glass rod.  Procedure   1. Grab a 250 mL beaker and fill half of it with water. 2. Try to induce an energy change by ONLY affecting change on Q. Use a thermometer to monitor your success. 3. Grat another 250 mL beaker and fill half of it with water. 4. Try to induce an energy change by ONLY affecting change on W. Use a thermometer to monitor your success. |