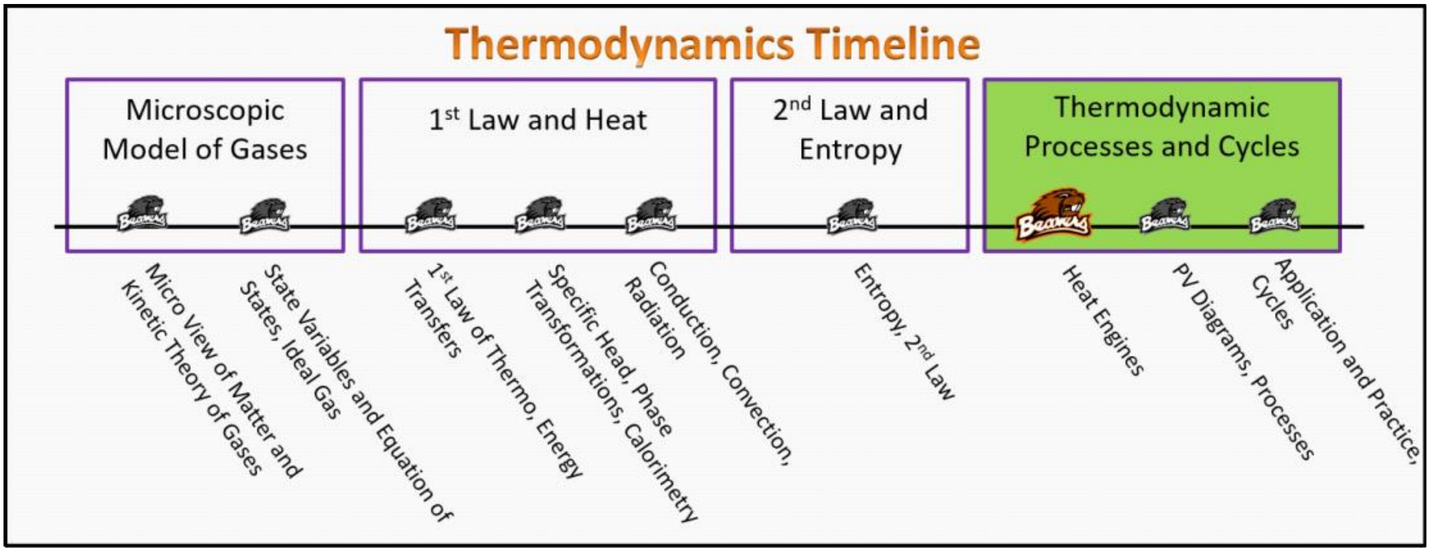
(PC.L1.123) Template for Boxsand

Thursday, March 29, 2018 8:34 PM

Thermodynamic Processes and Cycles
Familiarize Stage (PC.L1.1)

Lecture 1
Heat Engines

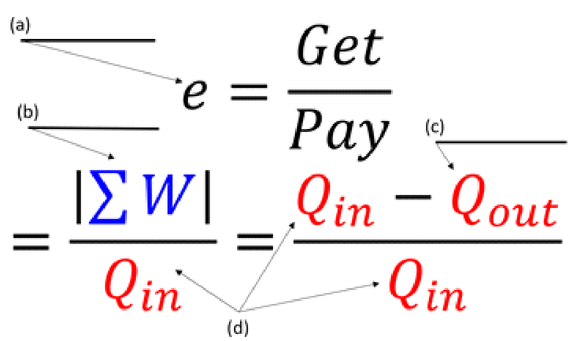


PC.L1.1-01

Description: Infographic quiz thermodynamic efficiency - label matching

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: Match each term in the equation with the correct description from the following list. (1) Net work, (2) Efficiency, (3) Heat out, (4) Heat in



PC.L1.1-02

Description: Understanding efficiency

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: What is thermal efficiency?

(1) Thermal efficiency is the ratio of work input to the energy input.
(2) Thermal efficiency is the ratio of work output to the energy input.
(3) Thermal efficiency is the ratio of work input to the energy output.
(4) Thermal efficiency is the ratio of work output to the energy output.

PC.L1.1-03

Description: Units for thermal efficiency

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: What are the units for thermal efficiency?

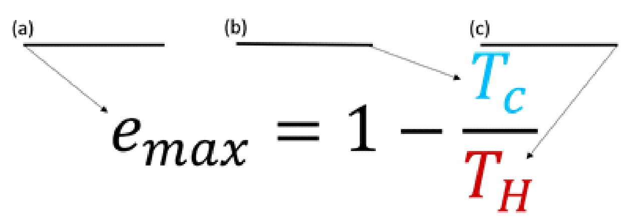
(1) Thermal efficiency has the dimension of energy.
(2) Thermal efficiency has the dimension of electric potential.
(3) Thermal efficiency has the dimension of mass.
(4) Thermal efficiency is dimensionless.

PC.L1.1-04

Description: Infographic quiz Carnot cycle - label matching

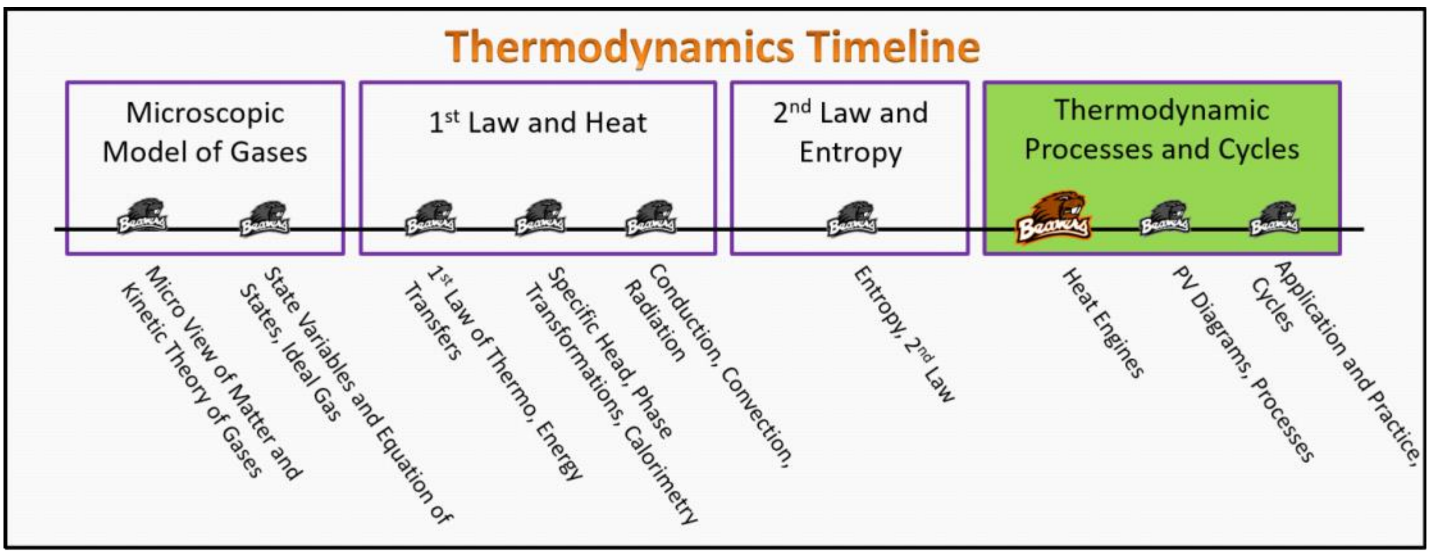
Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: Match each term in the equation with the correct description from the following list. (1) Temperature of the hot reservoir, (2) Efficiency maximum, (3) Temperature of the cold reservoir



Thermodynamic Processes and Cycles
Foundation Stage (PC.L1.2)

Lecture 1
Heat Engines



Textbook Chapters (* Calculus version)

- **BoxSand** :: KC videos (Entropy and 2nd Law of Thermodynamics)
- **Knight** (College Physics : A strategic approach 3rd) :: 11.4 ; 11.5 ; 11.6
- ***Knight** (Physics for Scientists and Engineers 4th) :: 21.1 ; 21.2
- **Giancoli** (Physics Principles with Applications 7th) :: 15-5 ; 15-6

Warm up

PC.L1.2-01:

Description: Application of 1st law.

Learning Objectives: [?] - Can you identify the objectives from the previous lecture, and this lecture, that this question is relevant to?

Problem Statement: A container of monatomic ideal gas is taken through two processes as follows: First the gas is compressed such that the work done on the gas is 10 J and 5 J of heat was removed during the compression. Second, the gas is then allowed to expand back to its original volume, pressure, and temperature. During the expansion, the gas does 10 J of work on the environment, and gains 5 J of heat.

(a) What is the change in thermal energy during the compression and expansion stages?

(b) What is the change in thermal energy for the complete 2 stage cycle?

Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Heat engine
- Heat pump
- Efficiency

Key Equations

Key Concepts

- Coming soon to a lecture template near you.

Questions

Act I: Thermo Laws and Sankey Diagrams

PC.L1.2-02:

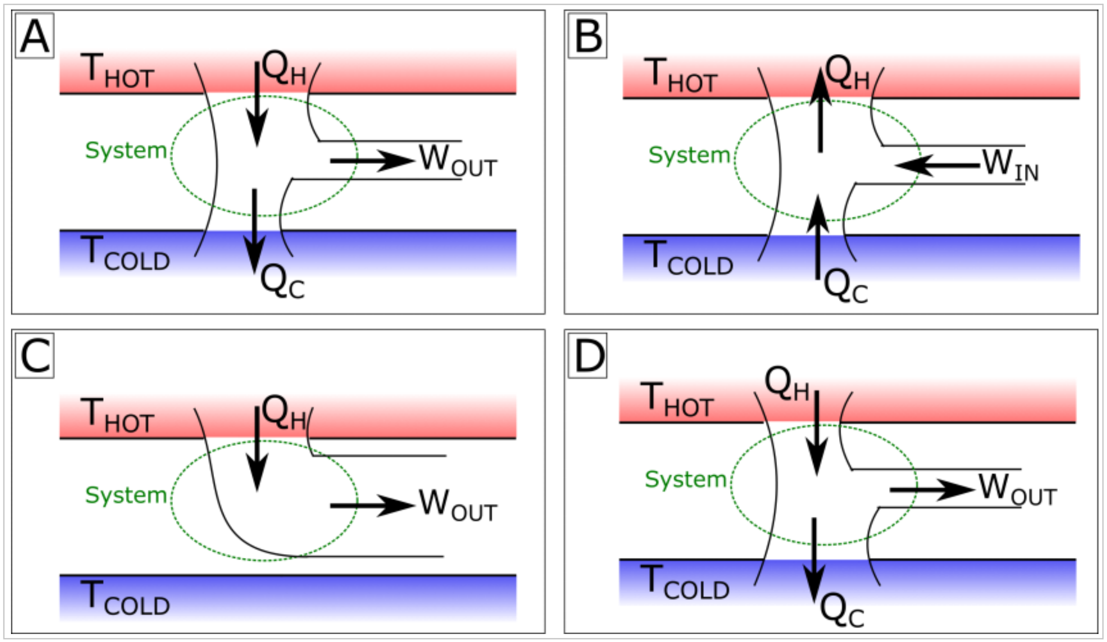
Description: Identify which Sankey diagrams are possible. (4 minutes)

Problem Statement: Diesel engines are used to perform work.

(a) After a diesel engine has been running for a long time, what happens to the temperature of the engine over time?

(1) Roughly steady
(2) Increases
(3) Decreases

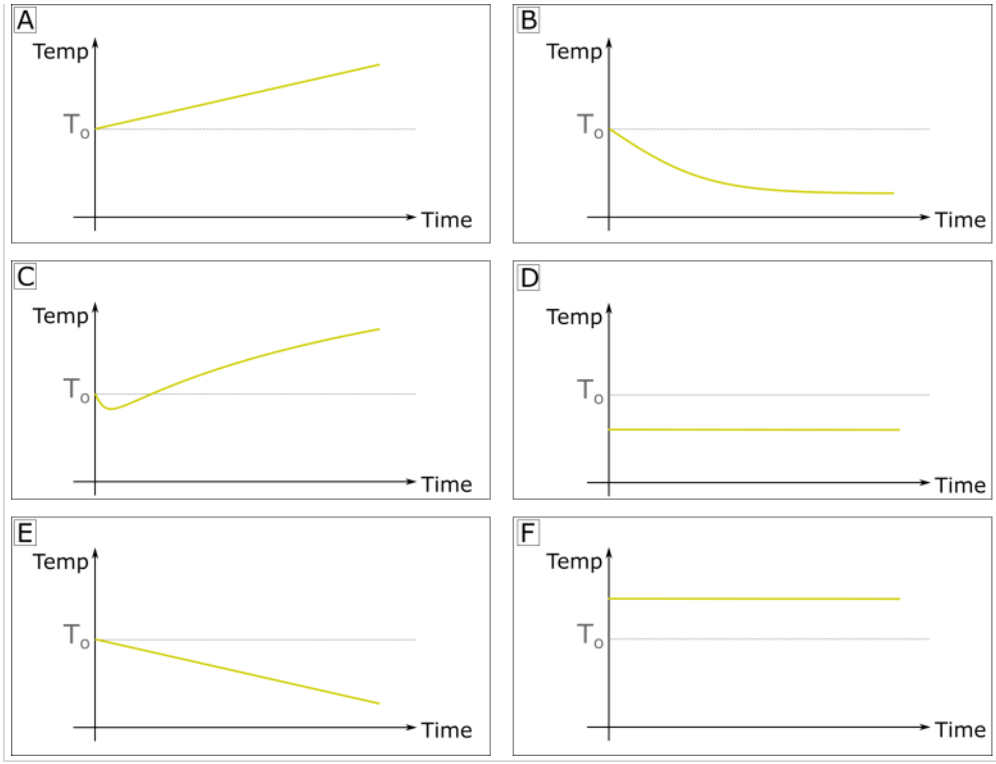
(b) Which of the following Sankey diagrams is physically possible?



PC.L1.2-03:

Description: Identify best graph of temperature vs time for open door of fridge. (4 minutes)

Problem Statement: On a particularly hot day you leave your refrigerator door open. Which of the following temperature vs time graphs would best represent the temperature of the room will be over the next couple of hours. Assume your kitchen is perfectly insulated and the temperature is being read right near the door of the fridge.



Act II: Characterizing Heat Engines (Using 1st Law and Efficiency)

PC.L1.2-04:

Description: Calculate efficiency of heat engine. (6 minutes)

Problem Statement: A heat engine does 10 J of work and exhausts 15 J of waste heat during each cycle. What is the engine's thermal efficiency?

PC.L1.2-05:

Description: Given theoretical max efficiency, what is a reservoir temperature. (5 minutes)

Problem Statement: You wish to produce a heat engine that has a 50% efficiency. You can access water at 350 K from the local factory. What is the maximum temperature your cold reservoir could be and possible achieve this kind of efficiency?

PC.L1.2-06:

Description: Calculate efficiency of heat engine. (6 minutes)

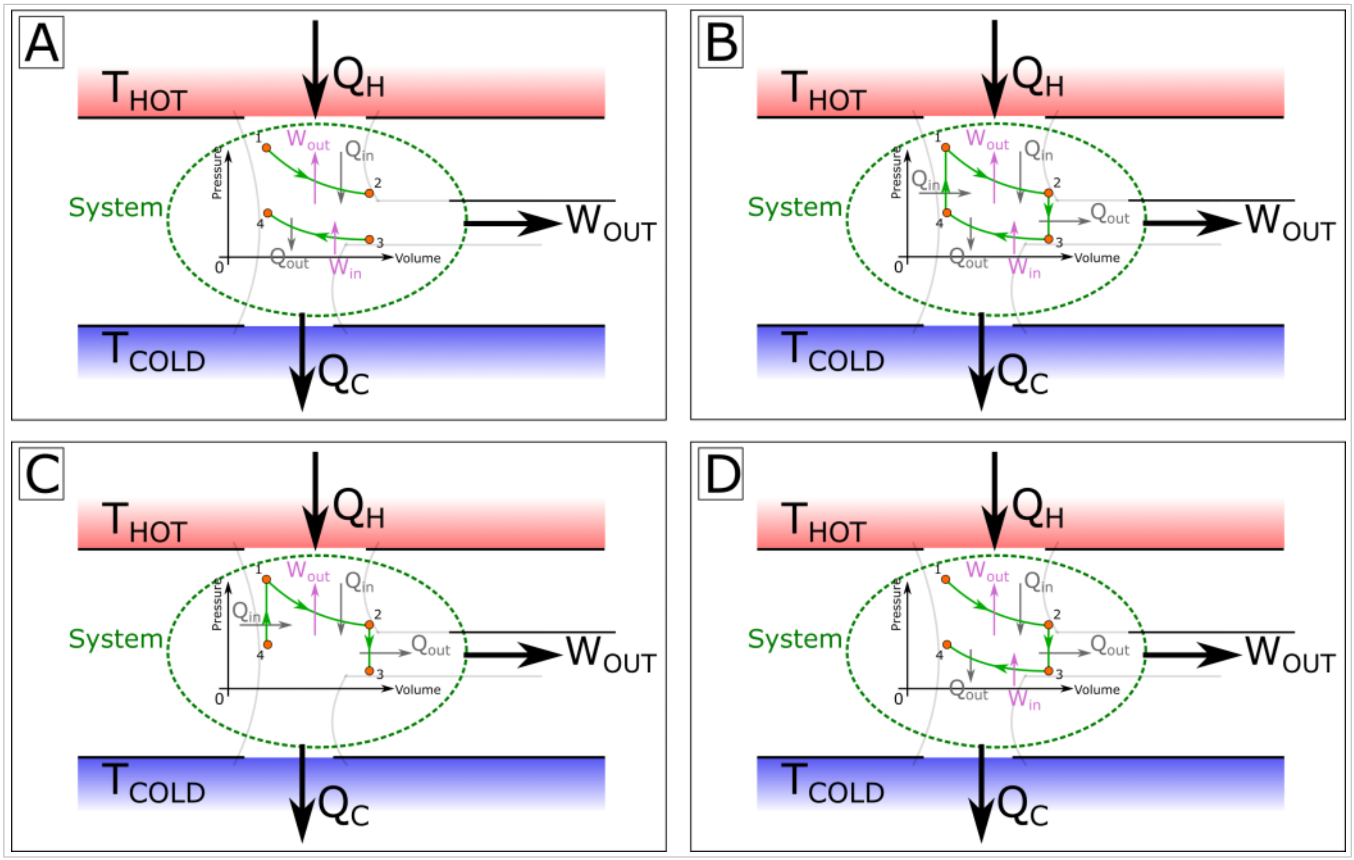
Problem Statement: A 60% efficient device uses chemical energy to generate 600 J of electric energy. A second device uses twice as much chemical energy to generate half as much electric energy. What is the efficiency of this second device?

Act III: Peering into the Black Box

PC.L1.2-07:

Description: Identify which PV-Diagram could represent a heat engine. (3 minutes)

Problem Statement: Another type of heat engine is called a Sterling engine. Which one of the four Sankey diagrams could possibly represent a Sterling engine?



Conceptual questions for discussion

1. Coming soon.

Hints

PC.L1.2-01: No hints.

PC.L1.2-02: No hints.

PC.L1.2-03: No hints.

PC.L1.2-04: No hints.

PC.L1.2-05: No hints.

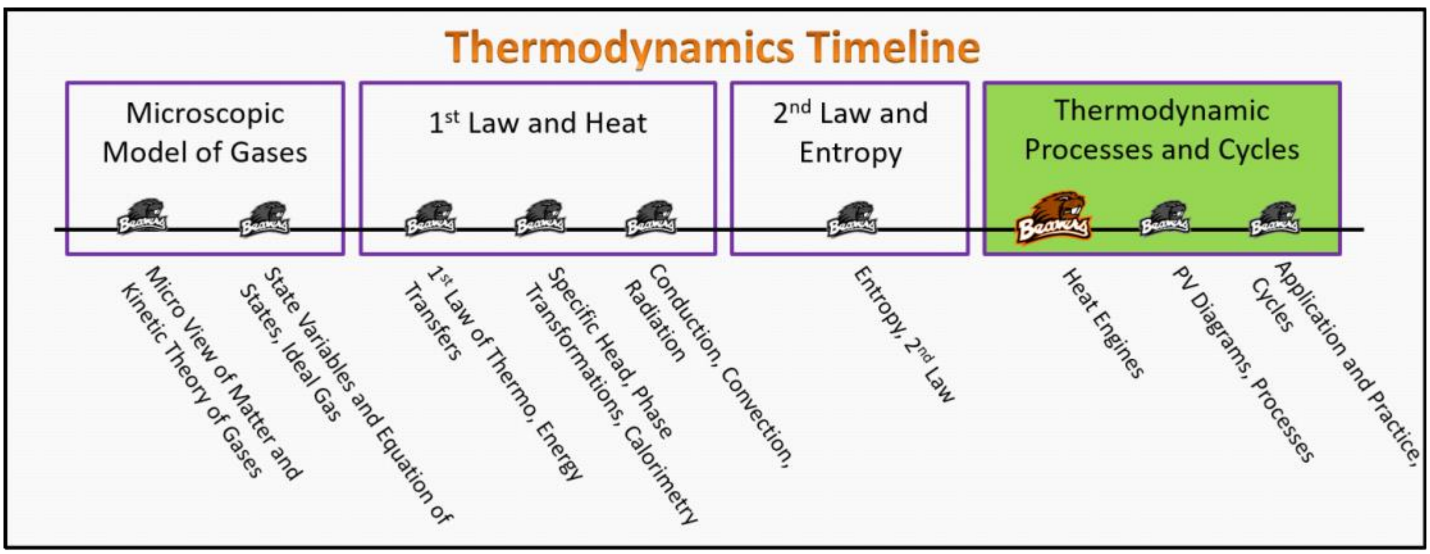
PC.L1.2-06: No hints.

PC.L1.2-07: No hints.

Thermodynamic Processes and Cycles

Practice Stage (PC.L1.3)

Lecture 1
Heat Engines



PC.L1.3-01

Description: Heat engine basic steady state calculation.

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: A 30% efficient heat engine wastes 1200 J of energy in one minute of operation. How much work is this heat engine capable of?

(1) 1200 J

(2) 360 J
(3) 4000 J
(4) 36000 J

PC.L1.3-02

Description: Conceptual question about heat engines.

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: Which of the following statements are true regarding a heat engine that has been running for a long period of time?

(1) The engine will continue to increase in temperature.
(2) The engine will decrease in temperature.
(3) The engine will remain at a constant temperature.

PC.L1.3-03

Description: Conceptual question about heat engines.

Learning Objectives: [x,xx,…] Put the learning objective numbers here

Problem Statement: Which of the following processes can make up a complete cycle in a heat engine?

(1) Adiabatic process.
(2) Isobaric process.
(3) Isothermal process.
(4) Isochoric.