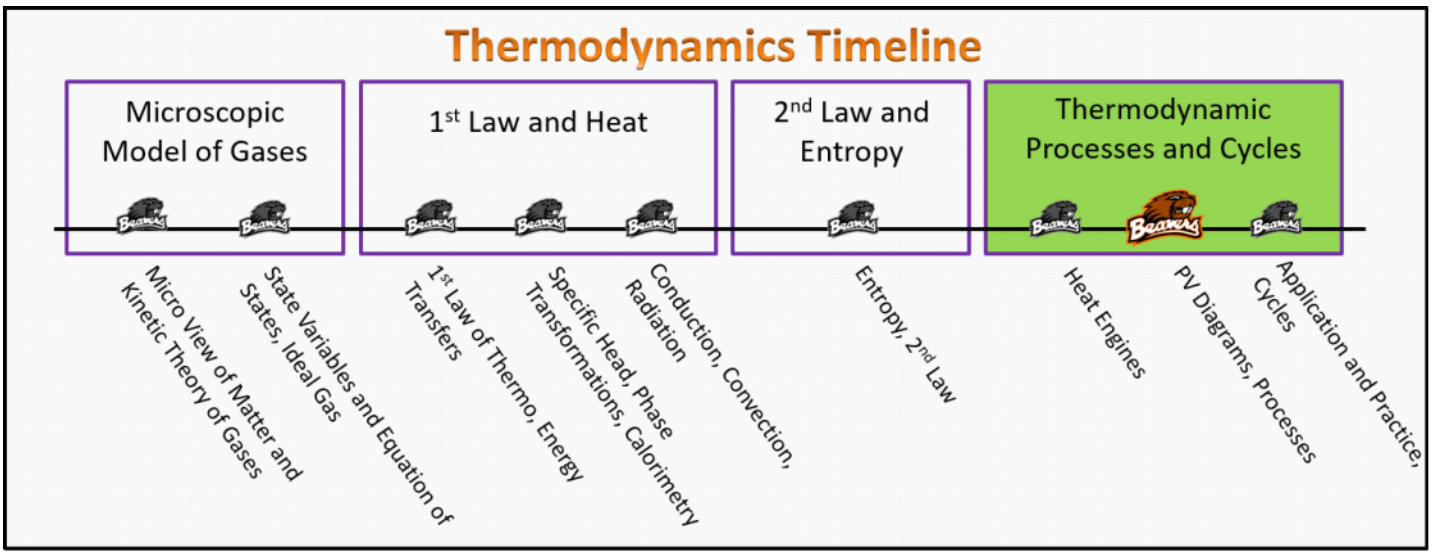
(PC.L2.123) Template for Boxsand

Thursday, March 29, 2018 8:34 PM

Thermodynamic Processes and Cycles

Familiarize Stage (PC.L2.1)

Lecture 2
PV Diagrams, Processes



PC.L2.1-01

Description: Work and a PV-diagram

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

Problem Statement: How is the magnitude of work related to a PV-diagram?

(1) Multiplication of pressure and volume
(2) Slope of the PV curve
(3) Area under a PV curve
(4) Nothing, work can be found from a PT-diagram

PC.L2.1-02

Description: Sign of work

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

Problem Statement: Consider a gas that expands. During this process, what is the sign of the work for the gas

system?

(1) Positive
(2) Negative
(3) Zero
(4) Unable to determine

PC.L2.1-03

Description: Zero work processes

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

Problem Statement: Which of the following processes involve zero work?

(1) Isochoric
(2) Isothermal
(3) Isobaric
(4) Adiabatic
(5) Isomorphic

PC.L2.1-04

Description: Zero heat processes

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

Problem Statement: Which of the following processes involve zero heat?

(1) Isochoric
(2) Isothermal
(3) Isobaric
(4) Adiabatic
(5) Isomorphic

PC.L2.1-05

Description: Zero change in internal thermal energy processes

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

Problem Statement: Which of the following processes involve zero change in internal thermal energy?

(1) Isochoric
(2) Isothermal
(3) Isobaric
(4) Adiabatic
(5) Isomorphic

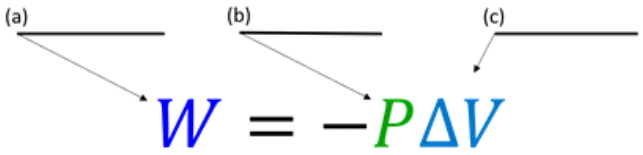
PC.L2.1-06

Description: Infographic quiz thermal process isobaric - label matching

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

Problem Statement: Consider a thermodynamic process

(a) Match each term in the equation with the correct description from the following list. (1) Pressure, (2) Work, (3) Change in volume



(b) Which of the following thermodynamic processes is the work equation in the figure relevant?

(1) Isochoric
(2) Isothermal
(3) Isobaric
(4) Adiabatic
(5) Isomorphic

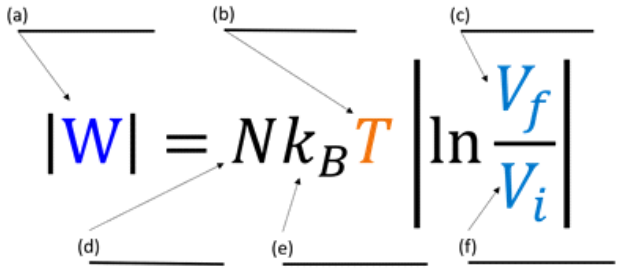
PC.L2.1-07

Description: Infographic quiz thermal process isothermal - label matching

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

Problem Statement: Consider a thermodynamic process.

(a) Match each term in the equation with the correct description from the following list. (1) Boltzmann's constant, (2) Number of particles, (3) Work, (4) Volume final, (5) Temperature, (6) Volume initial



Answer: (a) Work, (b) Temperature, (c) Volume final, (d) Number of particles, (e) Boltzmann's constant, (f) Volume initial

(b) Which thermodynamic process is the work equation in the figure relevant?

(1) Isochoric
(2) Isothermal
(3) Isobaric
(4) Adiabatic
(5) Isomorphic

PC.L2.1-08

Description: processes on a PV diagram

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

Problem Statement: Which comparison of adiabatic and isothermal processes is correct?

(1) The two processes are the same. There is no change in heat content in either process.
(2) In adiabatic processes, temperatures vary without heat transfer into or out of the system. In isothermal processes temperature does not change, but the system can transfer heat.
(3) In adiabatic processes, no heat transfer occurs so the temperature cannot change. In isothermal processes heat transfer can occur, but does not alter temperature.
(4) In adiabatic processes, temperature does not change, but heat can be transferred. In isothermal processes, the system cannot transfer heat so there is no change in the temperature of the system.

PC.L2.1-09

Description: Adiabatic versus isothermal PV curves

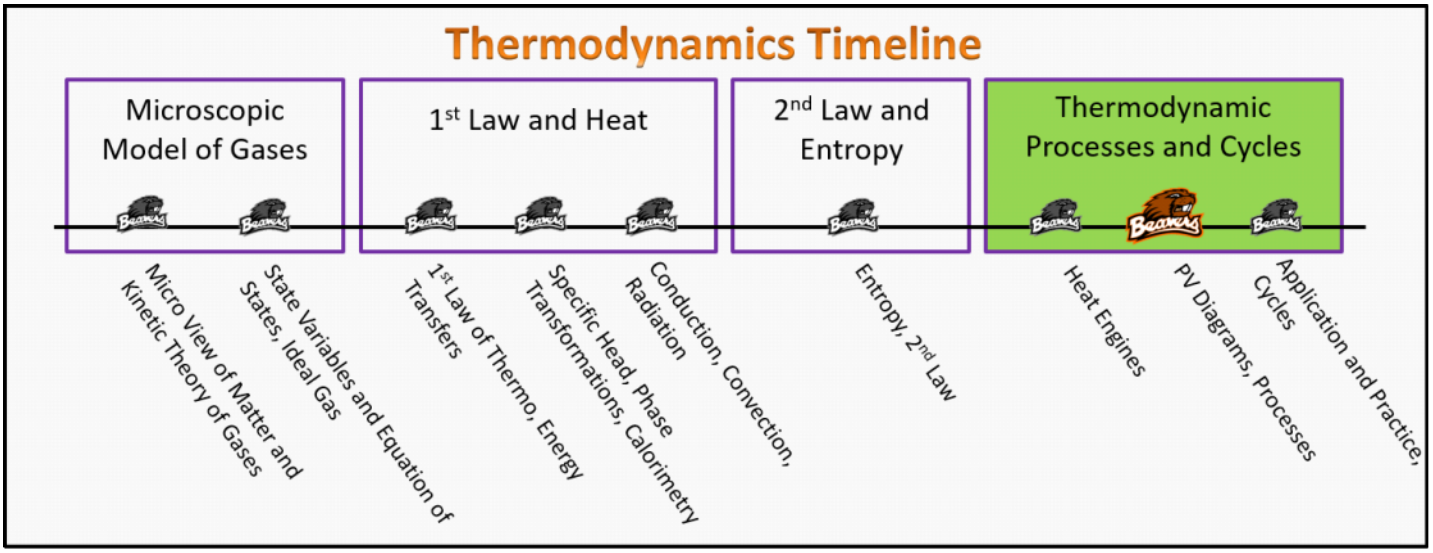
Learning Objectives: [x,xx,...] Put the learning objective numbers here

Problem Statement: Both adiabatic and isothermal processes involve curvy lines on a PV-diagram. What is different between the two?

(1) Adiabatic curves are steeper than isothermal curves
(2) Adiabatic curves are less steep than isothermal curves
(3) Nothing, both are processes are identical so their PV curves are identical

Thermodynamic Processes and Cycles
Foundation Stage (PC.L2.2)

Lecture 2
PV Diagrams, Processes



Textbook Chapters (* Calculus version)

- **BoxSand** :: KC videos (Processes and PV-Diagrams)
- **Knight** (College Physics : A strategic approach 3rd) :: 12.3
- ***Knight** (Physics for Scientists and Engineers 4th) :: 18.7 ; 19.2
- **Giancoli** (Physics Principles with Applications 7th) :: 15-2

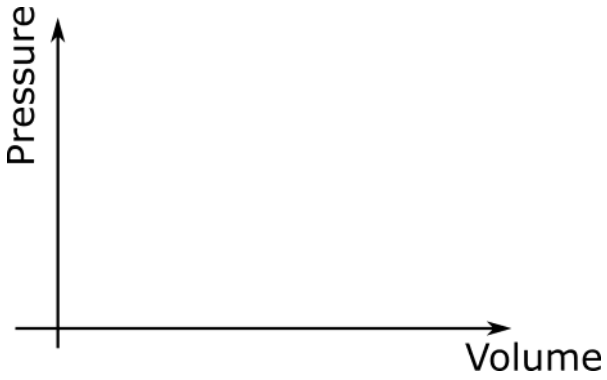
Warm up

PC.L2.2-01:

Description: Sketch any process that starts at one equilibrium state and ends at another.

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

Problem Statement: On the PV diagram below, sketch any process that takes an ideal gas from one equilibrium state to a new equilibrium state. Basically, how are equilibrium states represented on a PV diagram and how are processes represented?



Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Thermodynamic process
- Isochoric process
- Isothermal process
- Adiabatic process
- Isobaric process

Key Equations

Key Concepts

- Coming soon to a lecture template near you.

Questions

Act I: Isochoric

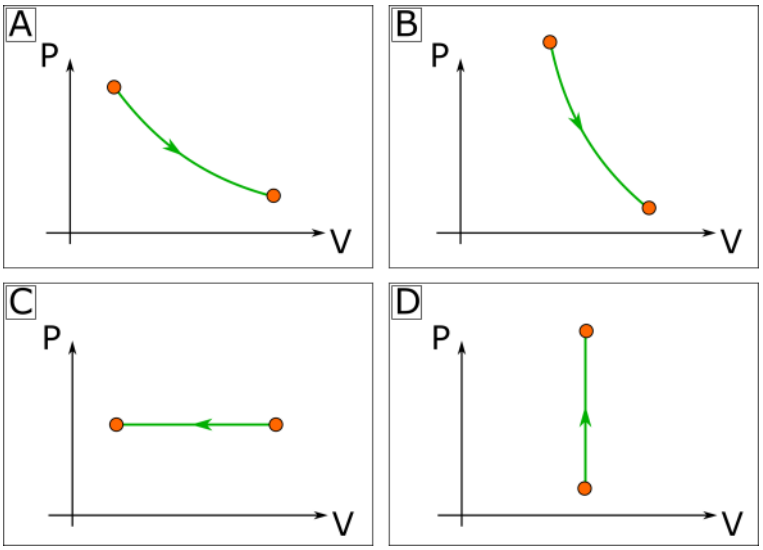
PC.L2.2-02:

Description: Identify which PV diagram represents an isochoric process. (2 minutes + 2 minutes)

Problem Statement: Consider the 4 PV diagrams below.

(a) Which diagram shows an isochoric process?

(b) What are the other diagrams called?



PC.L2.2-03:

Description: Proportional reasoning with ideal gas law. (3 minutes)

Problem Statement: Consider one mole of an ideal monatomic gas that undergoes an isochoric process from one equilibrium state to another. If the pressure is increased by a factor of 4, by what factor does the temperature change by?

(1) 1/16
(2) 1/4
(3) 1
(4) 4
(5) 16

PC.L2.2-04:

Description: Determine signs of first law quantities. (5 minutes)

Problem Statement: Which of the following are the correct signs for an isochoric increase in temperature?

(1) ΔE^{TH} (+) , **W** (+) , **Q** (+)
(2) ΔE^{TH} (+) , **W** (0) , **Q** (+)
(3) ΔE^{TH} (+) , **W** (0) , **Q** (-)
(4) ΔE^{TH} (-) , **W** (-) , **Q** (-)
(5) ΔE^{TH} (-) , **W** (0) , **Q** (-)

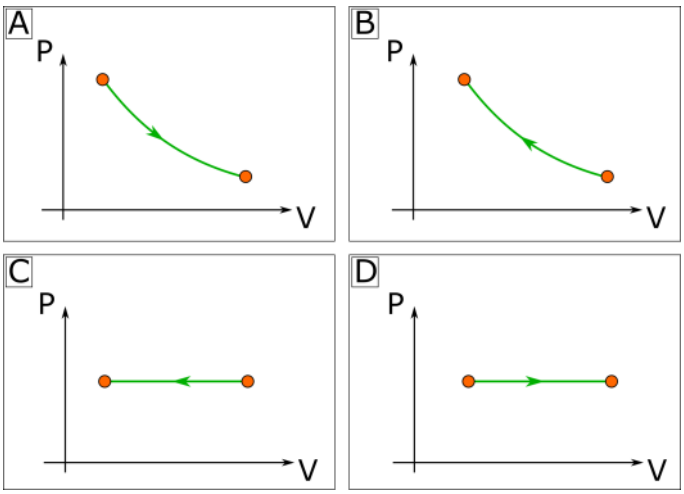
Process	ΔE^{TH}	W	Q
Isochoric increase in temp			
Isochoric decrease in temp			
Isothermal expansion			
Isothermal compression			
Adiabatic expansion			
Adiabatic compression			
Isobaric expansion			
Isobaric compression			

Act II: Isothermal

PC.L2.2-05:

Description: Identify which diagram represents an isothermal process. (2 minutes)

Problem Statement: Which of the following P-V diagrams represents an isothermal compression?



PC.L2.2-06:

Description: Proportional reasoning with ideal gas law. (2 minutes + 4 minutes)

Problem Statement: Consider one mole of an ideal monatomic gas that undergoes an isothermal process from one equilibrium state to another.

(a) How is the pressure related to the volume?

(1) Linear
(2) Quadratic
(3) Inversely
(4) Inverse squared
(5) No relation

(b) The pressure starts at 400 kPa and goes to 100 kPa. If the volume started at 0.5 m^3, what is the final volume?

PC.L2.2-07:

Description: Determine signs of first law quantities. (5 minutes)

Problem Statement: Which of the following are the correct signs for an isothermal compression?

(1) ΔE^{TH} (+) , **W** (+) , **Q** (+)
(2) ΔE^{TH} (+) , **W** (-) , **Q** (-)
(3) ΔE^{TH} (0) , **W** (+) , **Q** (-)
(4) ΔE^{TH} (0) , **W** (+) , **Q** (+)
(5) ΔE^{TH} (0) , **W** (-) , **Q** (+)

Process	ΔE^{TH}	W	Q
Isochoric increase in temp			
Isochoric decrease in temp			
Isothermal expansion			
Isothermal compression			
Adiabatic expansion			
Adiabatic compression			
Isobaric expansion			
Isobaric compression			

Act III: Adiabatic

PC.L2.2-08:

Description: Identify which statements best represents an adiabatic curve on PV diagram (3 minutes)

Problem Statement: Which student do you agree with the most?

(1) I think adiabatic PV lines are curvy and less steep than isotherms.
(2) I agree that they are curvy, but they are more steep than isotherms, right?
(3) Nah, you're both wrong, they are straight lines with a slope that depends on whether the gas is expanding or contracting .

PC.L2.2-09:

Description: Identify proportionality for adiabatic process. (3 minutes)

Problem Statement: Which of the following statements could be true for monatomic ideal gases that go through an adiabatic process?

(1) Pressure is proportional to $1/\mathbf{V}$
(2) Pressure is proportional to $1/\mathbf{V}^{0.5}$
(3) Pressure is proportional to $1/\mathbf{V}^{1.5}$
(4) 42

PC.L2.2-10:

Description: Determine signs of first law quantities. (5 minutes)

Problem Statement: Which of the following are the correct signs for an adiabatic expansion?

(1) ΔE^{TH} (+) , **W** (+) , **Q** (+)
(2) ΔE^{TH} (0) , **W** (-) , **Q** (+)
(3) ΔE^{TH} (-) , **W** (-) , **Q** (0)
(4) ΔE^{TH} (+) , **W** (-) , **Q** (0)
(5) ΔE^{TH} (+) , **W** (+) , **Q** (0)

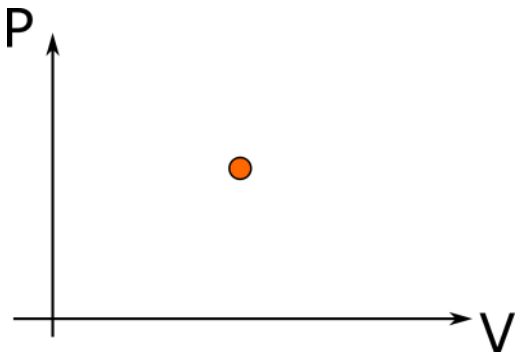
Process	ΔE^{TH}	W	Q
Isochoric increase in temp			
Isochoric decrease in temp			
Isothermal expansion			
Isothermal compression			
Adiabatic expansion			
Adiabatic compression			
Isobaric expansion			
Isobaric compression			

Act IV: Isobaric

PC.L2.2-11:

Description: Sketch an isobaric process. (2 minutes)

Problem Statement: Use the provided PV diagram and initial equilibrium state to sketch an isobaric expansion.

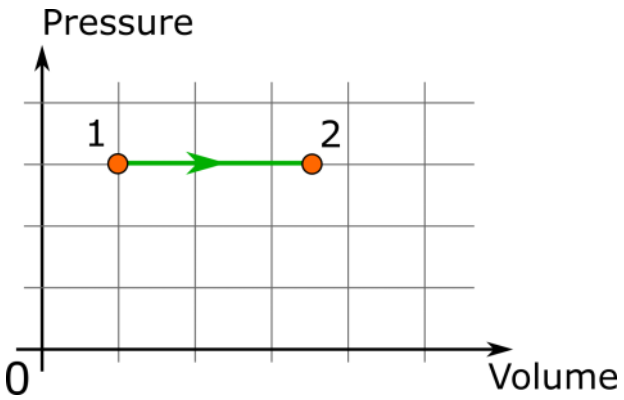


PC.L2.2-12:

Description: Proportional reasoning with ideal gas law. (4 minutes)

Problem Statement: Below shows an isobaric process. By what factor does the temperature change by?

(1) 1/2.5
(2) 2/3
(3) 1
(4) 3/2
(5) 2.5
(6) 7/2



PC.L2.2-13:

Description: Determine signs of first law quantities. (5 minutes)

Problem Statement: Which of the following are the correct signs for an isobaric expansion?

(1) ΔE^{TH} (+) , **W** (+) , **Q** (+)
(2) ΔE^{TH} (-) , **W** (-) , **Q** (+)
(3) ΔE^{TH} (-) , **W** (-) , **Q** (-)
(4) ΔE^{TH} (+) , **W** (-) , **Q** (+)
(5) ΔE^{TH} (-) , **W** (+) , **Q** (-)

Process	ΔE^{TH}	W	Q
Isochoric increase in temp			
Isochoric decrease in temp			
Isothermal expansion			
Isothermal compression			
Adiabatic expansion			
Adiabatic compression			
Isobaric expansion			
Isobaric compression			

Act III: Other processes

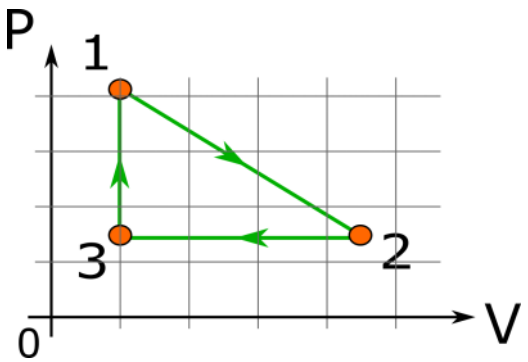
PC.L2.2-14:

Description: Identify the process type. Proportional reasoning with ideal gas law. (2 minutes + 4 minutes + 2 minutes + 1 minute)

Problem Statement: Consider the PV diagram shown below with 3 processes that form a complete cycle.

(a) What type of process is represented from equilibrium states 1 → 2 ?

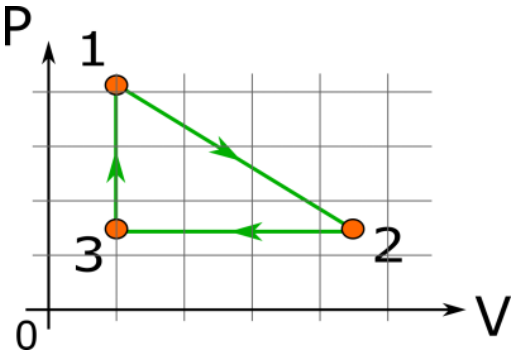
(1) Isochoric
(2) Isothermal
(3) Adiabatic
(4) Isobaric
(5) None of the above



(b) Considering the stage from 1 → 2, by what factor does the temperature change by?

(1) 3/8
(2) 9/5
(3) 27/16
(4) 9/2

(c) What is the sign of the net work on the gas after going through all three processes sequentially?



(1) Positive
(2) Negative
(3) Zero

(d) What is the sign of ΔE^{TH} of the gas after going through all three processes sequentially?

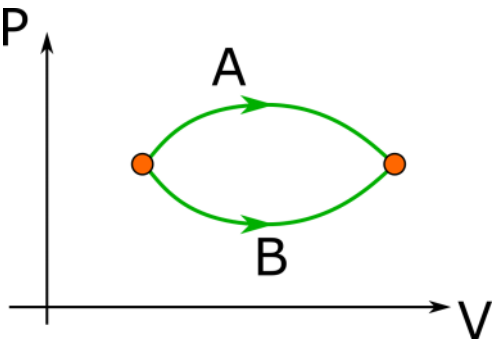
(1) Positive
(2) Negative
(3) Zero

PC.L2.2-15:

Description: Determine which processes has a larger value of heat flowing into system. (2 minutes + 2 minutes + 3 minutes)

Problem Statement: Consider the two different processes shown on the PV diagram below.

(a) How does the change in temperature compare between process **A** and process **B**?



(1) $\Delta T_A > \Delta T_B$
(2) $\Delta T_A < \Delta T_B$
(3) $\Delta T_A = \Delta T_B$

(b) Which process does more work on the environment?

(1) **A**
(2) **B**
(3) **A** and **B** do equal work on the environment.

(c) Which processes has a larger value of heat?

(1) $Q_A > Q_B$
(2) $Q_A < Q_B$
(3) $Q_A = Q_B$

Conceptual questions for discussion

1. Coming soon.

Hints

PC.L2.2-01: No hints.

PC.L2.2-02: No hints.

PC.L2.2-03: No hints.

PC.L2.2-04: No hints.

PC.L2.2-05: No hints.

PC.L2.2-06: No hints.

PC.L2.2-07: No hints.

PC.L2.2-08: No hints.

PC.L2.2-09: No hints.

PC.L2.2-10: No hints.

PC.L2.2-11: No hints.

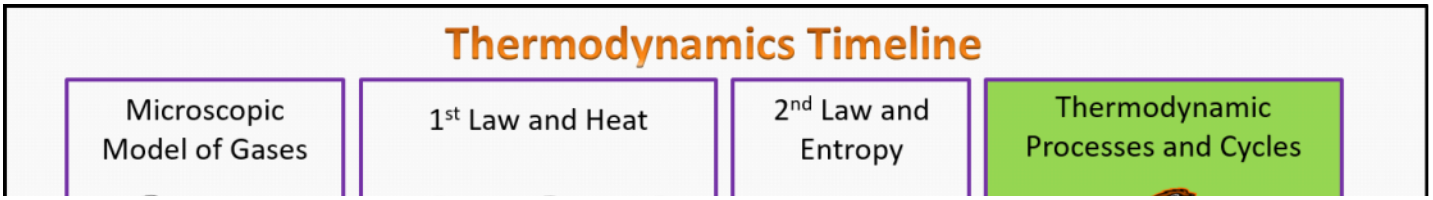
PC.L2.2-12: No hints.

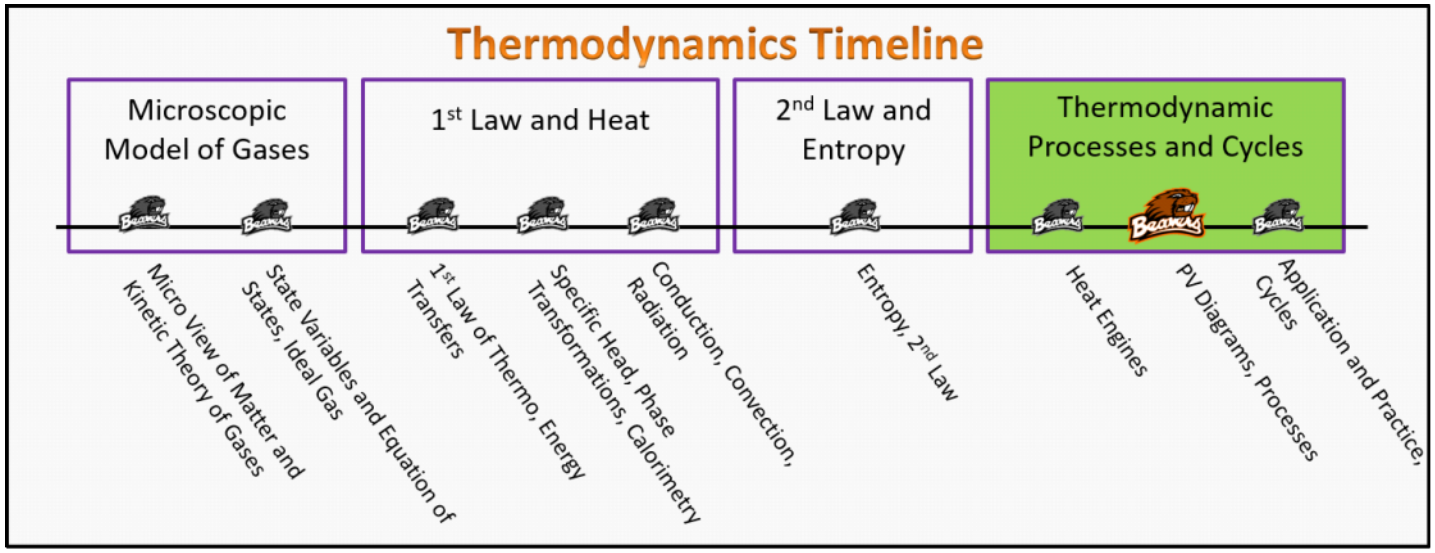
PC.L2.2-13: No hints.

PC.L2.2-14: No hints.

Thermodynamic Processes and Cycles
Practice Stage (PC.L2.3)

Lecture 2
PV Diagrams, Processes





PC.L2.3-01

Description: Features of non-uniform circular motion

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

Problem Statement: Consider 1.3 moles of an ideal gas at an initial temperature of 400 K and in a 1.2 m^3 closed container. If the gas goes through an isochoric process to twice the initial temperature, what is the new pressure of the gas?

PC.L2.3-02

Description: Direction of acceleration in non-uniform circular motion

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

Problem Statement: Consider 1.3 moles of an ideal gas at an initial temperature of 400 K and in a 1.2 m^3 closed container. If the gas goes through an isothermal process to 3.6 m^3, what is the new pressure of the gas?

PC.L2.3-03

Description: Compare angular acceleration of two objects on the same turntable.

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

Problem Statement: Consider 1.3 moles of an ideal gas at an initial temperature of 400 K and in a 1.2 m^3 closed container. If the gas goes through an isobaric process to 3.6 m^3, what is the new temperature of the gas?

PC.L2.3-04

Description: Non-UCM kinematics of a car's crankshaft

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

Problem Statement: In an adiabatic process, no energy is lost or gained via heat. Which of the following scenarios would best represent an adiabatic process?

(1) A closed container of gas is placed next to a fire.
(2) A closed container of gas initially at room temperature has a piston that very slowly compresses the gas.
(3) A closed container of gas initially at room temperature has a piston that very quickly compresses the gas.
(4) A closed container of gas is suddenly opened to the environment where the gas escapes to.