

# Orientation

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# Internal Policy

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## ▣ 지각이란

- 수업 시작보다 10분 초과하여 늦는 경우
- 수업 후 지각한 인원은 면담후 수정.

## ▣ 결석이란

- 수업 시작에서 30분 초과하여 나타나거나, no-show

## ▣ 평가

- 출결 (10%)
  - ❖ 지각 (0.5 시간): 1회× 1점 차감
  - ❖ 결석 (1.5 시간): 1회× 3점 차감
- 과제 (20%)
- Mid-term (30%)
- Final (40%)



# Internal Policy (continued)

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## □ 교재

- W. Callister Jr. – 재료과학과 공학
- Materials Science and Engineering: An Introduction

## □ Interactions

- 강의중
  - ❖ 구두 질문, 혹은 포스트잇
- 강의후
  - ❖ 면담
  - ❖ Email: [yjeong@changwon.ac.kr](mailto:yjeong@changwon.ac.kr)
  - ❖ Office: 52-208



# Objectives of today's lecture

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- ❑ Understand Materials Classification
- ❑ Understand fundamental 'Material Properties'
- ❑ Understand Material Selection Process

\* Metallic materials are primarily discussed

\*\* The structures may be in various scales (micro, nano, ...)



# Materials Science and Engineering

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## □ Engineering (공학이란?)

- The branch of science and technology concerned with the design, building, and use of engines, machines, and structures.

## □ Materials Science (재료과학)

- Study the relationships between the structures and properties of materials.
- Structure exist in various scales (nano-, micro-, macro)

## □ Materials Engineering (재료공학)

- Design/engineer the structure that meets the set of desired properties.
- Create new products using existing materials / develop technique for processing materials



# History of human tied to history of materials

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돌, 노끈, 나무



청동: 구리+주석



Cast Iron + 목재

\*화순 대곡리 청동기 일괄, 국보 제 143호



# Materials for engineered devices/tools

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## Raw materials in nature



## Materials Science?

- New materials?
- Understand what determines a material property
- Develop a way to 'improve' it using the knowledges



# Materials for engineered devices/tools

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- Raw materials in nature. Engineered materials
- Engineering devices / products are usually consisting of various components
  - Cars made of metals, polymers ...
  - Mobile phones?
  - Even hammers?
  - Combinations of various materials (why?)
- Engineered Materials constitute the world
  - Vehicles, Aircrafts (transportation)
  - Mobile devices (communication)
  - Bridges/Buildings (Infrastructure)



# Raise your mobile device and tell me what materials you see

- Ceramics
- Metals
- Polymers
- Composites
- Advanced materials
  - Semiconductor
  - Biomaterials
  - Smart materials
  - Nanoengineered materials

## ELEMENTS OF A SMARTPHONE

ELEMENTS COLOUR KEY: ● ALKALI METAL ● ALKALINE EARTH METAL ● TRANSITION METAL ● GROUP 13 ● GROUP 14 ● GROUP 15 ● GROUP 16 ● HALOGEN ● LANTHANIDE

### SCREEN



### BATTERY

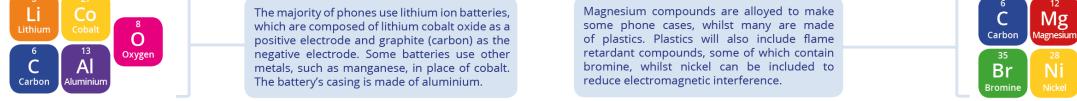
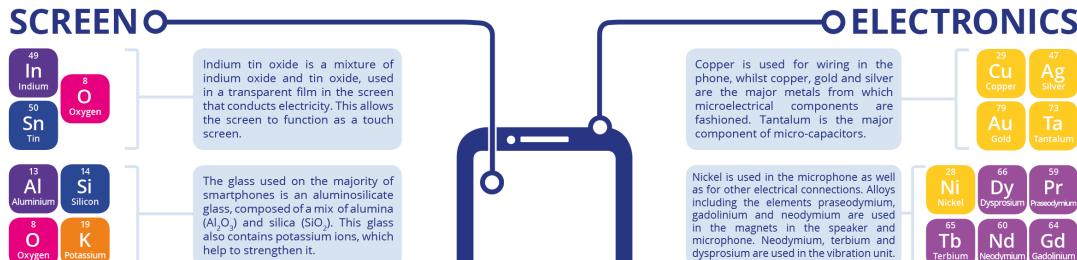


Inium tin oxide is a mixture of indium oxide and tin oxide, used in a transparent film in the screen that conducts electricity. This allows the screen to function as a touch screen.

The glass used on the majority of smartphones is an aluminosilicate glass, composed of a mix of alumina ( $Al_2O_3$ ) and silica ( $SiO_2$ ). This glass also contains potassium ions, which help to strengthen it.

A variety of Rare Earth Element compounds are used in small quantities to produce the colours in the smartphone's screen. Some compounds are also used to reduce UV light penetration into the phone.

### ELECTRONICS



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Image from  
<http://www.compoundchem.com/2014/02/19/the-chemical-elements-of-a-smartphone/>



# Elements

Explore the chemical elements through this periodic table

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period	1 H 1.008		3 Li 6.94	4 Be 9.0122									5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180	
			11 Na 22.990	12 Mg 24.305									13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948	
4	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798	
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.96	[97.91]	43 Tc 101.07	44 Ru 102.91	45 Rh 106.42	46 Pd 107.87	47 Ag 112.41	48 Cd 114.82	49 In 118.71	50 Sn 121.76	51 Sb 127.60	52 Te 126.90	53 I 131.29	
6	55 Cs 132.91	56 Ba 137.33	*	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	[208.98]	[209.99]	[222.02]
7	87 Fr [223.02]	88 Ra [226.03]	**	103 Lr [262.11]	104 Rf [265.12]	105 Db [268.13]	106 Sg [271.13]	107 Bh [270]	108 Hs [277.15]	109 Mt [276.15]	110 Ds [281.16]	111 Rg [280.16]	112 Cn [285.17]	113 Nh [284.18]	114 Fl [289.19]	115 Mc [288.19]	116 Lv [293]	117 Ts [294]	118 Og [294]

*Lanthanoids	*	57 La 136.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [144.91]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05
**Actinoids	**	89 Ac [227.03]	90 Th 232.04	91 Pa 231.04	92 U 238.03	[237.05]	[244.08]	[243.06]	[247.07]	[247.07]	[251.08]	[252.08]	[257.10]	[258.10]	[259.10]



# Cases of material failures

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How to prevent material Failure?

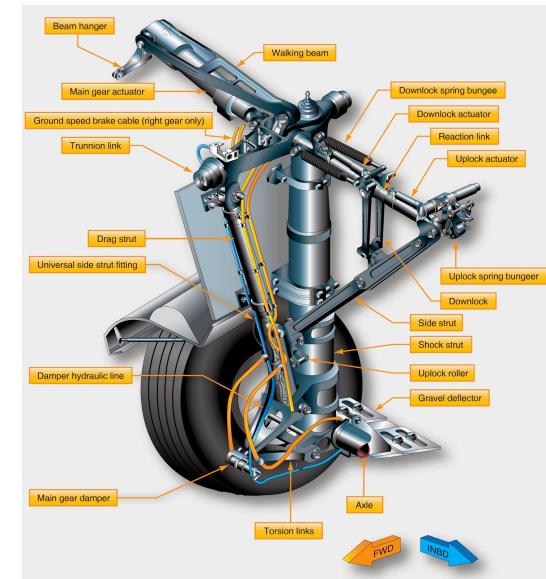


# Example 1: Landing gear

Materials used for aircrafts usually are lightweight metals (aluminum alloys are most widely adapted).

However, a large portion of a landing gear is made of steel alloys. Steel alloy is a lot heavier than aluminum alloy.

Then, why do the aircraft manufacturers decide to use 'steel' rather than aluminum?



# Example 2: Housing for mobile devices

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# Example 3: Car-body?



# Example 4: beverage container

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The role of container? (Questions)

Advantages and Disadvantages? (Questions)



# Materials “Science” and Materials “Engineering”

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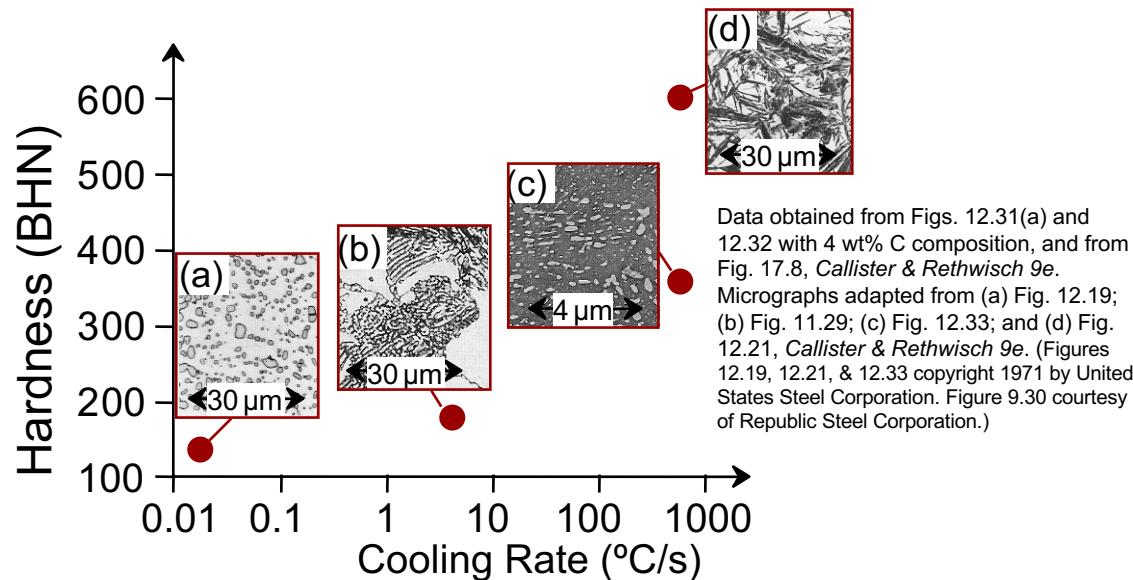


**Figure 1.1** The four components of the discipline of materials science and engineering and their interrelationship.



# Example: Mechanical (microstructure)

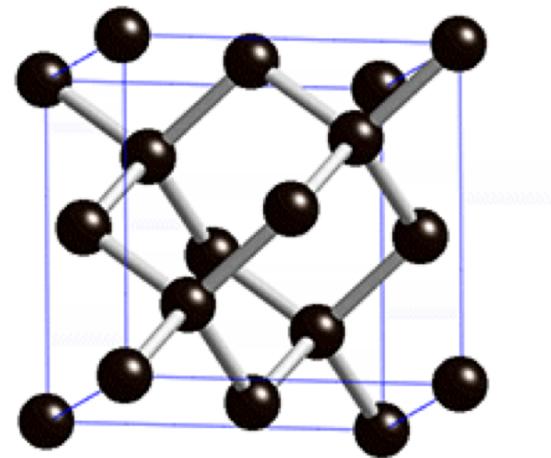
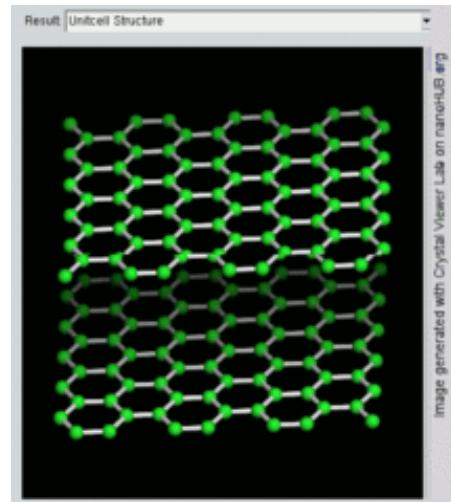
- Properties depend on structure  
ex: hardness vs structure of steel



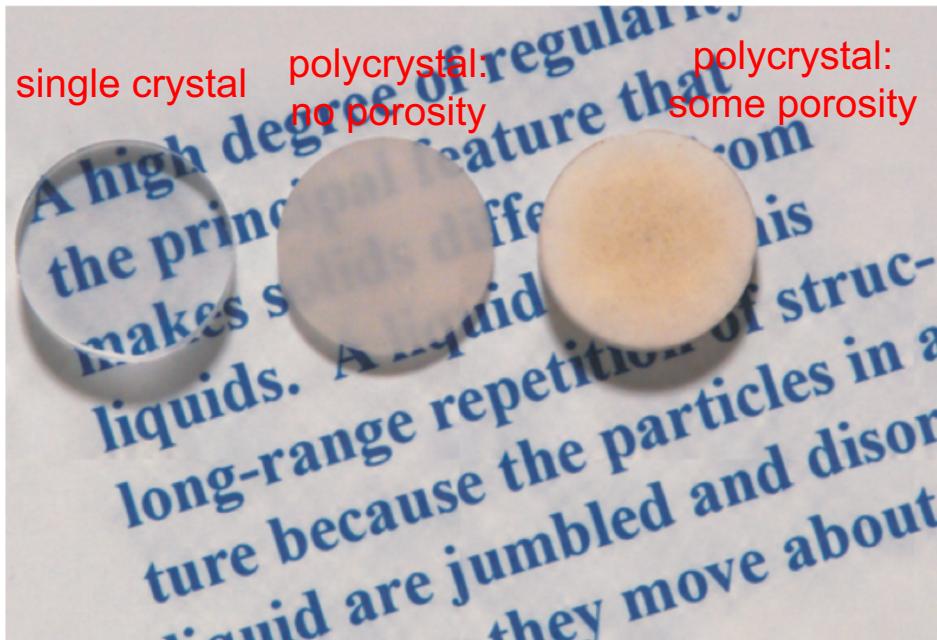
- Processing can change structure  
ex: structure vs cooling rate of steel



# Example: Mechanical (crystal structure)



# Examples: Optical



Same crystal structure but different microstructure (porosity)

## Aluminum Oxide



**Figure 1.1** The four components of the discipline of materials science and engineering and their interrelationship.



# Examples: Electrical

- Electrical Resistivity of Copper:

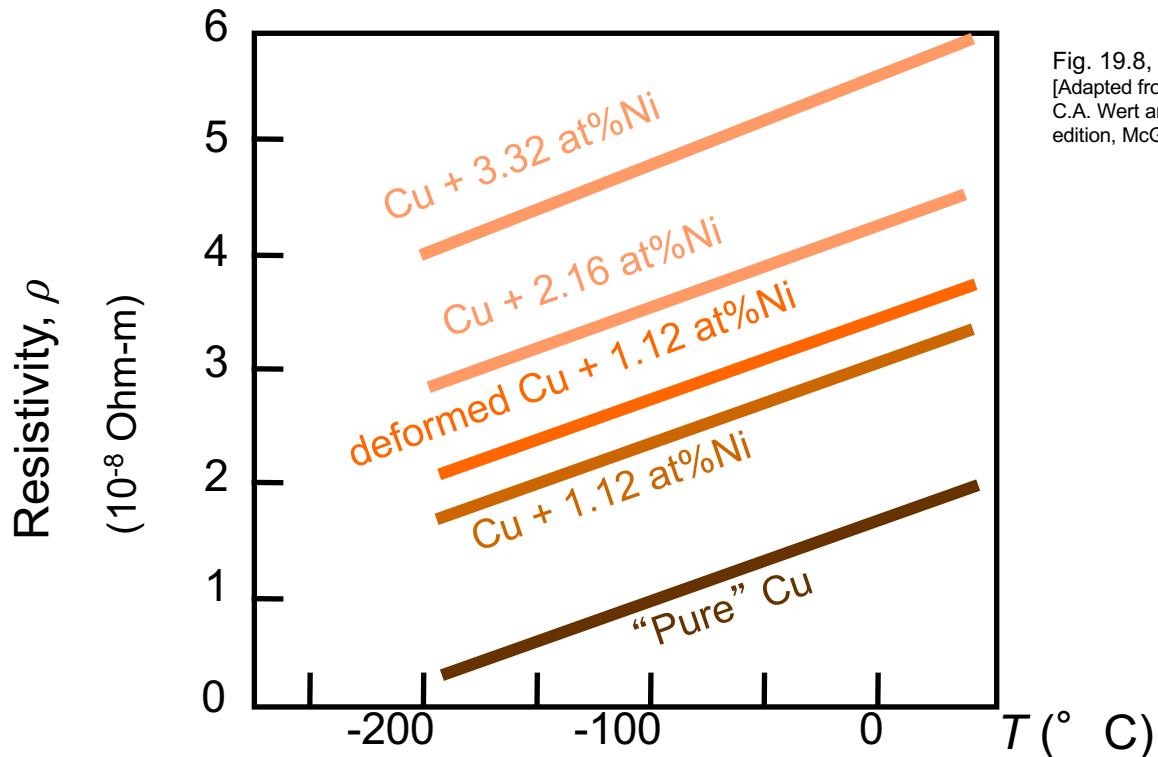


Fig. 19.8, Callister & Rethwisch 9e.  
[Adapted from: J.O. Linde, *Ann Physik* 5, 219 (1932); and  
C.A. Wert and R.M. Thomson, *Physics of Solids*, 2nd  
edition, McGraw-Hill Company, New York, 1970.]

- Adding “**impurity**” atoms to Cu increases **resistivity**.
- Deforming Cu increases **resistivity**.



# DETERIORATIVE

- Stress & Saltwater...  
-- causes cracks!

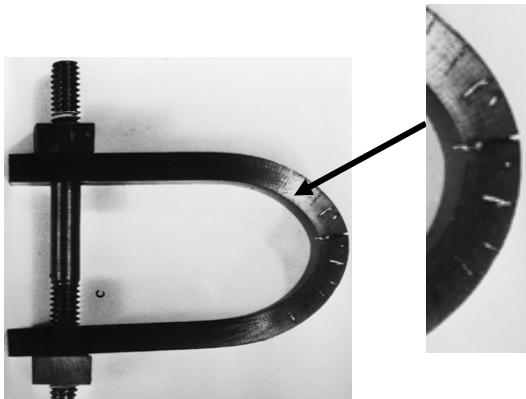
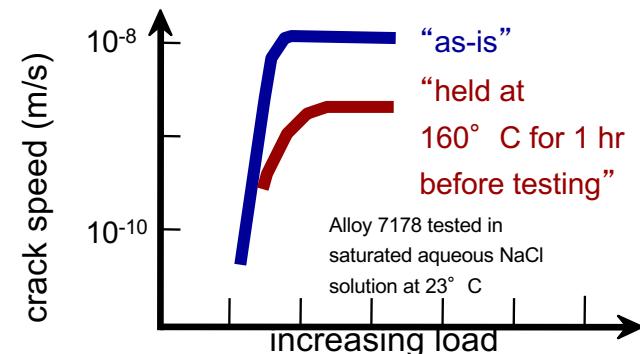


Fig. 18.21, Callister & Rethwisch 9e.  
(from *Marine Corrosion, Causes, and Prevention*,  
John Wiley and Sons, Inc., 1975.)

- Heat treatment: slows crack speed in salt water!



Adapted from Fig. 11.20(b), R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials" (4th ed.), p. 505, John Wiley and Sons, 1996. (Original source: Markus O. Speidel, Brown Boveri Co.)



# What would be your future role?

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❑ Imagine that you are a team member working in a mobile phone manufacturing company. Your mission, as a senior material engineer, is to correctly choose materials used in a new mobile phone is targeted to launch in year 2019.

- What factors should be considered?
- Certain performance guidelines?
- You are expected know what materials are available from the material suppliers

❑ Materials Classifications

- Metals
- Ceramics
- Polymers
- New materials?



# Types of Materials

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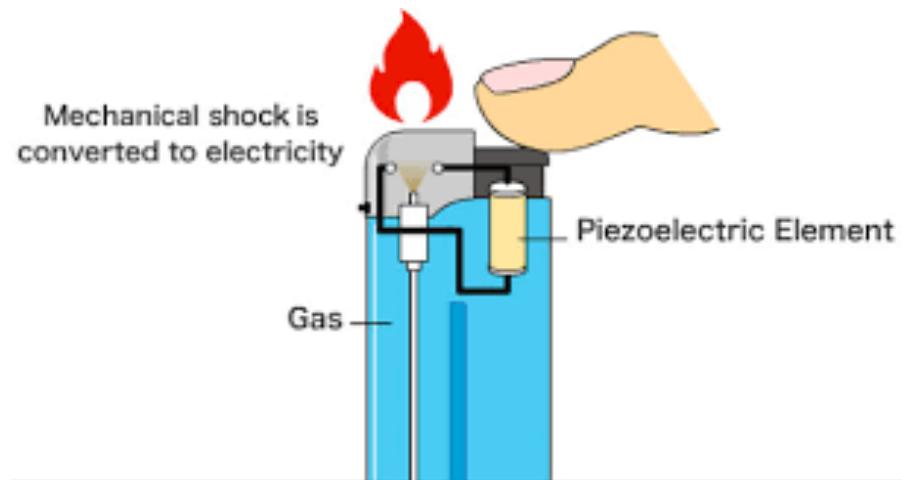
- **Metals:**
  - Strong, ductile
  - High thermal & electrical conductivity
  - Opaque, reflective.
- **Polymers/plastics:** Covalent bonding → sharing of electrons
  - Soft, ductile, low strength, low density
  - Thermal & electrical insulators
  - Optically translucent or transparent.
- **Ceramics:** ionic bonding (refractory) – compounds of metallic & non-metallic elements (oxides, carbides, nitrides, sulfides)
  - Brittle, glassy, elastic
  - Non-conducting (insulators)



# What is a material property?

- ❑ Strength?
- ❑ Density?
- ❑ Electric/thermal conductivity
- ❑ This also gives a way to measure the specific material prop
- ❑ Example: 밀도와 무게의 차이

Stimuli and response



# What properties matter?

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- Mechanical
- Electro-magnetism
- Chemical



# Reading Assignment

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- ❑ Chapter 1 of the text book.

