

1st Law of Thermodynamics (Heat Engine)

U4P2a

- The “purpose” of the _____ is to explain changes to the energy contained within an object, called _____ energy. Technically, internal energy includes many things: chemical, nuclear, etc. energy. For our purposes internal energy, however, it is a synonym for _____ energy. The two ways to add/remove thermal energy from an object is to apply a source/sink of organized motion energy (_____) or apply a _____/_____ of _____ motion energy (_____). So, change in internal energy = $\Delta U = \text{_____} + \text{_____}$.
- The 1st Law of Thermodynamics fixes the “problem” of explaining where the energy goes in an _____ collision. The energy goes _____ and makes the object _____.

Internal Combustion Engine (Heat Engine)

Motion Revisited

- The 1st Law of Thermodynamics is based on the Law of Conservation of _____. In fact, we can now rewrite this law as _____ = _____. This means that changes in motion can cause _____ of an object to change. It also means, adding heat to a system can be used to change an object’s _____.

Hammer and Nail

Locomotive

- In real life, not all the energy released from burning gasoline is actually transformed into _____. Efficiency measures energy _____ vs _____ energy supplied. A 20% efficiency means that for every 10J of input _____ is actually completely wasted.

More Realistic Locomotive

2nd Law of Thermodynamics (Entropy)

U4P2b

- o Entropy measures the amount of _____ in a system. The _____ states, “Entropy of an isolated system always _____ with time.” A practical result of the 2nd Law of Thermodynamics is that _____ (_____ motion) is always created during an energy transfer so efficiency (= _____ / _____) of any “motor/generator” must _____ 100%.

Power Transmission

NOTE:

The 2nd Law of Thermodynamics is a law of statistics. Gravitation is a law of nature. If your mass is 100kg and you’re on Earth, then your weight is _____. Nothing else is possible.

In contrast, if you shuffle a deck of cards, most likely the cards will seem _____. If they came out ordered by suit from ace to king, you would assume the shuffler _____.

Similarly, the natural law of energy conservation says, if the pencil you are holding starts at a room temperature and no energy is added/removed, then its temperature will _____. The 2nd law of thermodynamics adds that it is **most likely** true that the pencil will be _____ temperature everywhere. Technically, though, random atomic collisions could temporarily result in a lot more vibration on one side of the pencil than the other. Still, we don’t live in fear that one side of our pencil will suddenly _____ while the other side _____.

Identifying Increases/Decreases in Entropy (Disorder)

Entropy increases if...

Examples

*** more _____
(the challenge is _____
_____)

- higher _____
(be careful of _____
_____)

- no _____ energy source
is required.
(be careful of _____
_____)

- an _____ the number of categories.
(be careful of _____
_____)