وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الشمالية
المعهد التقني كركوك

الحقيبة التعليمية

القسم العلمي: ميكانيك القدرة/ التبريد والتكييف

اسم المقرر: مبادئ ديناميك الحرارة

المرحلة / المستوى: الاول

الفصل الدراسي: الاول

السنة الدراسية:2025/2024

معلومات عامة

اسم المقرر:	مبادئ ديناميك الحرارة					
القسم:	ميكانيك القدرة/ التبريد والتكييف					
المعهد:	المعهد التقني كركوك					
المرحلة / المستوى	الاول					
الفصل الدراسي:	الاول					
عدد الساعات الاسبوعية:	نظري	ساعتان	عملي	ساعتان		
عدد الوحدات الدراسية:	4					
الرمز:	PMTR137					
نوع المادة	نظري		عملي		كلهما	√
هل يتوفر نظير للمقرر في الاقسام الاخرى	/					
اسم المقرر النظير	/					
القسم	/					
رمز المقرر النظير	/					

معلومات تدريسي المادة

اسم مدرس (مدرسي) المقرر:	مرال محمود حسين	محمود حسين خليل
اللقب العلمي:	مدرس مساعد	مدرس
سنة الحصول على اللقب	2021	2021
الشهادة :	ماجستير	ماجستير
سنة الحصول على الشهادة	2021	2014
عدد سنوات الخبرة (تدريس)	15	10

الوصف العام للمقرر

مقرر ديناميك الحرارة يتناول دراسة الخواص الحرارية للمواد، والقوانين الأساسية للديناميكا الحرارية، مع التركيز على تطبيقها في تصميم وتشغيل أنظمة التبريد والتكييف لتحسين الكفاءة الحرارية.

الاهداف العامة

- إكساب الطلاب الفهم الأساسي للقوانين الحرارية.
- تمكين الطلاب من تطبيق النظريات الحرارية على الأنظمة الهندسية.
- تطوير القدرة على تحليل العمليات الحرارية في أنظمة التبريد والتكييف.

الأهداف الخاصة

- فهم وتحليل الدورة الحرارية لأنظمة التبريد والتكييف.
- استيعاب كيفية حساب الكفاءة الحرارية للآلات والأجهزة.
- تطبيق القوانين الأساسية للطاقة والحرارة في مواقف عملية.
- التعرف على خواص المواد المستخدمة في أنظمة التبريد والتدفئة.
- تطوير المهارات اللازمة لحل المسائل المتعلقة بالطاقة والحرارة في الأنظمة الهندسية.

الأهداف السلوكية او نواتج التعلم

- استخدام المفاهيم الأساسية: يتمكن الطالب من تعريف وتطبيق المفاهيم الأساسية للثرموديناميك مثل الطاقة، الحرارة، والعمل في سياقات عملية.
- حل المشكلات: يتقن الطالب مهارات حل المشكلات المتعلقة بالدورات الحرارية، وتحليل العمليات في أنظمة التبريد والتدفئة.
- تحليل الأنظمة: يكون الطالب قادراً على تحليل كفاءة الأنظمة الحرارية المختلفة مثل المحركات، والمبادلات الحرارية، والضواغط.
- استخدام الجداول والرسوم البيانية: يستطيع الطالب قراءة واستخدام جداول البخار والرسوم البيانية مثل مخطط (P-V) و(T-S) لتحليل العمليات الثرموديناميكية.
- التفكير النقدي: يطور الطالب القدرة على نقد وتقييم أداء الأنظمة الحرارية وتحسين كفاءتها.

المتطلبات السابقة

- مقدمة في الفيزياء: فهم أساسي لمفاهيم الفيزياء، بما في ذلك القوى، والحركة، والطاقة.
- مقدمة في الرياضيات: القدرة على استخدام الرياضيات لحل المعادلات الرياضية الأساسية، بما في ذلك التفاضل والتكامل.
- مقدمة في الكيمياء: معرفة بالمفاهيم الأساسية في الكيمياء، وخاصة المتعلقة بالحرارة والتفاعلات الكيميائية.
- المبادئ الأساسية في الهندسة: فهم مبادئ الهندسة الأساسية، مثل الديناميكا السائلة والمواد الهندسية.
- مقدمة في الميكانيكا: فهم الأساسيات المتعلقة بالميكانيكا والكفاءة الديناميكية.

الأهداف السلوكية او مخرجات التعليم الأساسية		
ت	تفصيل الهدف السلوكي او مخرج التعليم	آلية التقييم
1	يتم تقييم فهم الطلاب للمفاهيم من خلال الاختبارات الكتابية التقليدية.	الاختبارات الكتابية
2	يتم تقييم القدرة على تطبيق المعرفة الرياضية في حل المشكلات.	الواجبات المنزلية
3	يتم تقييم القدرة على تطبيق المعرفة في سياقات العالم الحقيقي.	المشاريع
4	يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم .	المشاركة في الصف
5	يتم استخدام الأدوات والبرامج الرقمية لتقييم فهم الطلاب للمفاهيم	الاختبارات الإلكترونية

أساليب التدريس

الاسلوب او الطريقة	مبررات الاختيار
1. المحاضرات	تقديم المعلومات والمفاهيم الرياضية بشكل مباشر للطلاب
2. التعلم النشط	تشجيع الطلاب على المشاركة في عملية التعلم من خلال حل المشكلات، المناقشات الجماعية، والأنشطة التفاعلية
3. التعلم القائم على المشروع	يتم تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة الرياضية في سياقات العالم الحقيقي
4. التعلم الذاتي	يتم تشجيع الطلاب على البحث والاستكشاف بشكل مستقل لتعزيز فهمهم للمفاهيم الرياضية
5. التعلم الرقمي	استخدام الأدوات والبرامج الرقمية لتعزيز التعلم والفهم
6. التقييم المستمر	يتم تقييم الطلاب بشكل مستمر من خلال الاختبارات، الواجبات، والمشاريع

الفصل الاول من المحتوى العلمي							
عنوان الفصل	الوقت		المصفوفات				
التوزيع الزمني	النظري (ساعة)	العملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
الأسبوع				العناوين الفرعية	محاضرة حضوري او الكتروني	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الأسبوع الأول	2	2	Introduction to Thermodynamics,	1. Definition of Thermodynamics 2. Key Concepts and Terminology 3. . Laws of Thermodynamics 4. Thermodynamic Devices and Instruments	حضوري	عرض تقديمي+ شرح	الامتحان اليومي
الأسبوع الثاني	2	2	Introduction to Fluid Measurement and Properties,	1. Measuring Devices 2. Properties of Fluids 3. State 4. Processes 5. Cycles	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الاسبوع الثالث	2	2	Understanding Pressure (Gage, Vacuum, and ,(Absolute	1. Definition of Pressure 2. Types of Pressure 3. Pressure Measurement Devices	حضوري	عرض تقديمي+ شرح+ أسئلة وأجوبة+ مناقشة	الامتحان اليومي
الاسبوع الرابع	2	2	Temperature Relations (Celsius, Kelvin, and Rankine ,(Scale	1. Definitions of Temperature Scales 2. Measuring Devices for Temperature	حضوري	عرض تقديمي+ شرح+ أسئلة وأجوبة+ مناقشة	الامتحان اليومي

الاسبوع الخامس	2	2	Energy and Renewable Energy Resources,	Renewable Energy Resources	حضوري	عرض تقديمي+ شرح+ أسئلة وأجوبة+ مناقشة	الامتحان اليومي

الفصل الثاني							
عنوان الفصل	الوقت		المحددات				
التوزيع الزمني	النظري	العملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
	ساعة			العناوين الفرعية	محاضرة	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الاسبوع السادس	2	2	Hydrocarbons Source (Oil & Gas,(	1. Types of Hydrocarbons 2. Properties and Measurements of Hydrocarbons	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الأسبوع السابع + الثامن	2	2	Internal Energy and Flow Work in Thermodynamics,	1. Key Definitions and Concepts 2. 3.Practical Applications in Refrigeration and Air Conditioning 3. Diagrams and Visual Aids	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الاسبوع التاسع	2	2	Forms of Energy in	1. Forms of Energy 2. Flow Work	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي

			Thermodynamics				
الاسبوع العاشر	2	2	First Law of Thermodynamics in Flow Systems,	1. . First Law of Thermodynamics 2. Types of Flow Systems	حضوري	عرض تقديمي + شرح + أسئلة و أجوبة + مناقشة	الامتحان اليومي

الفصل الثالث							
عنوان الفصل	الوقت		المتجهات				
التوزيع الزمني	نظري	عملي	العنوان الرئيسي		طريقة التدريس	التقنيات	طرق القياس
الأسبوع.....	ساعة			العناوين الفرعية	محاضرة	عرض تقديمي، شرح، أسئلة وأجوبة, مناقشة	
الأسبوع الحادي عشر	2	2	Applications of the First Law of Thermodynamics in Various Devices,	1. Applications of the First Law of Thermodynamics in Various Devices 2. First Law of Thermodynamics 3. Applications of the First Law in Thermal Devices	حضوري	عرض تقديمي + شرح + أسئلة و أجوبة + مناقشة	الامتحان اليومي
الاسبوع الثاني عشر + الثالث عشر	2	2	Thermodynamic Processes at Constant Pressure, Volume, Temperature, and Enthalpy,	1. Thermodynamic Processes 2. Polytrophic Process	حضوري	عرض تقديمي + شرح + أسئلة و أجوبة + مناقشة	الامتحان اليومي

الاسبوع الرابع عشر	2	2	Specific Heat, Types of Specific Heat, and Gas Constant,	1. Specific Heat 2. Types of Specific Heat 3. Gas Constant (R)	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي
الاسبوع الخامس عشر	2	2	The Second Law of Thermodynamics ,	1. The Second Law of Thermodynamics 2. Heat Engines 3. Heat Pumps 4. Applications of the Second Law	حضوري	عرض تقديمي + شرح + أسئلة وأجوبة + مناقشة	الامتحان اليومي

المحتوى العلمي

خارطة القياس المعتمدة

المحتوى التعليمي	عناوين الفصول	الأهمية النسبية	الأهداف السلوكية					عدد الفقرات
			المعرفة	الفهم	التطبيق	التحليل	التقييم	
			النسبة %20	%20	%20	%20	%20	
الفصل الاول	Introduction to Thermodynamics, Introduction to Fluid Measurement and Properties, Understanding Pressure (Gage, Vacuum, and Absolute), Temperature Relations (Celsius, Kelvin, and Rankine Scale, Energy and Renewable Energy Resources,	%40	8	8	8	8	8	4
الفصل الثاني	Hydrocarbons Source (Oil & Gas,) Internal Energy and Flow Work in Thermodynamics, Forms of Energy in Thermodynamics, First Law of Thermodynamics in Flow Systems,	%35	7	7	7	7	7	4
الفصل الثالث	Applications of the First Law of Thermodynamics in Various Devices, Thermodynamic Processes at Constant Pressure, Volume, Temperature, and Enthalpy , Specific Heat, Types of Specific Heat, and Gas Constant, The Second Law of Thermodynamics,	%25	5	5	5	5	5	5
المجموع		%100	20	20	20	20	20	**13**

الفصل الاول: رقم المحاضرة: 5+4+3+2+1	
عنوان المحاضرات:	مقدمة في ديناميك الحرارة وخصائص الموائع ومقاييسه فضلا عن الوحدات المستخدمة في قياس درجات الحرارة
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في علم ديناميك الحرارة والمقاييس والوحدات
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

Week No.	Details
1	Introduction to Thermodynamics
2	Introduction to Fluid Measurement and Properties
3	Understanding Pressure (Gage, Vacuum, and Absolute)
4	Temperature Relations (Celsius, Kelvin, and Rankine Scale)
5	Energy and Renewable Energy Resources
6	Hydrocarbons Source (Oil & Gas)
7-8	Internal Energy and Flow Work in Thermodynamics
9	Forms of Energy in Thermodynamics
10	First Law of Thermodynamics in Flow Systems
11	Applications of the First Law of Thermodynamics in Various Devices
12-13	Thermodynamic Processes at Constant Pressure, Volume, Temperature, and Enthalpy
14	Specific Heat, Types of Specific Heat, and Gas Constant
15	The Second Law of Thermodynamics

The First Lecture

(Introduction to Thermodynamics)

1. Pre-lecture Questions:

1. What do you understand by the term "thermodynamics"?
2. Can you name any applications of thermodynamics in daily life?
3. What are the basic laws of thermodynamics you are aware of?
4. Why is it important to understand energy transfer in thermodynamic processes?

---

2. Definition of Thermodynamics

Thermodynamics is the branch of physics that deals with the relationships between heat, work, temperature, and energy. It provides the principles that govern the behavior of energy transfer and transformation in physical systems.

Thermodynamics is essential in engineering, particularly in areas like refrigeration, power generation, and HVAC (Heating, Ventilation, and Air Conditioning).

---

3. Key Concepts and Terminology

a. System and Surroundings

- **System:** A defined region in space where we analyze energy and mass transfer. It can be open, closed, or isolated.
  - **Open System:** Allows mass and energy transfer (e.g., a boiler).
  - **Closed System:** Allows energy transfer but not mass transfer (e.g., a sealed container).
  - **Isolated System:** Does not allow mass or energy transfer (e.g., a thermos bottle).
- **Surroundings:** Everything external to the system that can interact with it.

b. State and Properties

- **State:** The condition of a system as defined by its properties.
- **Properties:** Characteristics of a system, which can be classified into:
  - **Intensive Properties:** Independent of the amount of substance (e.g., temperature, pressure).
  - **Extensive Properties:** Dependent on the amount of substance (e.g., mass, volume).

c. Thermodynamic Processes

- A thermodynamic process is a transition from one state to another. Types of processes include:
    - **Isothermal:** Occurs at a constant temperature.
    - **Adiabatic:** No heat exchange with the surroundings.
    - **Isochoric:** Occurs at a constant volume.
    - **Isobaric:** Occurs at a constant pressure.

---

4. Laws of Thermodynamics

First Law of Thermodynamics (Law of Energy Conservation)

- States that energy cannot be created or destroyed, only transformed from one form to another.
- Mathematically represented as:

$$\Delta U = Q - W$$

Where:

- ΔU = Change in internal energy.
- Q = Heat added to the system.
- W = Work done by the system.

Second Law of Thermodynamics

- States that the total entropy of an isolated system can never decrease over time. It implies that heat cannot spontaneously flow from a colder body to a hotter body.
- It introduces the concept of entropy, which is a measure of energy dispersal in a system.

---

5. Thermodynamic Devices and Instruments

a. Thermometer

- A device that measures temperature, which is a critical property in thermodynamic systems.

b. Barometer

- Measures atmospheric pressure and is essential for understanding pressure changes in various processes.

c. Calorimeter

- Used to measure the heat of chemical reactions or physical changes.

d. Heat Exchangers

- Devices designed to transfer heat between two or more fluids.

e. Refrigeration Cycles

- Systems that utilize thermodynamic principles to transfer heat from a low-temperature reservoir to a high-temperature reservoir.

---

6. Sample Problems

Problem 1: First Law Calculation

A closed system receives 500 J of heat, and the system does 200 J of work. What is the change in internal energy?

$$\Delta U = Q - W$$
$$500J - 200J = 300J$$

Problem 2: Efficiency of a Heat Engine

A heat engine absorbs 800 J of heat from a hot reservoir and expels 600 J to a cold reservoir. What is its efficiency?

$$\eta = \frac{W}{Q_H} = \frac{Q_H - Q_C}{Q_H} = \frac{800J - 600J}{800J} = \frac{200J}{800J} = 0.25 \text{ or } 25\%$$

---

7. Post-lecture Questions:

1. How do you apply the first law of thermodynamics in real-world applications?
2. Can you explain the significance of entropy in thermodynamic processes?
3. What are the limitations of real thermodynamic cycles compared to the ideal cycles?
4. How can understanding thermodynamic principles improve the efficiency of heating and cooling systems?

The Second Lecture

(Introduction to Fluid Measurement and Properties)

1. Pre-lecture Questions:

1. What measuring devices do you know for measuring fluid properties?
2. Can you explain what the density of a liquid or gas means?
3. How do temperature and pressure affect the state of matter?
4. What is the concept of specific volume, and how is it calculated?

---

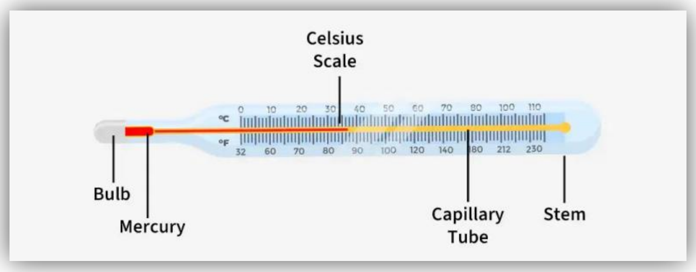
2. Measuring Devices

A. Pressure Gauge

- A device that measures the pressure of gases or liquids. It is used in industrial applications such as refrigeration systems.

B. Thermometer

- Measures the temperature of liquids or gases. It comes in various forms, such as mercury thermometers and digital thermometers.



C. Flow Meter

- Measures the quantity of liquid or gas passing through a specific point in a system. Includes magnetic, transparent, and rotary flow meters.

D. Densitometer

- Used to measure the density of liquids or gases. It is essential in chemical and oil industries.

---

3. Properties of Fluids

A. Density

- Density is the mass per unit volume of a liquid or gas. It is given by the relationship:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

B. Specific Volume

- Specific volume is the volume occupied by a unit mass of the substance. It is expressed by the equation:

$$\text{Specific Volume} = \frac{\text{Volume}}{\text{Mass}}$$

C. Pressure

- Pressure is the force exerted perpendicularly on a unit area. Pressure is measured in units like Pascals (Pa) or bars.

D. Temperature

- Temperature measures the amount of heat in a system. Digital or mercury thermometers are used to measure it.

4. State

A. Definition of State

- The state represents the properties of the system at a specific moment, including pressure, temperature, volume, and density.

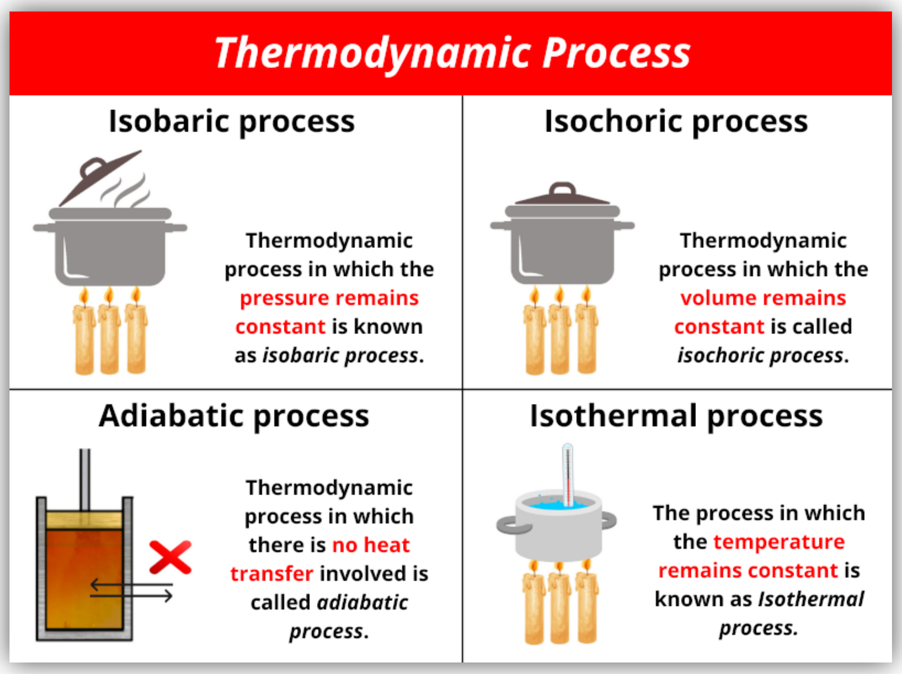
B. Phase Diagram

- A phase diagram is used to illustrate the different states of matter, such as solid, liquid, and gas, under varying pressure and temperature conditions.

5. Processes

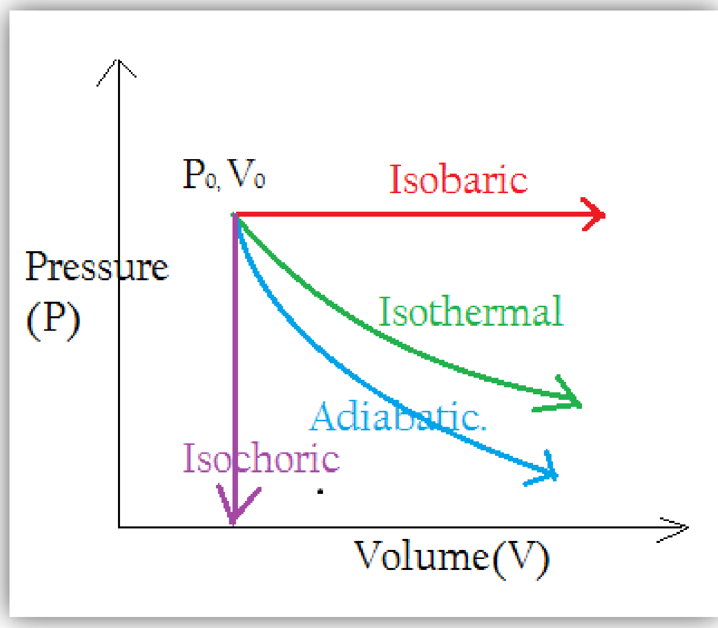
A. Types of Processes

- **Isothermal Process:** Occurs at a constant temperature.
- **Adiabatic Process:** No heat exchange occurs with the environment.
- **Isochoric Process:** Occurs at a constant volume.
- **Isobaric Process:** Occurs at a constant pressure.



B. Process Diagram

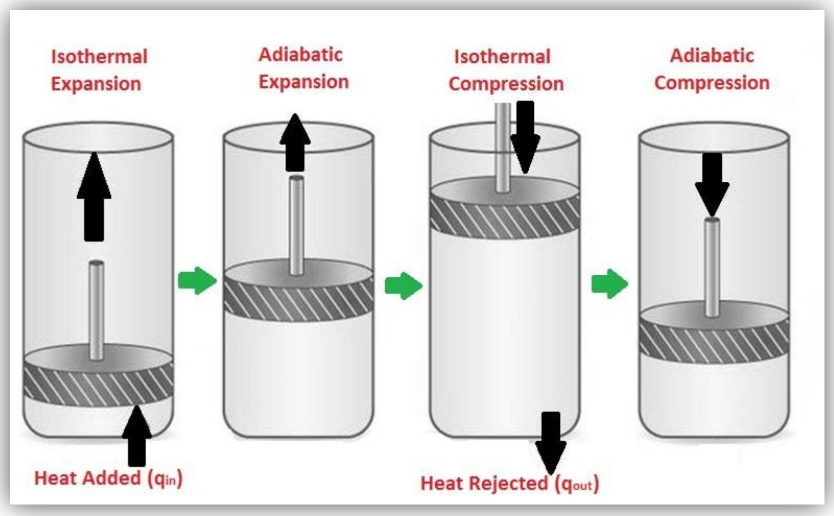
- Use diagrams to represent different processes. A pressure-volume (P-V) diagram can illustrate the relationship between pressure and volume in dynamic processes.



6. Cycles

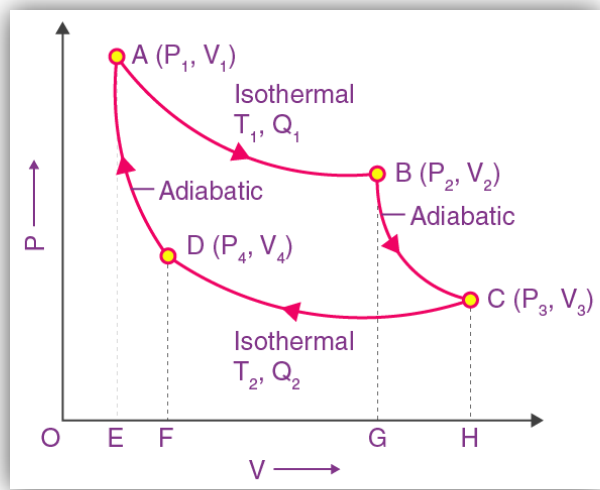
A. Thermodynamic Cycle

- A set of processes that return the system to its original state. Includes:
  - **Carnot Cycle:** An ideal cycle based on the fundamental principle of thermodynamics.
  - **Refrigeration Cycle:** Involves processes of heat absorption and rejection.



B. Cycle Representation

- Use diagrams to represent cycles. For example, a circular graph can illustrate the Carnot cycle.



---

7. Sample Problems

Problem 1: Calculate Density

If a liquid has a mass of 200 kg and a volume of 0.5 m³, what is its densi

$$\text{Density} = \frac{200\,\text{kg}}{0.5\,\text{m}^3} = 400\,\text{kg/m}^3$$

Problem 2: Calculate Specific Volume

If you have a liquid with a mass of 10 kg and a volume of 0.01 m³, what is its specific volume?

$$\text{Specific Volume} = \frac{0.01\,\text{m}^3}{10\,\text{kg}} = 0.001\,\text{m}^3/\text{kg}$$

---

8. Post-lecture Questions:

1. How do temperature and pressure affect the density of a liquid?
2. What is the difference between a thermodynamic cycle and an ideal cycle?
3. Explain how a pressure gauge can affect the performance of refrigeration systems.
4. How can specific volume be calculated in an isolated system?

The Third Lecture

Understanding Pressure (Gage, Vacuum, and Absolute)

1. Pre-lecture Questions:

1. What do you understand by the term "pressure" in fluids?
2. Can you differentiate between gage pressure, absolute pressure, and vacuum pressure?
3. Why is it important to measure pressure accurately in refrigeration systems?

---

2. Definition of Pressure

Pressure is defined as the force exerted per unit area on a surface. It is a fundamental concept in fluid mechanics, affecting the behavior of liquids and gases.

$$\text{Pressure}(P) = \frac{\text{Force}(F)}{\text{Area}(A)}$$

- **Units:** The SI unit of pressure is Pascal (Pa), which is equivalent to one Newton per square meter (N/m^2). Other common units include:
    - Bar
    - Atmosphere (atm)
    - Pounds per square inch (psi)

---

3. Types of Pressure

A. Absolute Pressure

- **Definition:** Absolute pressure is the total pressure exerted on a system, including atmospheric pressure. It is measured relative to a perfect vacuum.
- **Formula:**

$$P_{absolute} = P_{gage} + P_{atmospheric}$$

- **Measurement Devices:**
    - **Absolute Pressure Gauge:** Measures pressure above a perfect vacuum. Often used in applications where precise measurements are critical, such as in thermodynamics.
- **Applications:** Used in applications such as barometers and scientific experiments.

B. Gage Pressure

- **Definition:** Gage pressure is the pressure measured relative to atmospheric pressure. It indicates how much pressure is above the surrounding atmosphere.
- **Formula:**

$$P_{gage}=P_{absolute}-P_{atmospheric}$$

- **Measurement Devices:**
    - **Gage Pressure Gauge:** Measures pressure relative to atmospheric pressure. Commonly used in automotive and HVAC systems.
- **Applications:** Used to monitor pressure in boilers, pressure vessels, and refrigeration systems.

C. Vacuum Pressure

- **Definition:** Vacuum pressure is the pressure below atmospheric pressure. It is measured as a negative value in comparison to the atmospheric pressure.
- **Formula:**

$$P_{vacuum}=P_{atmospheric}-P_{absolute}$$

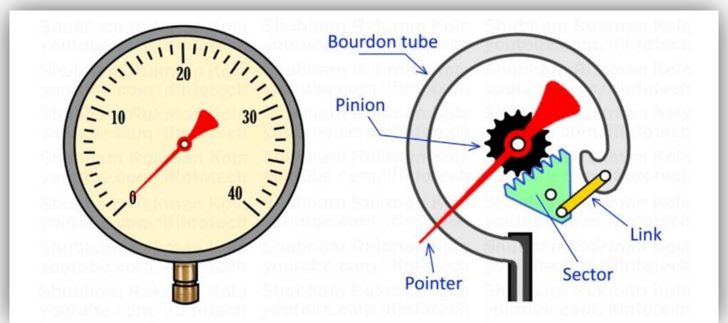
- **Measurement Devices:**
    - **Vacuum Gauge:** Measures how much pressure is below atmospheric pressure. Used in applications such as vacuum systems and refrigeration.
- **Applications:** Used in food packaging, vacuum pumps, and refrigeration systems.

---

4. Pressure Measurement Devices

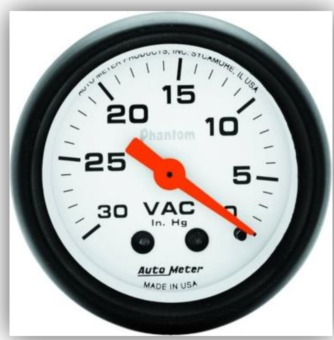
A. Pressure Gauge

- **Description:** A mechanical device that measures the pressure of gases or liquids within a system.
- **Types:**
    - Bourdon Tube Gauge
    - Digital Pressure Gauge



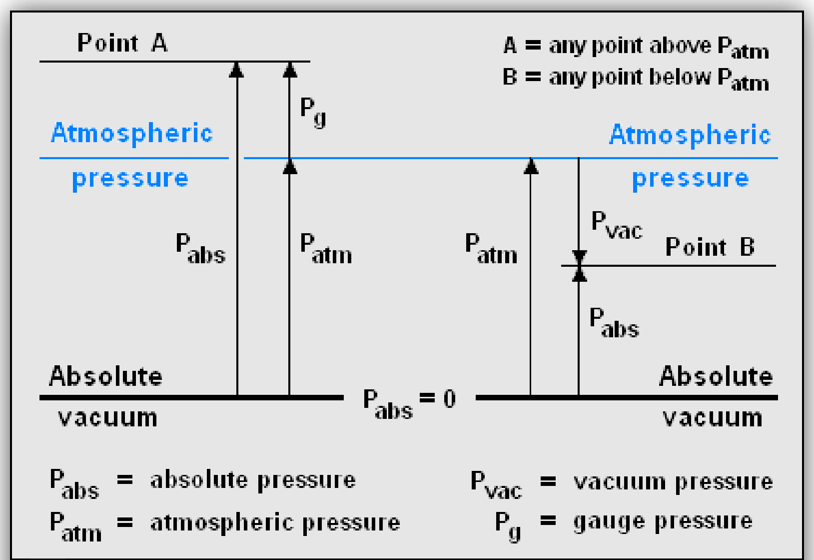
B. Vacuum Gauge

- **Description:** A device used to measure vacuum pressure in a system.
- **Types:**
    - Mechanical Vacuum Gauge
    - Digital Vacuum Gauge



C. Absolute Pressure Gauge

- **Description:** Measures absolute pressure in a system, accounting for atmospheric pressure.



The relationship between absolute, gauge and vacuum pressures.

---

5. Sample Problems

Problem 1: Calculating Absolute Pressure

A gage pressure reading is 150 kPa, and the atmospheric pressure is 100 kPa. What is the absolute pressure?

$$P_{absolute}=P_{gage}+P_{atmospheric}=150\ kPa+100\ kPa=250\ kPa$$

If the absolute pressure in a vacuum chamber is measured to be 30 kPa, and the atmospheric pressure is 100 kPa, what is the vacuum pressure?

$$P_{vacuum}=P_{atmospheric}-P_{absolute}=100\ kPa-30\ kPa=70\ kPa$$

---

6. Post-lecture Questions:

1. Why is it important to know whether you are measuring gage or absolute pressure in a refrigeration system?
2. How can atmospheric pressure variations affect pressure readings in gage pressure devices?
3. Discuss how vacuum pressure is crucial in maintaining the efficiency of refrigeration systems.
4. What applications require the use of absolute pressure gauges instead of gage or vacuum gauges?

The Fourth Lecture

Temperature Relations (Celsius, Kelvin, and Rankine Scale)

1.Pre-lecture Questions:

1. What do you understand by the term "temperature"?
2. Can you name some temperature scales used in science and engineering?
3. Why is it important to convert temperatures between different scales?

---

2. Definitions of Temperature Scales

A. Celsius Scale (°C)

- **Definition:** The Celsius scale is a temperature scale where 0°C is defined as the freezing point of water, and 100°C is defined as the boiling point of water at 1 atm pressure.
- **Usage:** Widely used in most countries and in scientific contexts.

- **Formula for Conversion to Kelvin:** K=°C+273.15K

B. Kelvin Scale (K)

- **Definition:** The Kelvin scale is an absolute temperature scale used primarily in scientific contexts. 0 K (absolute zero) is the point at which all molecular motion ceases.
- **Usage:** Commonly used in physics and engineering calculations.
- **Conversion Formula from Celsius:** °C=K−273.15°C
- **Absolute Zero:** 0 K is equivalent to -273.15°C.

C. Rankine Scale (°R)

- **Definition:** The Rankine scale is another absolute temperature scale used primarily in thermodynamics, where 0°R is absolute zero.
- **Usage:** Less common but used in some engineering applications, particularly in the United States.
- **Conversion Formulas:**

$$^{\circ}R = K \times 1.8$$

$$K = \frac{^{\circ}R}{1.8}$$

D. Temperature Conversion Chart

Celsius (°C)	Kelvin (K)	Rankine (°R)
0	273.15	491.67
25	298.15	536.67
100	373.15	671.67
-40	233.15	419.67

---

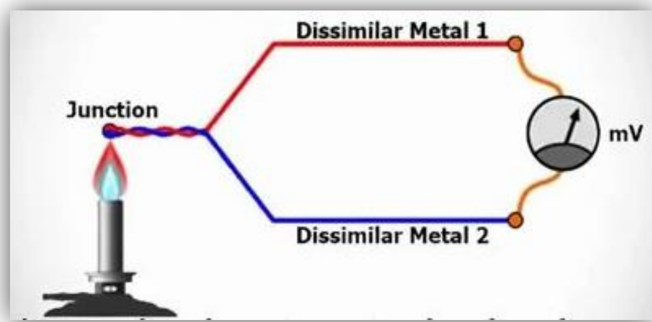
3. Measuring Devices for Temperature

A. Thermometer

- **Description:** A device used to measure temperature.
- **Types:**
  - **Mercury Thermometers:** Use mercury expansion to measure temperature.
  - **Digital Thermometers:** Provide electronic readings, usually in °C or °F.

B. Thermocouples

- **Description:** Devices that measure temperature based on the voltage generated at the junction of two different metals.
- **Usage:** Widely used in industrial applications for temperature measurement.



---

4. Sample Problems

Problem 1: Temperature Conversion

Convert 25°C to Kelvin and Rankine.

Solution:

1. Convert to Kelvin:

$$K = 25 + 273.15 = 298.15\ K$$

Convert to Rankine:

$$°R = K \times 1.8 = 298.15 \times 1.8 = 536.67\ °R$$

Problem 2: Absolute Zero

What is the temperature in Celsius and Rankine at absolute zero (0 K)?

Solution:

1. In Celsius:

$$°C = 0 - 273.15 = -273.15\ °C$$

In Rankine:

$$°R = 0 \times 1.8 = 0\ °R$$

---

5. Post-lecture Questions:

1. How do temperature scales impact calculations in thermodynamics?
2. What are the practical applications of the Kelvin and Rankine scales?
3. Why is it essential to use absolute temperature scales in scientific calculations?

الفصل الثاني: رقم المحاضرة: 10+9+8+7+6	
عنوان المحاضرات:	مصادر الهيدروكربونات واشكال الطاقة الداخلية والتدفق والقانون الاول لديناميك الحرارة
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في علم الهيدروكربونات واشكال الطاقة الداخلية والتدفق والقانون الاول لديناميك الحرارة
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

The Fifth Lecture

(Energy and Renewable Energy Resources)

1.Pre-lecture Questions:

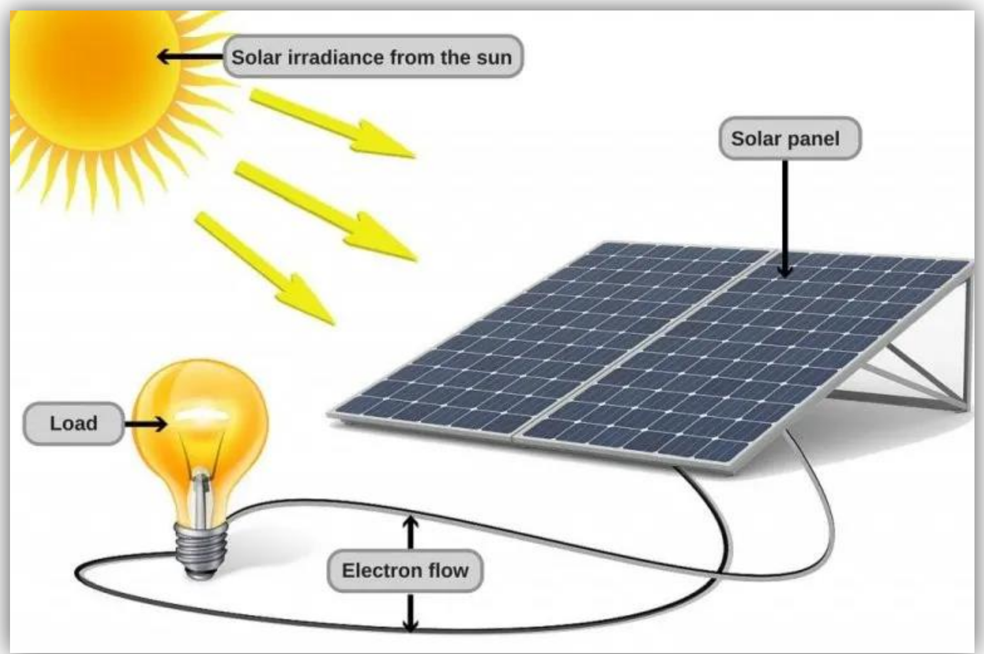
1. What is your understanding of renewable energy?
2. Can you name some sources of renewable energy?
3. Why is it important to shift towards renewable energy sources?

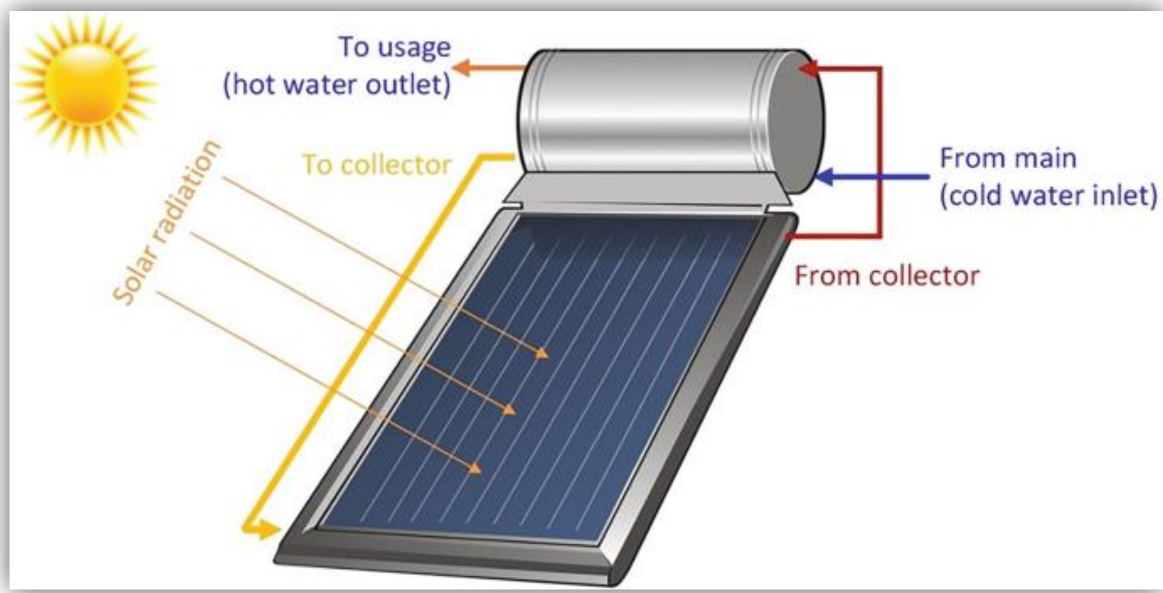
---

2. Renewable Energy Resources

A. Solar Energy

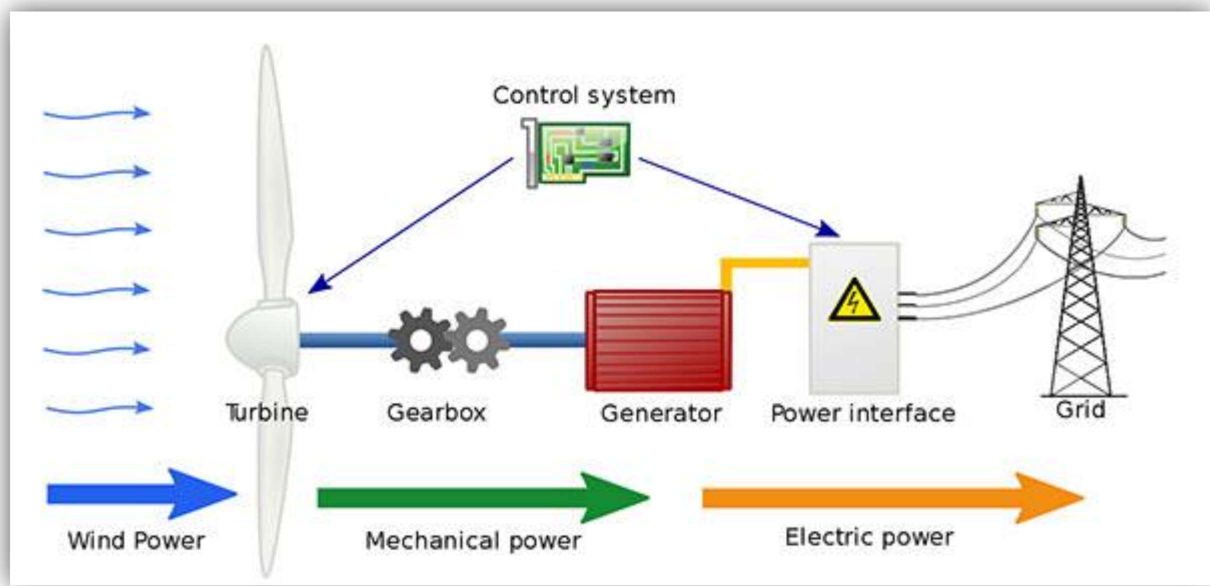
- **Definition:** Solar energy is the radiant energy emitted by the sun, which can be converted into thermal or electrical energy.
- **Principle:** Photovoltaic cells convert sunlight directly into electricity. Solar thermal systems use sunlight to heat a fluid, which can then produce steam to drive turbines.
- **Applications:** Used in residential and commercial heating, electricity generation, and solar cooking.





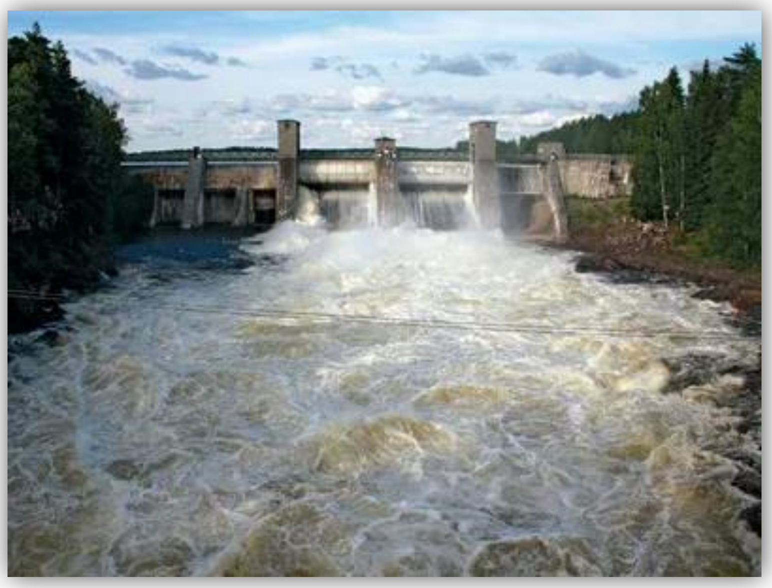
B. Wind Energy

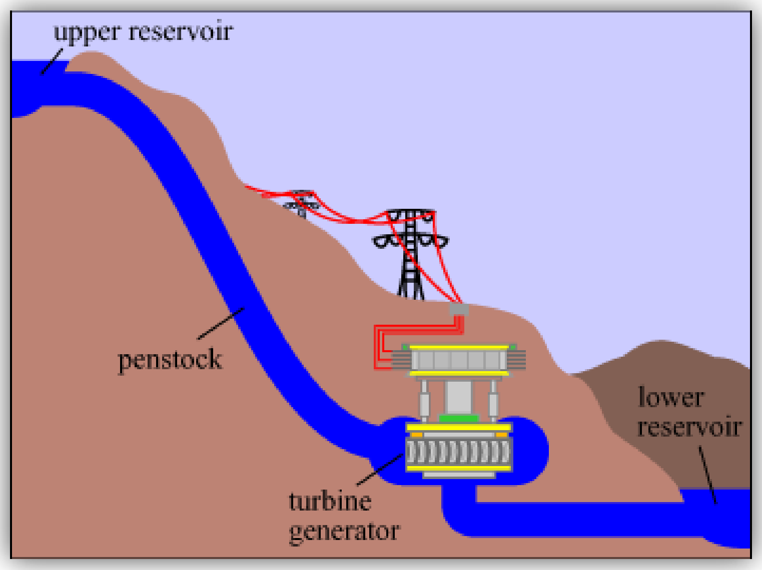
- **Definition:** Wind energy is the kinetic energy generated by the movement of air. Wind turbines convert this kinetic energy into mechanical power, which is then converted into electricity.
- **Principle:** The wind turns the blades of a turbine, which spins a generator to produce electricity.
- **Applications:** Utilized in large wind farms for electricity generation, as well as in smaller systems for local energy needs.



C. Hydro Energy (Water Energy)

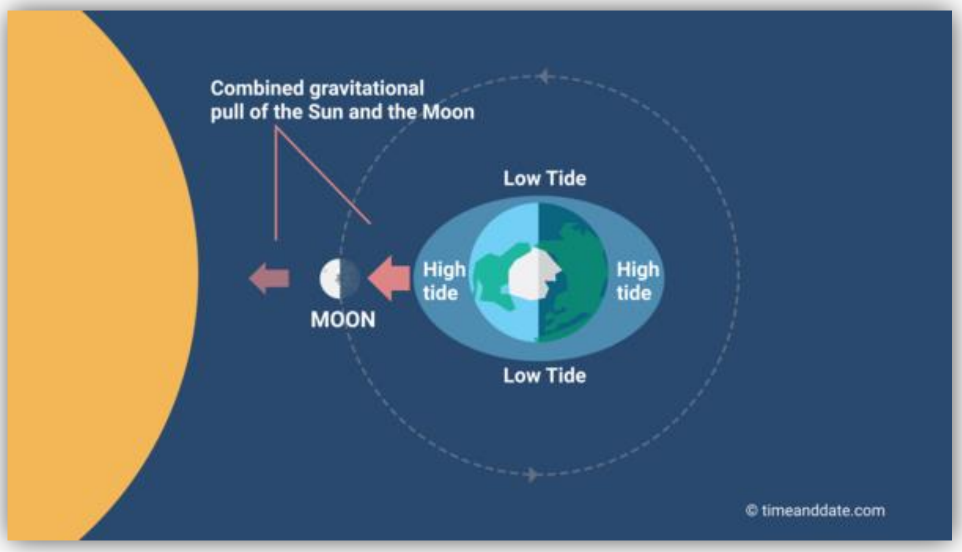
- **Definition:** Hydro energy refers to the energy derived from the movement of water, typically in rivers or through dams.
- **Principle:** Water flow spins turbines connected to generators, producing electricity.
- **Applications:** Used in hydropower plants to generate electricity, as well as in small-scale applications like micro-hydropower systems.

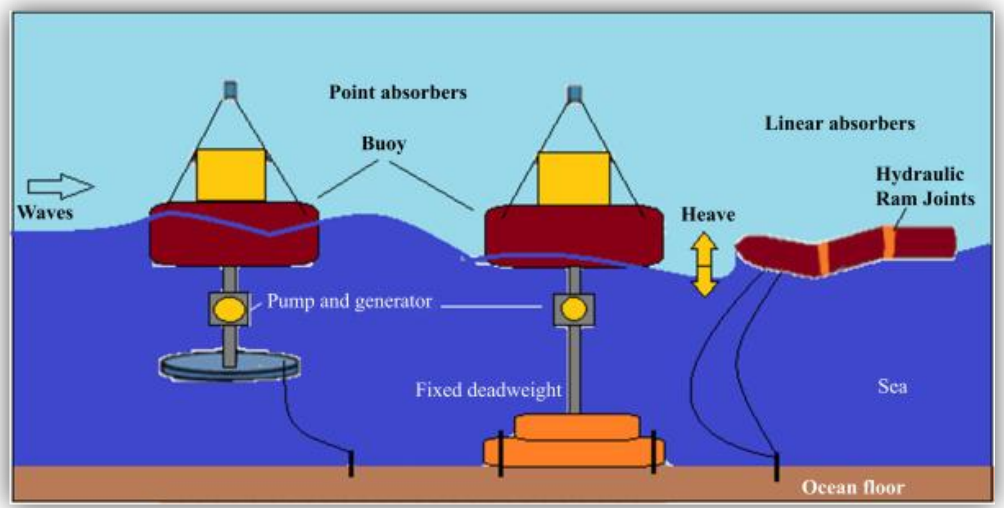




D. Tidal Energy

- **Definition:** Tidal energy is derived from the gravitational pull of the moon and the sun on the Earth's oceans, leading to tidal movements.
- **Principle:** Tidal turbines and barrages capture the kinetic and potential energy of tidal movements to generate electricity.
- **Applications:** Used in tidal power plants, primarily in coastal areas.





3. Sample Problems

Problem 1: Solar Energy Calculation

A solar panel generates 300 watts of power under optimal sunlight conditions. How much energy does it produce in 5 hours?

Solution: Energy produced (in watt-hours) = Power × Time

$$\text{Energy} = 300\ \text{W} \times 5\ \text{hours} = 1500\ \text{Wh}$$

Problem 2: Wind Energy Calculation

A wind turbine has a rotor diameter of 80 meters and operates at a wind speed of 10 m/s. Calculate the power output using the formula:

$$P = \frac{1}{2}\rho A v^3$$

Where:

- $\rho = 1.225\,\mathrm{kg/m^3}$ (air density)
- $A = \pi(D/2)^2$

Solution:

1. Calculate the area A:

$$A = \pi(80/2)^2 = \pi(40)^2 \approx 5026.55\,\mathrm{m}^2$$

2. Calculate the power P:

$$P = \frac{1}{2}(1.225)(5026.55)(10^3) \approx 15477.84\,\mathrm{W} = 15.48\,\mathrm{kW}$$

---

4. Post-lecture Questions:

1. How do renewable energy sources contribute to reducing greenhouse gas emissions?
2. What are some challenges associated with the integration of renewable energy sources into existing power grids?
3. Can you identify any local renewable energy projects or installations in your area?

The Sixth Lecture

Hydrocarbons Source (Oil & Gas)

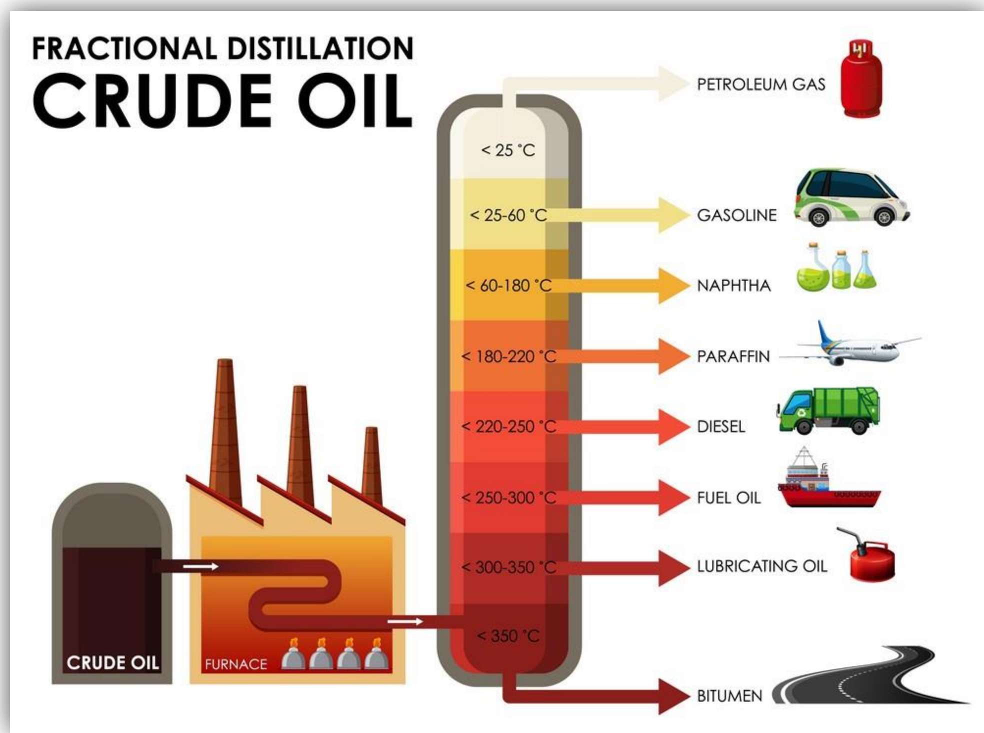
1.Pre-Lecture Questions:

1. What are hydrocarbons, and why are they important?
2. Can you identify different types of hydrocarbons?
3. What are the primary uses of oil and gas in modern industries?

2. Types of Hydrocarbons

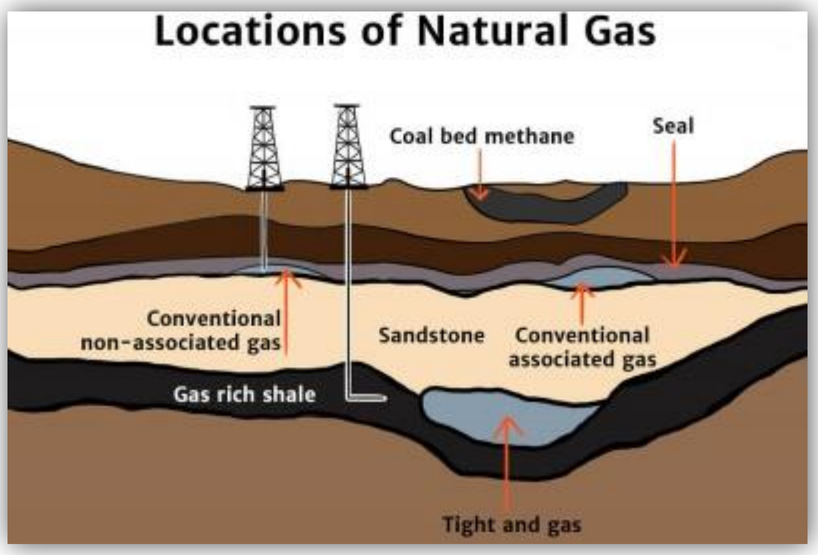
A. Crude Oil

- **Definition:** Crude oil is a naturally occurring, unrefined petroleum product composed of hydrocarbon deposits and other organic materials.
- **Characteristics:** It varies in composition, density, and viscosity, depending on its source.
- **Extraction:** Obtained through drilling wells in oil fields.



B. Natural Gas

- **Definition:** Natural gas is primarily composed of methane (CH_4) and is found in underground reservoirs often associated with oil deposits.
- **Characteristics:** It is lighter than air, colorless, and odorless; an odorant is usually added for safety reasons.
- **Uses:** Commonly used for heating, electricity generation, and as a feedstock for chemical production.



C. Refined Products

- **Definition:** These are products derived from crude oil after various refining processes.
- **Types:** Includes gasoline, diesel, jet fuel, and lubricating oils.
- **Applications:** Used in transportation, industrial processes, and heating.

---

3. Properties and Measurements of Hydrocarbons

A. Physical Properties

- **Density:** Refers to the mass per unit volume. It's critical for determining buoyancy and flow in pipelines.
- **Viscosity:** A measure of a fluid's resistance to flow. It affects the pumping and transportation of oil and gas.

B. Measurement Devices

- **Flow Meters:** Devices used to measure the flow rate of fluids in a pipeline.
- **Viscometers:** Instruments for measuring the viscosity of liquids.

4. Sample Problems

Problem 1: Density Calculation

A certain crude oil has a mass of 850 kg in a volume of 1000 liters. Calculate its density.

Solution:

$$Density = \frac{Mass}{Volume} = \frac{850\,\mathrm{kg}}{1000\,\mathrm{L}} = 0.85\,\mathrm{kg/L}$$

Problem 2: Viscosity Calculation

A sample of oil has a viscosity of 10 centipoise. If a cylinder with a diameter of 10 cm is filled with this oil, calculate the force required to move a piston at a speed of 0.1 m/s.

Solution: Using the formula:

$$F=\eta\times A\times vd$$

Where:

- F = Force
- η = Viscosity (in Pascal-seconds)
- A = Area of the piston
- v = Velocity of the piston
- d = Distance (thickness of oil layer)

1. Calculate area:

$$A = \pi \left(\frac{D}{2}\right)^2 = \pi \left(\frac{0.1}{2}\right)^2 \approx 0.00785\,\mathrm{m}^2$$

2. Assume $\eta = 0.01\,\mathrm{Pa.s}$:

$$F = 0.01 \times 0.00785 \times \frac{0.1}{0.1} = 0.000785\,\mathrm{N}$$

---

3. Post-Lecture Questions:

1. What are the environmental impacts of oil and gas extraction?
2. How do hydrocarbons contribute to the energy needs of society?
3. What alternatives exist to reduce dependence on fossil fuels?

The Seventh and Eighth Lecture

(Internal Energy and Flow Work in Thermodynamics)

1. **Pre-Lecture Questions:**

1. What is internal energy, and how does it relate to temperature?
2. How does flow work contribute to energy transfer in open systems?
3. What role does internal energy play in refrigeration and air conditioning systems?

---

2. **Key Definitions and Concepts**

1. Internal Energy (U): Internal energy is the total energy contained within a system due to the microscopic movements and interactions of the molecules within it. It includes both:

- **Kinetic Energy**: The energy of molecules in motion.
- **Potential Energy**: The energy stored due to molecular forces and positions.
- **Formula:**

$$\Delta U = Q - W$$

Where:

- ΔU = Change in internal energy

- Q = Heat added to the system
- W = Work done by the system

- **Application in Refrigeration:** Internal energy is a key concept in refrigeration, especially during phase changes (e.g., refrigerant evaporation in the evaporator). As refrigerants absorb or release heat, their internal energy changes, influencing the cooling process.

---

2. Flow Work (W_flow): Flow work, also known as flow energy, is the energy required to move a fluid into or out of an open system. This concept is vital in refrigeration and HVAC systems, where refrigerants are constantly flowing through components such as compressors, condensers, and evaporators.

- **Formula:**

$$W_{flow} = P \times V$$

Where:

- P = Pressure (Pa)
- V = Volume (m^3)

- **Application in HVAC Systems:** Flow work occurs in systems where a fluid is pushed through, such as compressors. Compressing the refrigerant increases both its pressure and temperature, requiring work to be done on the system, which is directly tied to the flow work.

---

3. Internal Energy vs. Flow Work in Open Systems: In an open thermodynamic system, both internal energy and flow work need to be considered, as mass and energy cross the system's boundaries. The relationship between internal energy and flow work in such systems is described using the **Steady Flow Energy Equation (SFEE)**.

- **Steady-Flow Energy Equation:**

$$\Delta H = Q - W$$

Where:

- H = Enthalpy (Internal Energy + Flow Work)
- Q = Heat added to the system
- W = Work done by the system

In an HVAC system, this equation helps analyze how energy is transferred as refrigerants flow through different stages (compression, condensation, expansion, and evaporation).

---

3. **Practical Applications in Refrigeration and Air Conditioning**

1. **Compressors (Flow Work and Internal Energy):** Compressors in refrigeration systems perform work on the refrigerant by compressing it, increasing both its internal energy and pressure (flow work). The compressor raises the temperature of the refrigerant, enabling it to reject heat in the condenser.
2. **Heat Exchangers:** In heat exchangers like evaporators and condensers, refrigerants either absorb or release heat. The change in internal energy during these processes directly affects the system's ability to cool or heat air.
3. **Expansion Valves:** In the expansion valve, refrigerants experience a rapid pressure drop. This drop reduces the refrigerant's flow work and internal energy, causing a cooling effect as it enters the evaporator.

---

4. **Example Problems**

Problem 1: Calculating Internal Energy Change A refrigeration system absorbs 5000 J of heat while performing 2000 J of work. Calculate the change in internal energy.

- **Solution:**

$$\Delta U = Q - W = 5000\text{ J} - 2000\text{ J} = 3000\text{ J}.$$

Problem 2: Flow Work in a Compressor A refrigerant is compressed from a volume of 0.02 m^3 to 0.01 m^3 at a constant pressure of 300 kPa. Calculate the flow work done during compression.

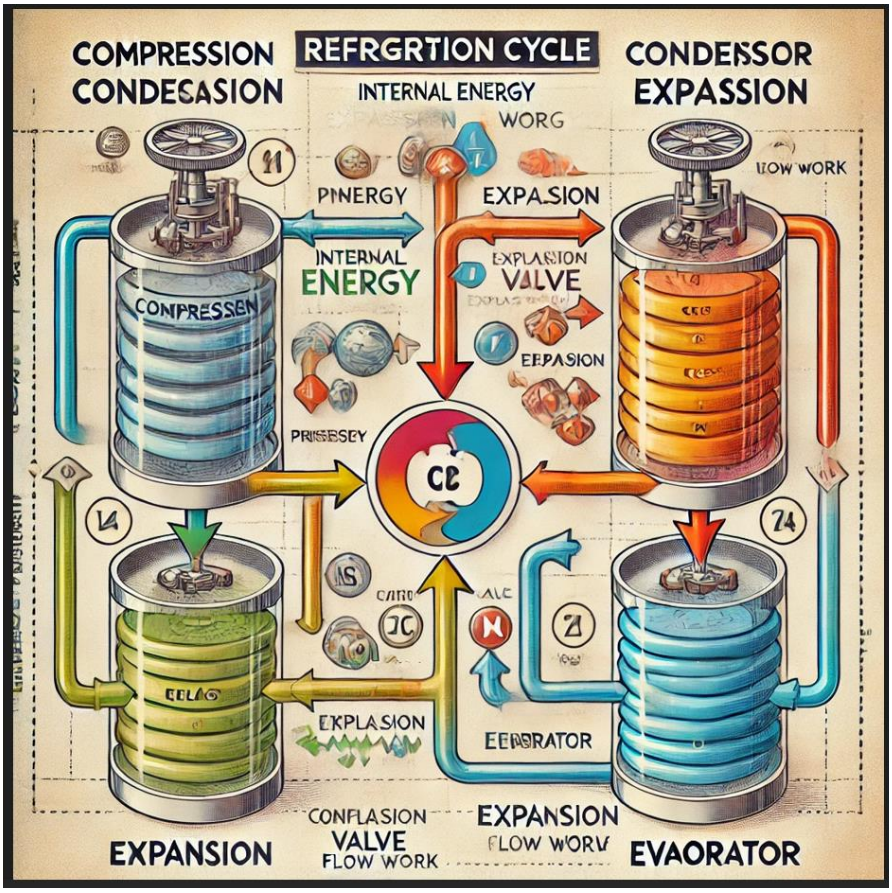
- **Solution:**

$$W_{flow} = P \times \Delta V = 300 \times 10^3 \times (0.02 - 0.01) = 3000\text{ J}.$$

---

5. Diagrams and Visual Aids

Diagram 1: Internal Energy Changes in a Refrigeration Cycle This diagram illustrates the refrigeration cycle (compression, condensation, expansion, and evaporation) and highlights the changes in internal energy and flow work at each stage.



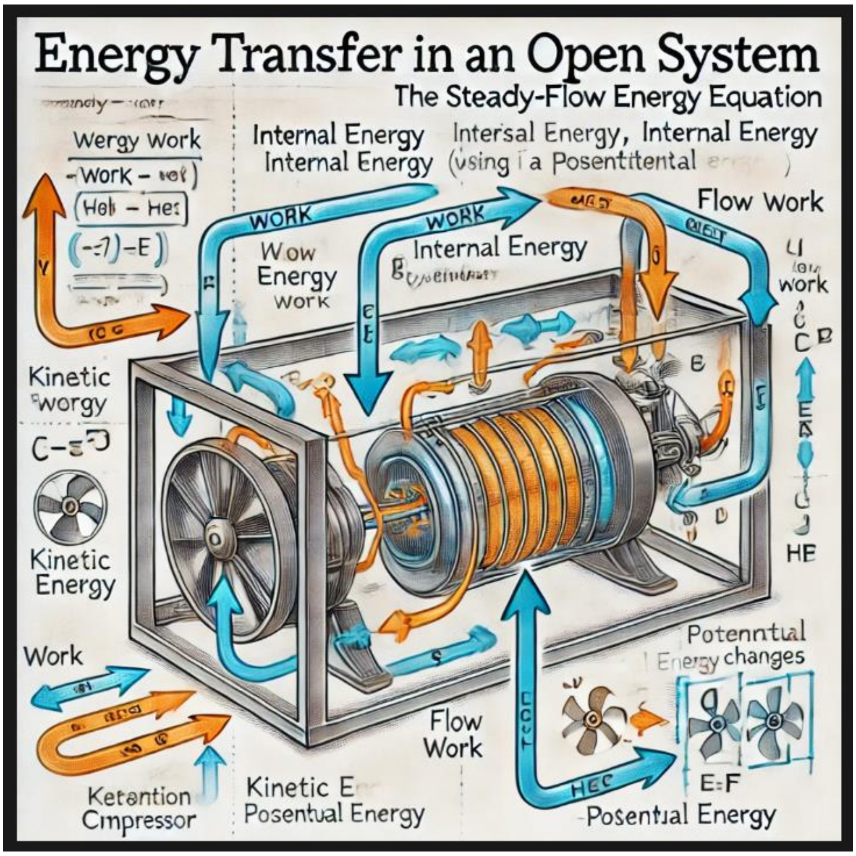
1) **Compression Stage**:
- High-pressure, high-temperature vapor is compressed, raising internal energy.

2) **Condensation Stage**:
- The refrigerant condenses, releasing heat and reducing internal energy.

3) **Expansion Stage**:
- Rapid pressure drop reduces internal energy significantly.

4) **Evaporation Stage**:
- Heat is absorbed from the surroundings, increasing internal energy.

Diagram 2: Steady Flow Energy in an Open System This flow diagram demonstrates how energy is transferred in an open system, such as a refrigeration compressor, using the Steady-Flow Energy Equation.



Visualization of the Refrigeration Cycle

1. **Compression Phase**:
   - **Process**: The refrigerant is compressed in the compressor, increasing its pressure and temperature.
   - **Internal Energy Change**: As the refrigerant gas is compressed, its internal energy increases due to the work done on it.
2. **Condensation Phase**:
   - **Process**: The high-pressure refrigerant gas enters the condenser, where it releases heat to the surroundings and condenses into a liquid.
   - **Internal Energy Change**: The internal energy decreases as heat is released.
3. **Expansion Phase**:
   - **Process**: The liquid refrigerant passes through an expansion valve, where it experiences a drop in pressure, leading to a temperature decrease.
   - **Internal Energy Change**: The internal energy further decreases as the refrigerant expands.
4. **Evaporation Phase**:

- **Process**: The low-pressure refrigerant absorbs heat from the environment (inside the refrigerator) in the evaporator and evaporates back into a gas.
- **Internal Energy Change**: The internal energy increases again as the refrigerant absorbs heat.

Steady Flow Energy in an Open System

1. **Energy Inputs**:
   - **Work (W)**: Energy added to the system through the compressor.
   - **Heat Transfer (Q)**: Heat absorbed or released during the phase changes (condensation and evaporation).
2. **Energy Outputs**:
   - **Flow Work**: The work required to move the refrigerant through the system (related to pressure and volume changes).
   - **Internal Energy Changes**: Changes in the internal energy of the refrigerant due to heat transfer and work done.

---

6. Post-Lecture Questions:

1. How does internal energy change during phase changes in refrigeration systems?
2. What is the significance of flow work in the compression stage of an HVAC system?
3. How is the steady-flow energy equation applied in the analysis of open systems like air conditioners?

The Ninth Lecture

(Forms of Energy in Thermodynamics)

1.Pre-Lecture Questions:

1. What are the different forms of energy?
2. How do energy transformations occur in thermodynamic systems?
3. Can you provide examples of work and heat in everyday applications?

---

2. Forms of Energy

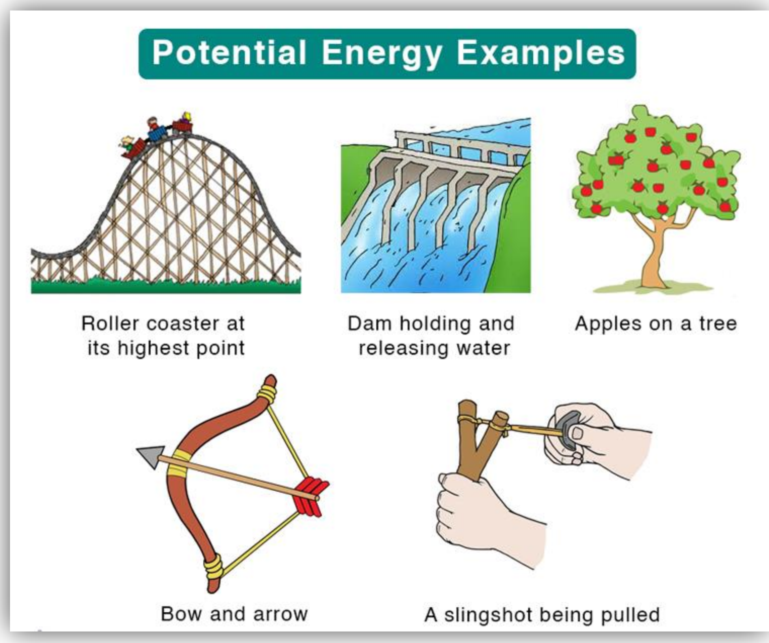
A. Potential Energy

- **Definition:** Potential energy is the energy possessed by an object due to its position or configuration. It is often related to gravitational forces.

- **Formula:**

$$PE=mgh$$

- Where:
    - PE = Potential energy
    - m = Mass of the object (kg)
    - g = Acceleration due to gravity (9.81 m/s^2)
    - h = Height above a reference point (m)



B. Kinetic Energy

- **Definition:** Kinetic energy is the energy of an object in motion. It depends on the mass and velocity of the object.
- **Formula:**

$$KE = \frac{1}{2}mv^2$$

Where:

- KE = Kinetic energy
- m = Mass (kg)
- v = Velocity (m/s)

C. Heat Energy

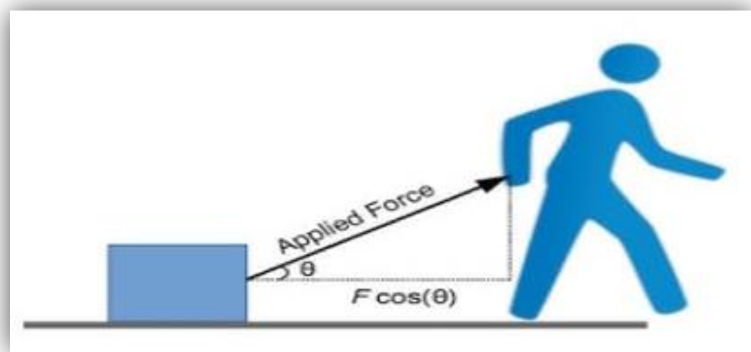
- **Definition:** Heat is the energy transferred between systems or objects due to a temperature difference. It flows from a hotter object to a cooler one.
- **Units:** Measured in joules (J) or calories (cal).

D. Work Energy

- **Definition:** Work is the energy transferred when a force is applied to an object causing it to move. It can be calculated as:

$$W=Fd_{cos}(\theta)$$

- Where:
  - W = Work done (J)
  - F = Force applied (N)
  - d = Displacement (m)
  - θ = Angle between force and displacement



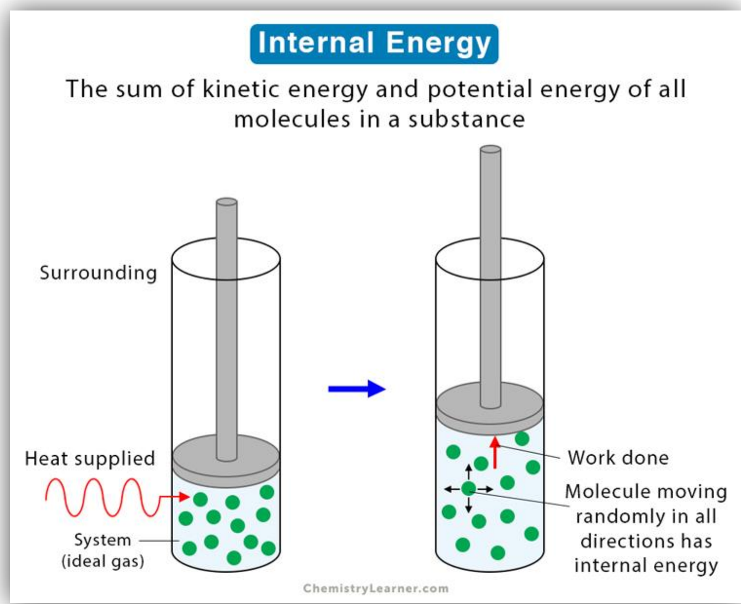
E. Internal Energy

- **Definition:** Internal energy is the total energy contained within a system, including kinetic and potential energies at the molecular level. It is a function of temperature and state of the substance.
- **Formula:**

$$U = U_{initial} + Q - W$$

Where:

- U = Internal energy
- Q = Heat added to the system
- W = Work done by the system



---

3. Flow Work

- **Definition:** Flow work (or boundary work) refers to the work required to push the boundary of a control volume as fluid enters or exits.
- **Formula:**

$$W_{flow} = P\Delta V$$

- Where:
  - P = Pressure (Pa)
  - ΔV = Change in volume (m^3)

---

4. Sample Problems

Problem 1: Potential Energy Calculation

A water tank has a mass of 200 kg and is raised to a height of 5 m. Calculate its potential energy.

Solution:

$$PE = mgh = 200 \times 9.81 \times 5 = 9810 \text{ J}$$

Problem 2: Kinetic Energy Calculation

A car with a mass of 1500 kg is traveling at a speed of 20 m/s. Calculate its kinetic energy.

Solution:

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1500 \times (20)^2 = 300,000\, J$$

Problem 3: Work Calculation

A force of 50 N is applied to move an object 3 m. Calculate the work done if the force is applied in the direction of displacement.

Solution:

$$W = Fd = 50 \times 3 = 150 \text{ J}$$

---

5. Post-Lecture Questions:

1. How does energy conservation apply in thermodynamic processes?
2. What is the relationship between heat, work, and internal energy?
3. Can you identify real-life examples of energy transformations?

The Tenth Lecture

(First Law of Thermodynamics in Flow Systems)

1.Pre-Lecture Questions:

1. What is the first law of thermodynamics?
2. How does energy transfer occur in flow systems?
3. Can you provide examples of different types of flow systems?

---

2. First Law of Thermodynamics

A. Statement of the First Law

The first law can be mathematically expressed as:

$$\Delta U = Q - W$$

Where:

- ΔU = Change in internal energy of the system
- Q = Heat added to the system
- W = Work done by the system

B. Significance in Flow Systems

In flow systems, the first law is crucial for analyzing energy changes as fluids flow into and out of systems, such as compressors and turbines.

C. Examples

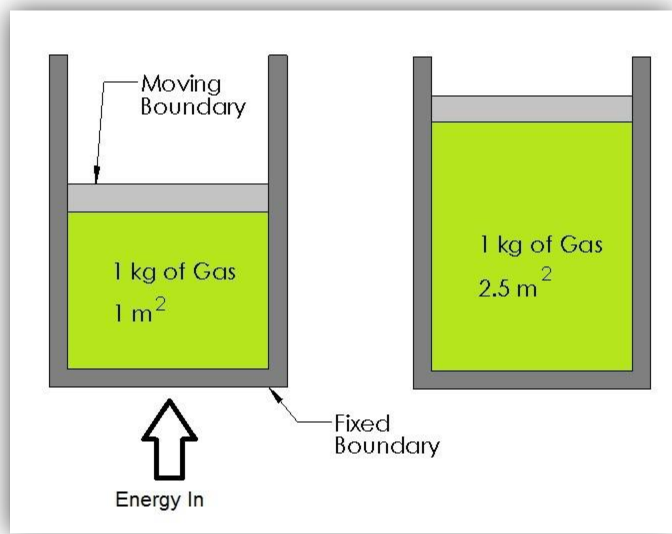
- **Heat Exchanger:** The first law is applied to evaluate heat transfer between two fluids.
- **Refrigeration Cycle:** The energy conservation principle is critical in analyzing the work input and heat removal.

---

3. Types of Flow Systems

A. Non-Flow System

- **Definition:** In a non-flow system, there is no mass transfer into or out of the system boundaries. The energy changes occur due to heat and work interactions only.
- **Example:** A sealed container of gas being heated.

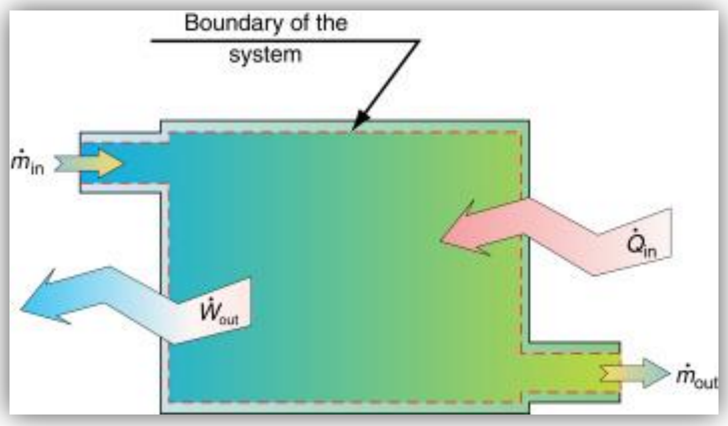


B. Flow System

In a flow system, mass can enter or exit the system. Flow systems can be categorized into:

1. Steady Flow System

- **Definition:** In a steady flow system, the fluid properties (velocity, pressure, temperature) at any given point do not change with time.
- **Example:** Water flowing through a pipe at constant speed.



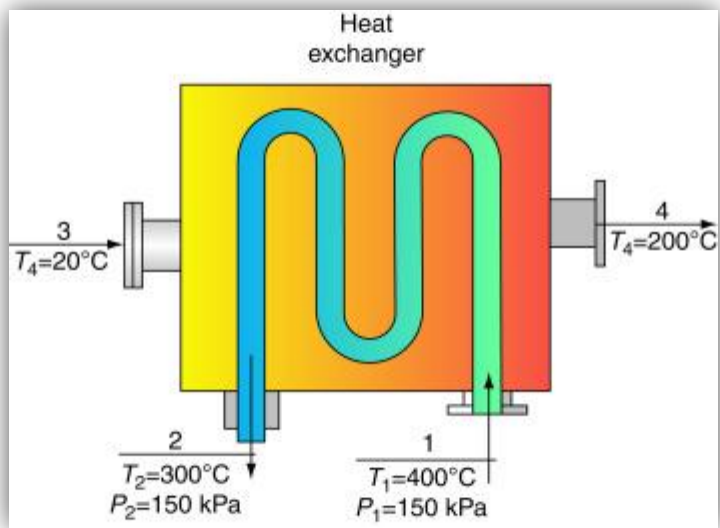
2. Unsteady Flow System

- **Definition:** In an unsteady flow system, the fluid properties change with time at any given point.
- **Example:** Water being discharged from a tank, where the flow rate decreases over time.

C. Open vs. Closed Systems

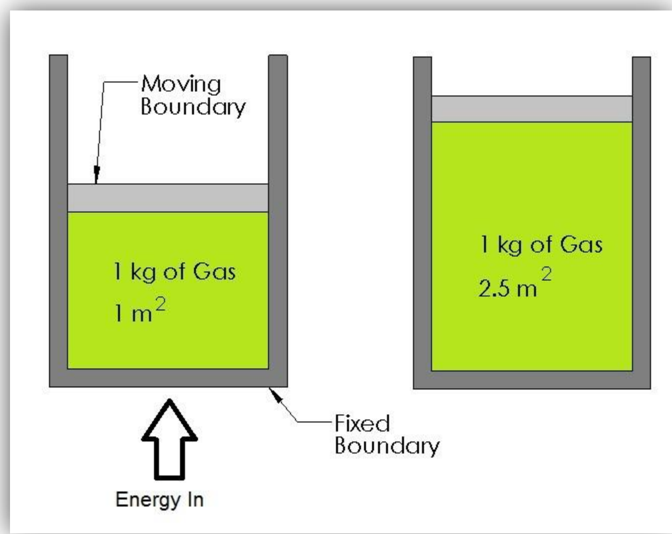
1. Open System

- **Definition:** An open system can exchange both energy and mass with its surroundings.
- **Example:** A steam boiler where water enters and steam exits.



2. Closed System

- **Definition:** A closed system can exchange energy but not mass with its surroundings.
- **Example:** A piston-cylinder assembly where the gas inside can do work but does not leave the cylinder.



4. Sample Problems

Problem 1: Steady Flow Work Calculation

Calculate the work done by a pump that moves water at a flow rate of 0.5 m^3/s against a pressure difference of 100 kPa.

Solution:

$$W=\Delta P\cdot Q=100{,}000\ \text{Pa}\cdot 0.5\ \text{m}^3/\text{s}=50{,}000\ \text{W}=50\ \text{kW}$$

Problem 2: Heat Transfer in a Non-Flow System

A gas in a closed container absorbs 2000 J of heat. If the work done by the gas is 500 J, what is the change in internal energy?

Solution:

$$\Delta U=Q-W=2000-500=1500\ \text{J}$$

5. Post-Lecture Questions:

1. How does the first law of thermodynamics apply in practical engineering applications?
2. What is the significance of steady and unsteady flow in thermodynamic analysis?
3. Can you identify real-life systems that can be classified as open or closed systems?

الفصل الثالث: رقم المحاضرة: 15+14+13+12+11	
عنوان المحاضرات:	تطبيقات القانون الاول للثرمو ديناميك والعمليات الحرارية عليها مع انواع الحرارة النوعية والقانون الثاني للثرمو ديناميك
اسـم المدرسين:	م.م. مرال محمود حسين و م. محمود حسين خليل
الفئة المستهدفة :	المرحلة الاولى/ المعهد التقني
الهدف العام من المحاضرة :	تزويد الطلاب بالمعرفة والفهم والتطبيق والتحليل والتقويم في تطبيقات القانون الاول للثرمو ديناميك والعمليات الحرارية عليها مع انواع الحرارة النوعية والقانون الثاني للثرمو ديناميك
الأهداف السلوكية او مخرجات التعلم:	1 - يتم تقييم فهم الطلاب للمفاهيم الثرموديناميكية من خلال الاختبارات الكتابية التقليدية. 2 - يتم تقييم القدرة على التطبيق في حل المشكلات. 3 - يتم تقييم القدرة على تطبيق المعرفة الرياضية في سياقات العالم الحقيقي. 4- يتم تقييم القدرة على التواصل الفعال للأفكار والمفاهيم الرياضية والمعرفية.
استراتيجيات التيسير المستخدمة	1. المحاضرات 2. التعلم النشط 3. التعلم القائم على المشروع 4. التعلم الذاتي 5. التعلم الرقمي 6. التقييم المستمر
المهارات المكتسبة	سيكون لدى الطالب قابلية التطوير والقدرة على التفكير المنطقي والتحليلي والنقدي في حل المشكلات التخصصية في الجانب الحراري والرياضي والهندسي.
طرق القياس المعتمدة	الامتحانات اليومية والشهرية و تكليف الطلاب بمشاريع تتطلب تطبيق المعرفة

The Eleventh Lecture

(Applications of the First Law of Thermodynamics in Various Devices)

1.Pre-Lecture Questions:

1. What is the first law of thermodynamics?
2. How is the first law applied in different thermal devices?
3. Can you identify examples of these devices in real-world applications?

---

2. First Law of Thermodynamics

A. Statement of the First Law

The first law can be expressed mathematically as:

$$\Delta U = Q - W$$

Where:

- ΔU = Change in internal energy
- Q = Heat added to the system
- W = Work done by the system

This principle is vital in understanding energy interactions in various devices.

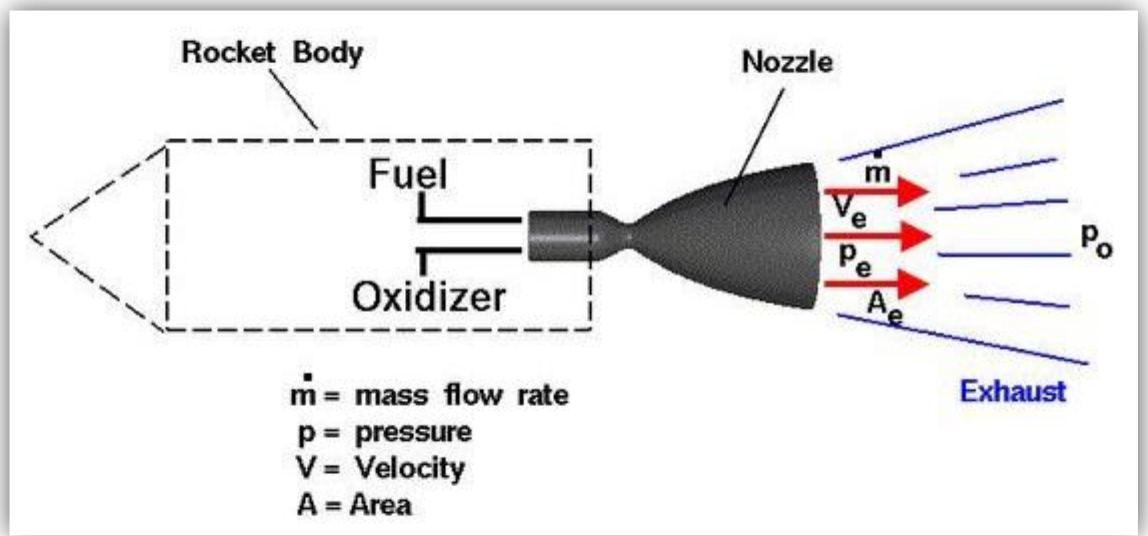
---

3. Applications of the First Law in Thermal Devices

A. Nozzle

- **Definition:** A nozzle is a device that converts pressure energy into kinetic energy, increasing the velocity of a fluid.
- **Application:** According to the first law, the energy loss in a nozzle is primarily due to the conversion of internal energy to kinetic energy.

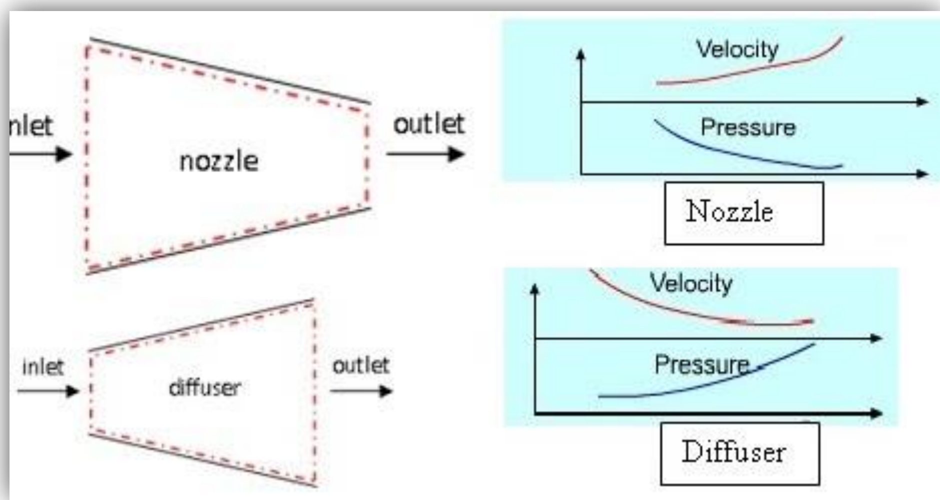
Example: In a steam nozzle, steam expands and accelerates as it passes through, resulting in a decrease in pressure and temperature.



B. Diffuser

- **Definition:** A diffuser increases the pressure of a fluid by decreasing its velocity.
- **Application:** The first law indicates that the kinetic energy is converted to pressure energy, which results in an increase in pressure.

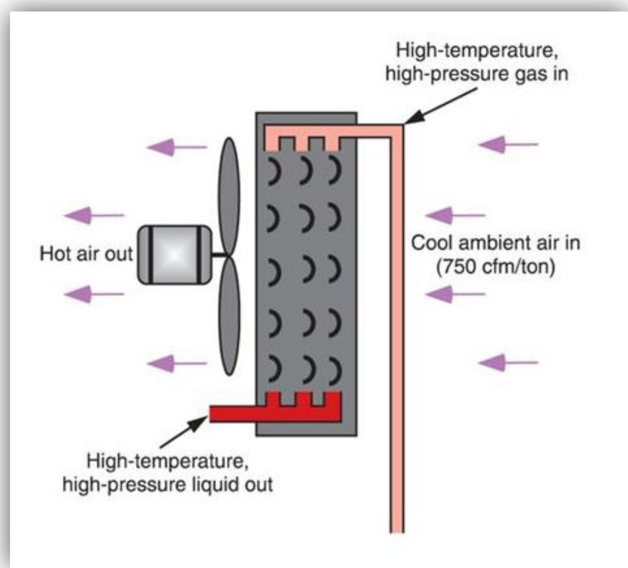
Example: In an air diffuser, high-speed air from a fan slows down, increasing its pressure before entering a room.



C. Condenser

- **Definition:** A condenser transfers heat from the refrigerant to the surrounding environment, causing the refrigerant to condense.
- **Application:** The first law shows that heat is removed from the refrigerant ($Q < 0$) while work is done by the cooling system.

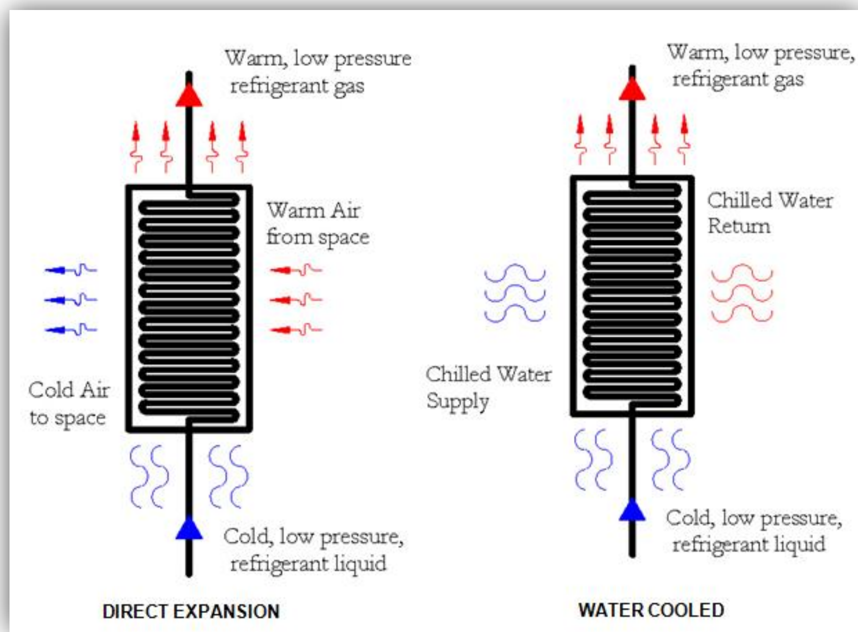
Example: In a refrigeration cycle, the condenser cools and condenses refrigerant vapor into liquid.



D. Evaporator

- **Definition:** An evaporator absorbs heat to convert refrigerant from a liquid to a vapor.
- **Application:** The first law demonstrates that heat is added to the refrigerant ($Q > 0$), increasing its internal energy.

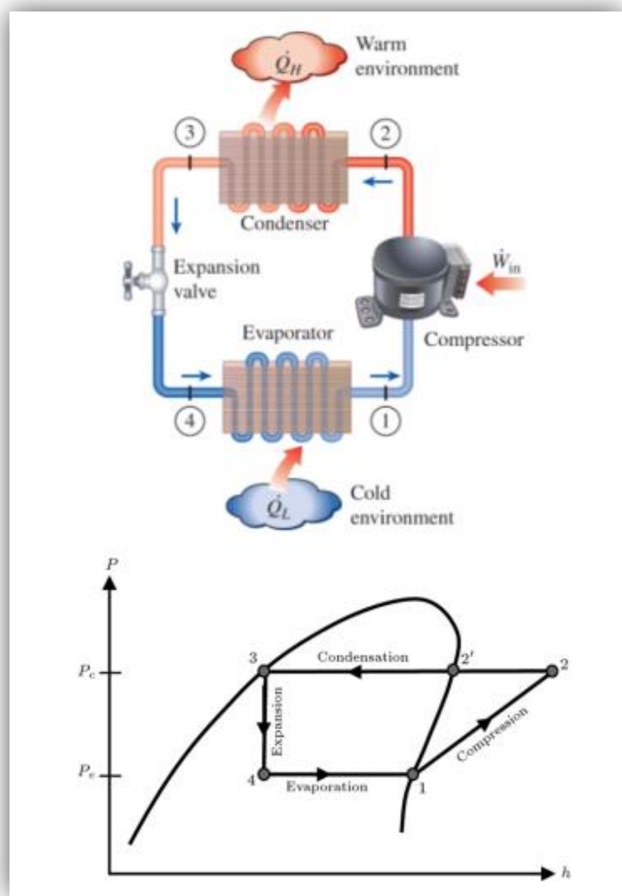
Example: In air conditioning systems, the evaporator absorbs heat from the indoor air, cooling the space.



E. Compressor

- **Definition:** A compressor increases the pressure of the refrigerant vapor by reducing its volume.
- **Application:** The first law illustrates that work is done on the refrigerant, increasing its internal energy and pressure.

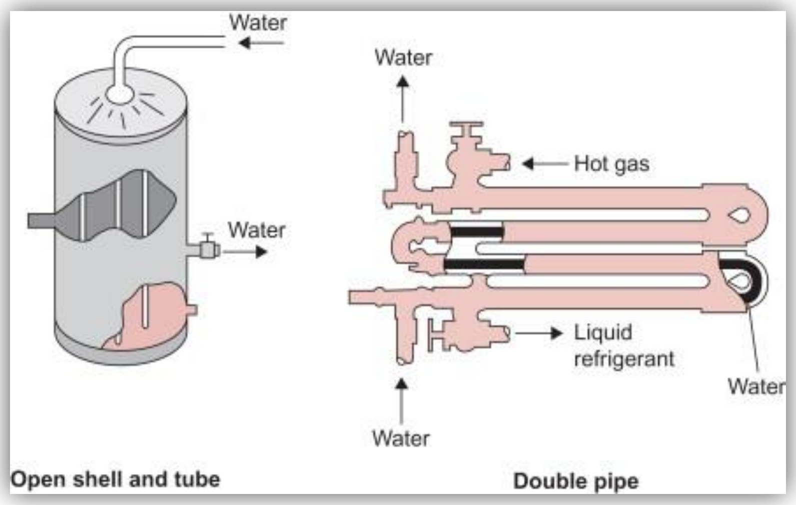
Example: In a refrigeration cycle, the compressor compresses low-pressure vapor to high-pressure vapor.



F. Heat Exchanger (Surface and Open)

- **Definition:** A heat exchanger transfers heat between two or more fluids without mixing them.
- **Application:** The first law is applied to evaluate the heat transfer efficiency and the energy balance between the hot and cold fluids.

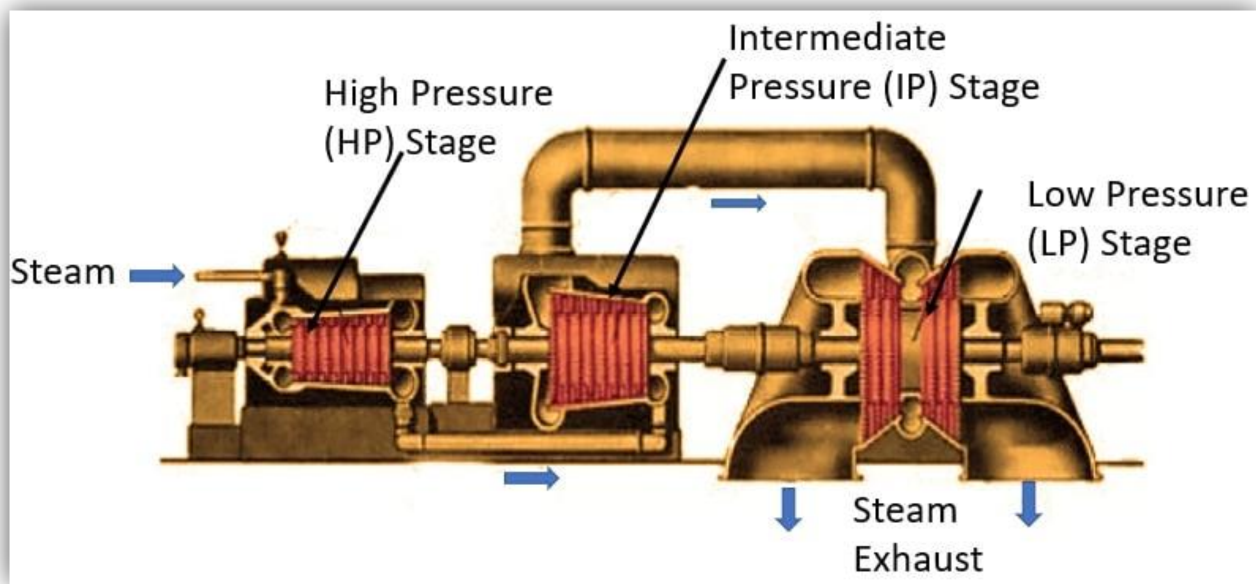
Example: In a car radiator, hot engine coolant transfers heat to air passing through the radiator, cooling the coolant.



G. Turbine

- **Definition:** A turbine converts thermal energy into mechanical energy by expanding fluid through rotor blades.
- **Application:** The first law indicates that energy is extracted from the fluid ($Q < 0$) and converted to work output ($W > 0$).

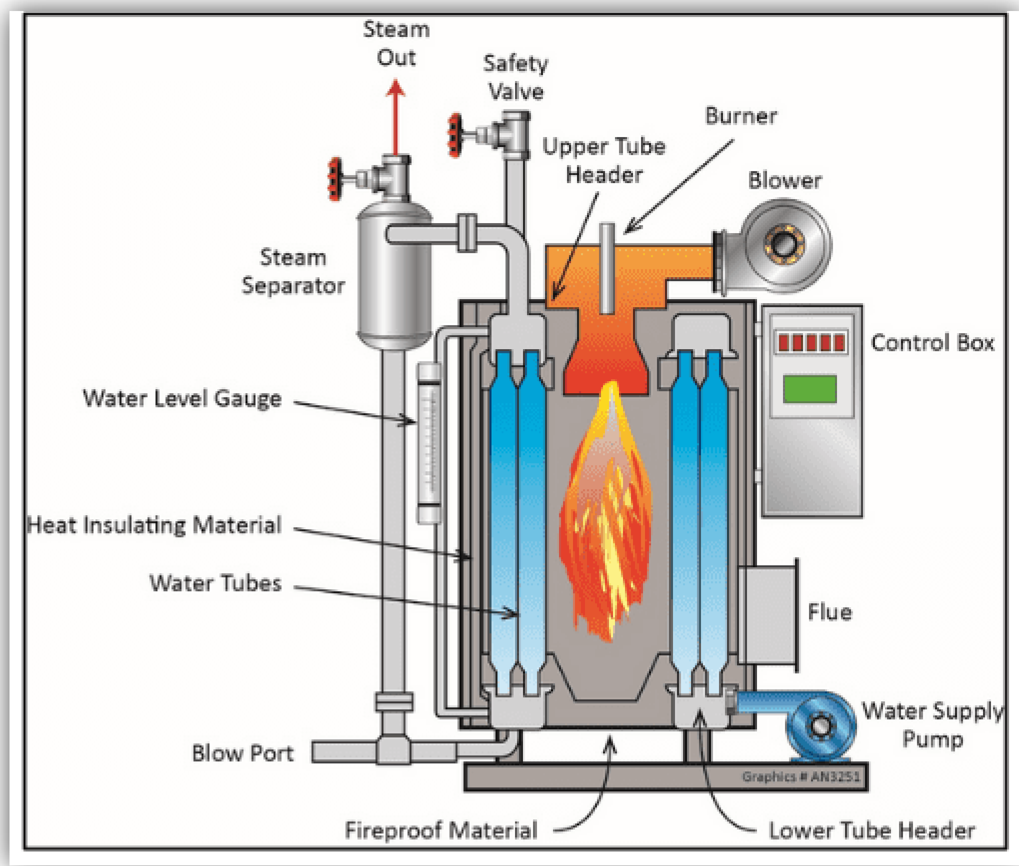
Example: In a steam power plant, steam expands in a turbine, producing electricity.



H. Boiler

- **Definition:** A boiler generates steam by transferring heat to water.
- **Application:** The first law shows that energy is added as heat to the water ($Q > 0$), converting it into steam.

Example: In a power plant, the boiler heats water to produce high-pressure steam for driving turbines.



4. Sample Problems

Problem 1: Heat Transfer in a Condenser

A condenser removes 1500 J of heat from the refrigerant. If the work done by the cooling system is 200 J, what is the change in internal energy of the refrigerant?

Solution:

$$\Delta U = Q - W = -1500\text{ J} - 200\text{ J} = -1700\text{ J}$$

Problem 2: Work Done by a Compressor

A compressor compresses refrigerant vapor from a pressure of 100 kPa to 500 kPa. If the work done on the refrigerant is 300 J, what is the change in internal energy if the heat removed is 100 J?

Solution:

$$\Delta U = Q - W = -100\text{ J} - 300\text{ J} = -400\text{ J}$$

5. Post-Lecture Questions:

1. How does the first law apply to different devices in a refrigeration cycle?
2. What factors influence the efficiency of heat exchangers?
3. Can you provide examples of how these devices are used in real-world applications?

The Twelfth and Thirteenth Lecture

(Thermodynamic Processes at Constant Pressure, Volume, Temperature, and Enthalpy)

1.Pre-Lecture Questions:

1. What is a thermodynamic process?
2. How do constant pressure, volume, temperature, and enthalpy processes differ from each other?
3. Can you identify examples of these processes in real-world applications?

2. Thermodynamic Processes

A. Constant Pressure Process (Isobaric)

- **Definition:** In an isobaric process, the pressure remains constant while other properties such as volume and temperature may change.
- **Equation:** The work done during an isobaric process can be calculated as:

$$W = P\Delta V$$

Representation: In a P-V diagram, the line is horizontal at a constant pressure. In a T-S diagram, it slopes upward, and in a P-H diagram, it slopes downward.

Example: Heating water in an open container.

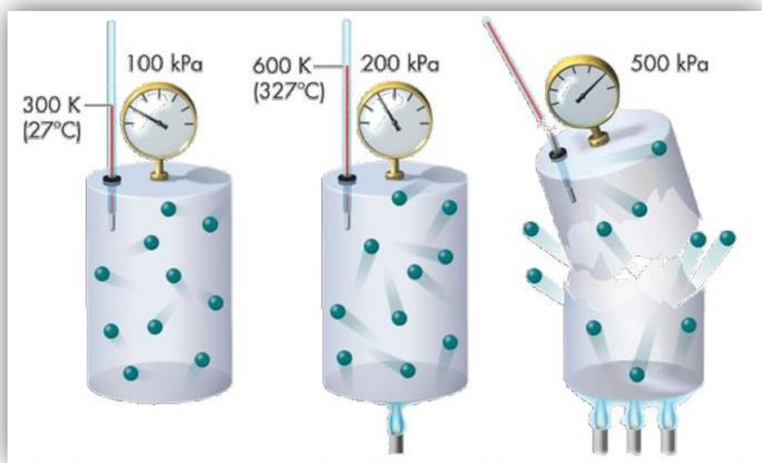
B. Constant Volume Process (Isochoric)

- **Definition:** In an isochoric process, the volume remains constant while pressure and temperature can change.
- **Equation:** The change in internal energy is given by:

$$\Delta U = Q$$

Representation: In a P-V diagram, the line is vertical. In a T-S diagram, it is horizontal, and in a P-H diagram, it slopes upward.

Example: Heating a gas in a sealed container.



C. Constant Temperature Process (Isothermal)

- **Definition:** An isothermal process occurs at a constant temperature while pressure and volume change.
- **Equation:** The work done can be expressed as:

$$W = nRT \ln\left(\frac{V_2}{V_1}\right)$$

Representation: In a P-V diagram, the curve is hyperbolic. In a T-S diagram, it slopes downward, and in a P-H diagram, it is horizontal.

Example: Expansion of an ideal gas at a constant temperature.

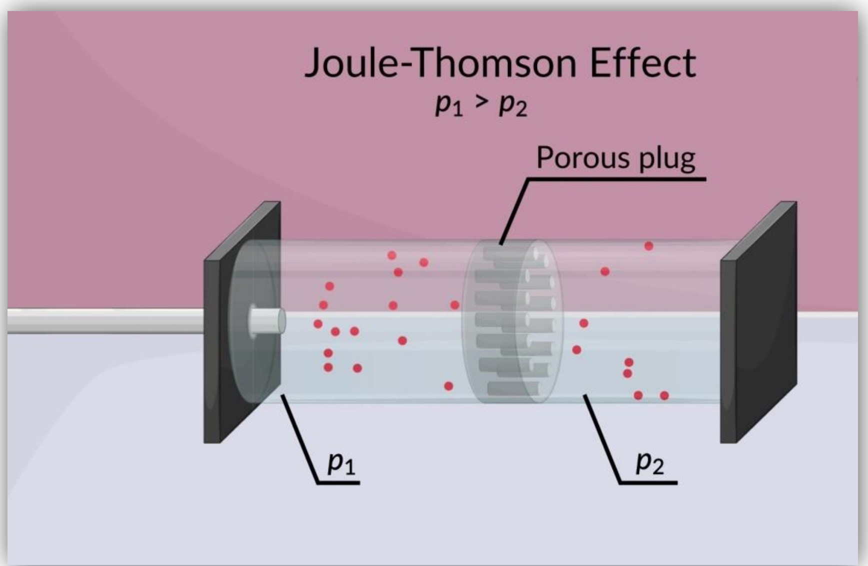
D. Constant Enthalpy Process (Isenthalpic)

- **Definition:** An isenthalpic process occurs at a constant enthalpy, often found in throttling processes.
- **Equation:** For an isenthalpic process, enthalpy remains constant:

$$H_1=H_2$$

Representation: In a P-V diagram, the process appears as a vertical line. In a T-S diagram, it slopes downward, and in a P-H diagram, it is horizontal.

Example: The Joule-Thomson effect, where gas expands through a throttle.



---

3. Polytrophic Process

A. Definition

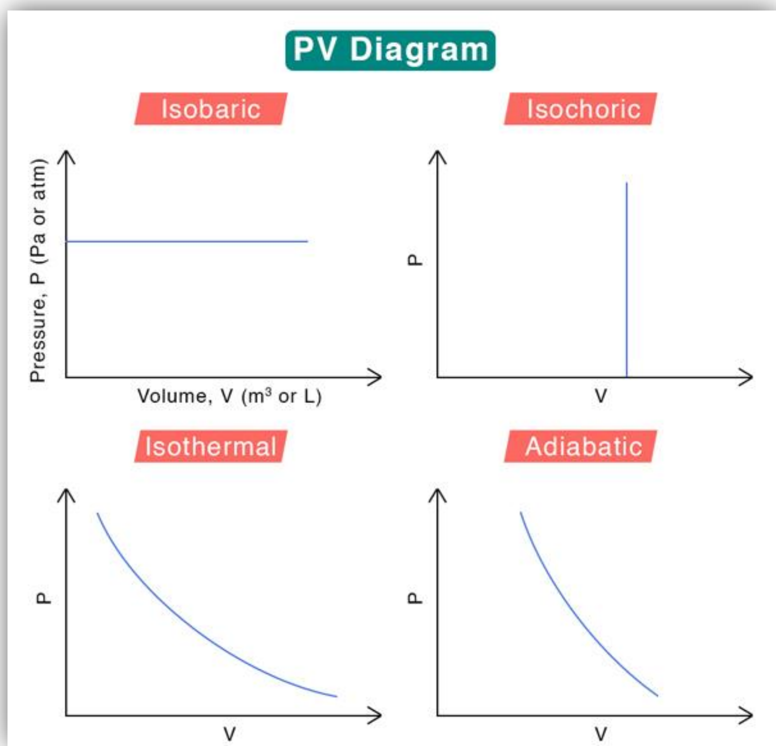
A polytrophic process is characterized by the equation:

$$PV^n = \text{constant}$$

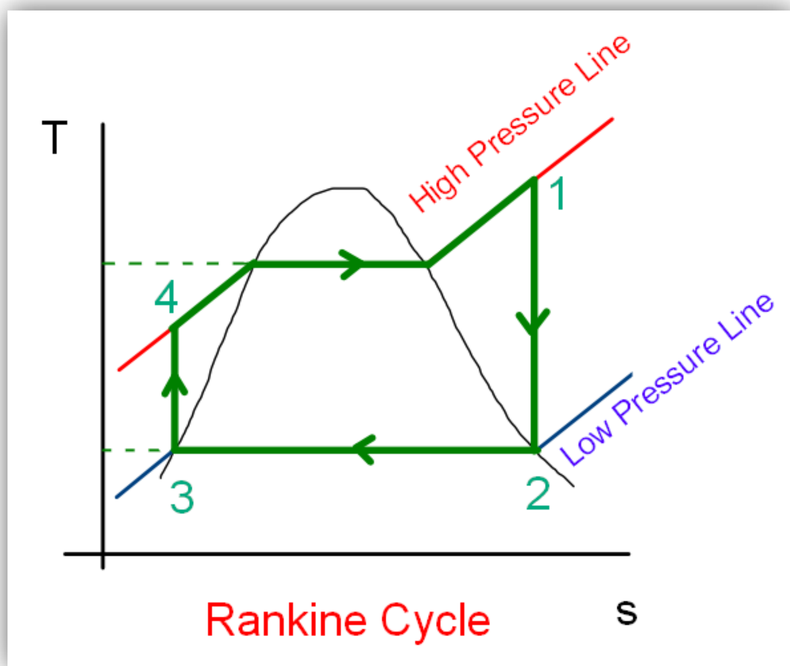
Where n is the polytrophic index, which can take different values depending on the type of process (e.g., isothermal, adiabatic).

B. Representation

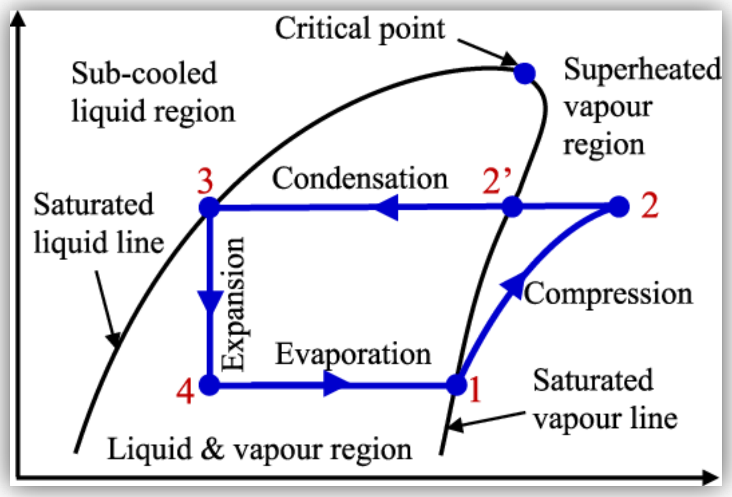
- **P-V Diagram:** The curve varies depending on the value of n.



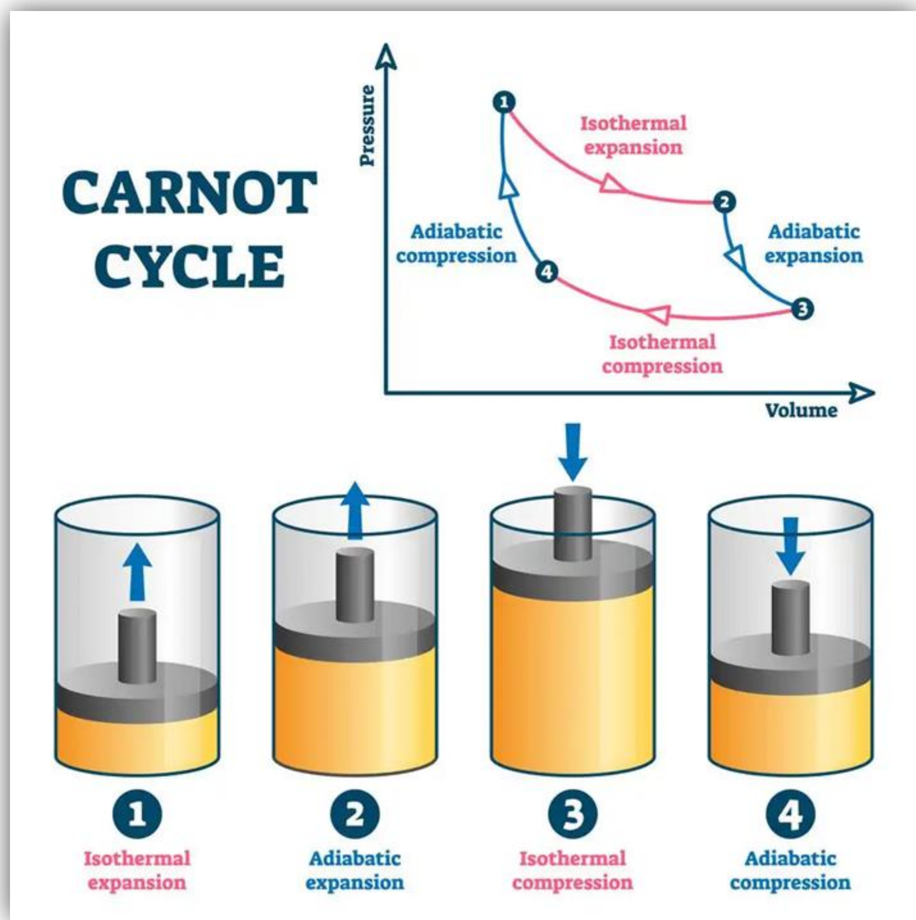
- **T-S Diagram:** The slope varies, showing different rates of heat transfer.



- **P-H Diagram:** The representation depends on specific enthalpy changes.



Example: Compression or expansion processes that do not fall into the ideal isothermal or adiabatic categories.



---

4. Sample Problems

Problem 1: Work Done in an Isobaric Process

A gas expands at constant pressure of 200 kPa from a volume of 0.5 m^3 to 1.0 m^3. Calculate the work done.

Solution:

$$W=P\Delta V=200\text{ kPa}\times(1.0-0.5)\text{ m}^3=200\times103\text{ Pa}\times0.5\text{ m3}=100{,}000\text{ J}$$

Problem 2: Change in Internal Energy in an Isochoric Process

If 500 J of heat is added to a gas at constant volume, what is the change in internal energy?

Solution:

$$\Delta U = Q = 500\ J$$

Problem 3: Polytrophic Process Calculation

If a gas undergoes a polytrophic process with n=1.4 from a pressure of 100 kPa and volume of 0.5 m^3 to a volume of 1.0 m^3, calculate the final pressure.

Solution: Using the polytrophic relation:

$$P_1 V_1^n = P_2 V_2^n \implies P_2 = P_1 \left(\frac{V_1}{V_2}\right)^n = 100\,kPa \left(\frac{0.5}{1.0}\right)^{1.4} \approx 100\,kPa \times 0.378 = 37.8\,kPa$$

---

5. Post-Lecture Questions:

1. How does each type of thermodynamic process impact the efficiency of a refrigeration system?
2. Can you describe real-world applications for each process?
3. How do the P-V, T-S, and P-H diagrams help visualize thermodynamic processes?

The Fourteenth Lecture

(Specific Heat, Types of Specific Heat, and Gas Constant)

1.Pre-Lecture Questions:

1. What is specific heat, and why is it important in thermodynamics?
2. What are the different types of specific heat?
3. How does the gas constant relate to specific heat in gases?

---

2. Specific Heat

A. Definition

- **Specific Heat (c):** The amount of heat required to raise the temperature of 1 kg of a substance by 1°C (or 1 K).

Mathematical Expression:

$$Q = mc\Delta T$$

Where:

- Q = Heat added (Joules)
- m = Mass of the substance (kg)
- c = Specific heat (J/kg·°C)
- ΔT = Change in temperature (°C)

B. Units

- The SI unit of specific heat is Joules per kilogram per degree Celsius (J/kg·°C).

---

3. Types of Specific Heat

A. Specific Heat at Constant Pressure (Cp)

- **Definition:** The amount of heat required to raise the temperature of 1 kg of a substance at constant pressure.
- **Equation:**

$$Q_p = m c_p \Delta T$$

- **Example:** Heating water in an open container at atmospheric pressure. The specific heat of water at constant pressure is approximately 4.186 J/g·°C or 4186 J/kg·°C.

B. Specific Heat at Constant Volume (Cv)

- **Definition:** The amount of heat required to raise the temperature of 1 kg of a substance at constant volume.
- **Equation:**

$$Q_v = m c_v \Delta T$$

- **Example:** Heating a gas in a closed, rigid container. The specific heat of a monatomic ideal gas is $3/2R$, where R is the universal gas constant.

C. Relationship Between Cp and Cv

For an ideal gas, the relationship between specific heats at constant pressure and constant volume can be expressed as:

$$C_p - C_v = R$$

Where R is the gas constant.

---

4. Gas Constant (R)

A. Definition

- **Gas Constant (R):** The constant that appears in the equation of state for an ideal gas. It relates pressure, volume, temperature, and the number of moles of a gas.

B. Value

- The universal gas constant RRR is approximately 8.314 J/(mol·K) or 0.287 kJ/(kg·K).

C. Applications

- Used in calculations involving ideal gas behavior, such as determining the state of a gas in refrigeration cycles.

---

5. Sample Problems

Problem 1: Calculate Heat Required

Calculate the amount of heat required to raise the temperature of 2 kg of water from 25°C to 75°C.

Given:

- Mass (m) = 2 kg
- Specific heat of water (c) = 4186 J/kg·°C
- $\Delta T = 75 - 25 = 50°C$

Solution:

$$Q = mc\Delta T = 2 \times 4186 \times 50 = 418600 \text{ J}$$

Problem 2: Calculate Specific Heat

A closed container holds 1 kg of gas, and it absorbs 500 J of heat while the temperature increases by 10°C. What is the specific heat of the gas?

Given:

- Heat absorbed (Q) = 500 J
- Mass (m) = 1 kg
- $\Delta T = 10°C$

Solution:

$$c = \frac{Q}{m\Delta T} = \frac{500}{1 \times 10} = 50\, J/kg \cdot {}^{\circ}C$$

Problem 3: Relationship Between Cp and Cv

For an ideal gas with Cp=1005 J/(kg·K), calculate Cv using the gas constant R=287 J/(kg·K).

Solution:

$$Cv = Cp - R = 1005 - 287 = 718 \text{ J/(kg·K)}$$

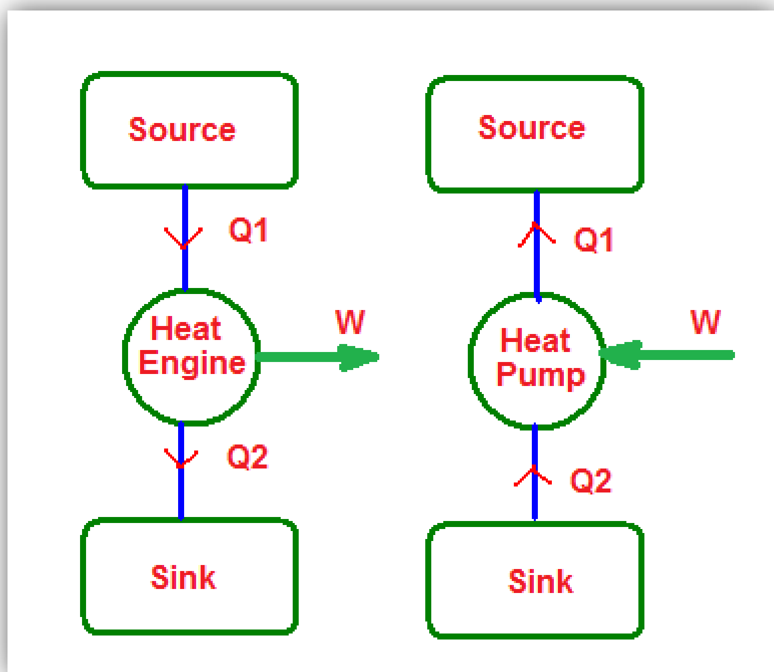
---

6. Post-Lecture Questions:

1. How do specific heats at constant pressure and volume affect the efficiency of refrigeration systems?
2. Can you describe how the gas constant is used in real-world applications?
3. How would you calculate the heat transfer for different substances with varying specific heats?

The Fifteenth Lecture

(The Second Law of Thermodynamics)



1.Pre-Lecture Questions:

1. What is the second law of thermodynamics, and how does it differ from the first law?
2. How do heat engines and heat pumps operate based on the second law?
3. What is the significance of entropy in thermodynamic processes?

---

2. The Second Law of Thermodynamics

A. Definition

- **Second Law of Thermodynamics:** The second law states that energy has quality as well as quantity, and actual processes occur in the direction of decreasing quality of energy. In simple terms, it asserts that heat cannot spontaneously flow from a colder body to a hotter body.

B. Statements of the Second Law

1. **Kelvin-Planck Statement:** It is impossible to construct a heat engine that operates in a cyclic process and converts all the heat absorbed from a high-temperature reservoir into work without rejecting some heat to a low-temperature reservoir.
2. **Clausius Statement:** It is impossible to construct a device that operates in a cyclic process and transfers heat from a colder body to a hotter body without the input of work.

C. Implications of the Second Law

- The second law introduces the concept of **entropy**, which is a measure of the disorder or randomness of a system. The entropy of an isolated system always increases over time, leading to the conclusion that energy transformations are not 100% efficient.

---

3. Heat Engines

A. Definition

- **Heat Engine:** A heat engine is a device that converts thermal energy (heat) into mechanical work by taking in heat from a high-temperature source, doing work, and releasing some heat to a low-temperature sink.

B. Operation of a Heat Engine

1. **Heat Absorption:** The engine absorbs heat (Q_H) from a high-temperature reservoir at temperature T_H.
2. **Work Output:** Part of this energy is converted into work (W).
3. **Heat Rejection:** The remaining heat (Q_C) is rejected to a low-temperature reservoir at temperature T_C.

Efficiency of a Heat Engine

The efficiency (η) of a heat engine can be calculated as:

$$\eta = \frac{W}{Q_H} = 1 - \frac{Q_C}{Q_H}$$

C. Example Problem:

Consider a heat engine that absorbs 500 kJ500 \, kJ500kJ of heat from a high-temperature reservoir and rejects 200 kJ200 \, kJ200kJ to a low-temperature reservoir. Calculate the efficiency of the engine.

Solution:

$$W = Q_H - Q_C = 500 - 200 = 300\,kJ$$

$$\eta = \frac{W}{Q_H} = \frac{300}{500} = 0.6 \text{ or } 60\%$$

---

4. Heat Pumps

A. Definition

- **Heat Pump:** A heat pump is a device that transfers heat from a colder area to a hotter area by using work. It operates on the same principles as a refrigeration cycle, but its primary purpose is to provide heating.

B. Operation of a Heat Pump

1. **Heat Absorption:** The heat pump absorbs heat (Q_C) from the cold reservoir at temperature T_C .
2. **Work Input:** Work (W) is done on the pump to transfer the heat.
3. **Heat Delivery:** The heat (Q_H) is delivered to the hot reservoir at temperature T_H .

Coefficient of Performance (COP) of a Heat Pump

The performance of a heat pump is measured using the coefficient of performance (COP):

$$COP = \frac{Q_H}{W} = \frac{T_H}{T_H - T_C}$$

C. Example Problem:

A heat pump extracts 350 kJ of heat from the outside environment (cold reservoir) and requires 100 kJ of work to operate. Calculate the COP of the heat pump.

Solution:

$$COP = \frac{Q_H}{W} = \frac{350}{100} = 3.5$$

---

5. Applications of the Second Law

A. Real-World Implications

- The second law of thermodynamics has wide-ranging implications in engineering and technology, particularly in the design and efficiency of thermal systems like power plants, refrigeration systems, and heat pumps.

B. Significance of Entropy

- Entropy is a critical concept in determining the feasibility of processes. An increase in entropy indicates a loss of useful energy, which affects the efficiency of thermal systems.

---

6. Post-Lecture Questions:

1. How does the second law of thermodynamics influence the design of real heat engines and heat pumps?
2. What are some methods to improve the efficiency of thermal systems based on the second law?

1) **مصادر اساسية:**

- **"Thermodynamics: An Engineering Approach"**لمؤلفيه Yunus Çengel وMichael Boles.
- **"Fundamentals of Thermodynamics"**لمؤلفيه Richard E. Sonntag و Claus Borgnakke وGordon J. Van Wylen.
- **"Introduction to Thermal Systems Engineering"**لمؤلفيه Gordon J. Van Wylen و Richard E. Sonntag.

2) **مراجع أكاديمية:**

- **"Thermodynamics"**لمؤلفه Howard Reith.
- **"Engineering Thermodynamics"**لمؤلفيه R.K. Rajput.

3) **كتب مرجعية إضافية:**

- **"Thermodynamics: An Interactive Approach"**لمؤلفه David F. Young.
- **"Thermodynamics"**لمؤلفه W. A. van Wylen.

4) **مواقع إلكترونية تعليمية:**

- **Coursera**و **edX**: تقدم دورات تعليمية في الديناميكا الحرارية.
- **Khan Academy**: توفر دروسًا شاملة حول المفاهيم الأساسية في الديناميكا الحرارية.

5) **مقالات بحثية:**

- يمكن البحث في المجلات العلمية مثل "Journal of Thermodynamics" و "Applied Thermal Engineering" للحصول على أبحاث ومقالات حديثة.