DEVIL PHYSICS

THE BADDEST CLASS ON CAMPUS

AP PHYSICS

LSN 6-10, POWER

Questions From Reading Activity?

Big Idea(s):

- Interactions between systems can result in changes in those systems.
- Changes that occur as a result of interactions are constrained by conservation laws.

Enduring Understanding(s):

- Interactions with other objects or systems can change the total energy of a system.
- Certain quantities are conserved, in the sense that the changes of those quantities in a given system are always equal to the transfer of that quantity to or from the system by all possible interactions with other systems.
- The energy of a system is conserved.

Essential Knowledge(s):

- The energy of a system includes its kinetic energy, potential energy, and microscopic internal energy. Examples should include gravitational potential energy, elastic potential energy, and kinetic energy.

Essential Knowledge(s):

- The internal energy of a system includes the kinetic energy of the objects that make up the system and the potential energy of the configuration of the objects that make up the system.
  - Since energy is constant in a closed system, changes in a system's potential energy can result in changes to the system's kinetic energy.
  - The changes in potential and kinetic energies in a system may be further constrained by the construction of the system.

Essential Knowledge(s):

- Energy can be transferred by an external force exerted on an object or system that moves the object or system through a distance; this energy transfer is called work. ***Energy transfer in mechanical or electrical systems may occur at different rates. Power is defined as the rate of energy transfer into, out of, or within a system.*** [A piston filled with gas getting compressed or expanded is treated in Physics 2 as a part of thermodynamics.]

Learning Objective(s):

- The student is able to calculate the total energy of a system and justify the mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy.
- The student is able to predict changes in the total energy of a system due to changes in position and speed of objects or frictional interactions within the system.

Learning Objective(s):

- The student is able to describe and make predictions about the internal energy of systems.
- The student is able to calculate changes in kinetic energy and potential energy of a system, using information from representations of that system.

Power

Power

- The rate at which work is done
- The rate at which energy is transformed
- Work – Energy Principle

$$P = \frac{W}{t} = \frac{\Delta E}{t}$$

Power - Units

- Unit for power is the watt (W)
- What?
- 1 watt = 1 joule/ 1 second
- Horsepower is an English unit for power

$$P = \frac{W(joules)}{t(\sec)}$$

$$1Watt(W) = 1J\ /1s$$

Power:
More Equations

$$P = \frac{W}{t}$$

$$W = Fd$$

$$P = \frac{Fd}{t}$$

$$\frac{d}{t} = v$$

$$P = Fv$$

Power

$$P = \frac{W}{t}$$

$$P = \frac{\Delta E}{t}$$

$$P = Fv$$

Sample Problem:

- A 60-kg girl runs the 12 m from the first to the third floor of the Bell Building in 10 seconds. An 80-kg boy takes his time and makes it up in 15 seconds.
  - Which one did more work?
  - Which one exerted more power? How much more?
  - Based purely on displacement, how much kinetic energy did each one have?

Sample Problem:

- A 60-kg girl runs the 12 m from the first to the third floor of the Bell Building in 10 seconds. An 80-kg boy takes his time and makes it up in 15 seconds.
  - ***Which one did more work?***
    - **Girl 7,200 J, Boy 9,600 J**
  - Which one exerted more power? How much more?
  - Based purely on displacement, how much kinetic energy did each one have?

$$W = Fd$$

$$W = mgh$$

$$W_{girl} = (60)(10)(12)$$

$$W_{girl} = 7{,}200\,J$$

$$W_{boy} = (80)(10)(12)$$

$$W_{girl} = 9{,}600\,J$$

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  - ***Which one did more work?***
    - **Girl 7,200 J, Boy 9,600 J**
  - ***Which one exerted more power? How much more?***
    - **Girl 720 W, Boy 640 W**
  - Based purely on displacement, how much kinetic energy did each one have?

$$P = \frac{W}{t}$$

$$P_{girl} = \frac{7200}{10}$$

$$P_{girl} = 720W$$

$$P_{boy} = \frac{9600}{15}$$

$$P_{boy} = 640W$$

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    - **Girl 7,200 J, Boy 9,600 J**
  - ***Which one exerted more power? How much more?***
    - **Girl 720 W, Boy 640 W**
  - Based purely on displacement, how much kinetic energy did each one have?
    - **Girl 43.2 J, Boy 25.6 J**

$$KE = 1/2\, mv^2$$

$$v = \frac{d}{t}$$

$$v_{girl} = \frac{12}{10} = 1.2 m/s$$

$$KE_{girl} = 1/2\,(60)(1.2)^2$$

$$KE_{girl} = 43.2 J$$

$$v_{boy} = \frac{12}{15} = 0.8 m/s$$

$$KE_{boy} = 1/2\,(80)(0.8)^2$$

$$KE_{boy} = 25.6 J$$

Efficiency

- Because of nonconservative forces, energy / work / power is never (in real life) completely conserved
- Efficiency is the ratio of output to input
- Because of the above, it will always be some fraction less than 1

$$e = \frac{output}{input} = \frac{P_{output}}{P_{input}}$$

Efficiency

$$e = \frac{output}{input} = \frac{P_{output}}{P_{input}}$$

- Car engines are only 15% (0.15) efficient
- CCDs in cameras (pixels) are roughly 85% efficient

Efficiency Sample Problem

- ***Angela doesn't study very efficiently when she listens to techno-rap-rave music. In two hours of "studying", she only accomplished 25 minutes of useful learning. What was the efficiency of her study method?***

Efficiency Sample Problem

- ***Anna doesn't study very efficiently when she listens to techno-rap-rave music. In two hours of "studying", she only accomplished 25 minutes of useful learning. What was the efficiency of her study method?***

$$e = \frac{output}{input} = \frac{25\,\text{min}}{120\,\text{min}} = 0.21 = 21\%$$

- ***Makes you wonder how she ever got to be the Student of the Week?***

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QUESTIONS?

Homework

#58-70