Chapter 1 GI Answers

1.1 First Law of Thermodynamics

1.1.1 cold gas is 50° C, hot gas is 100° C
1.1.2 cold gas is 70° C, hot gas is 80.14° C
1.1.3 from hot gas to cold gas
1.1.4 for cold gas, initial energy is $6.7\text{x}10^{-21}$ J; final energy is $7.1\text{x}10^{-21}$ J
1.1.5 for hot gas, initial energy is $7.7\text{x}10^{-21}$ J; final energy is $7.3\text{x}10^{-21}$ J
1.1.6 energy change of hot gas is $-4\text{x}10^{-22}$ J; energy change of cold gas is $+4\text{x}10^{-22}$ J
1.1.7 $4\text{x}10^{-22}$ J of energy was transferred.
1.1.8 The total energy change of the system is zero.
1.1.9 ΔE(cold gas) = -ΔE(hot gas)
1.1.10 2 kg
1.1.11 The paddles will spin.
1.1.12 0.98 J
1.1.13 0.98 J
1.1.14 It originally came from the loss in potential energy of the mass, which was transferred to the paddles, which in turn transferred it to the water.
1.1.15 0.98 J
1.1.16 ΔE(water)=w(mass); w = work done by the mass
1.1.17 0.98 J + 1.2 J = 2.18 J
1.1.18 ΔE(water) = w(mass) + h(brick); h = heat transferred from brick
1.1.19 Energy is conserved.

1.2.1 In Class 1 the instructor is responsible; in Class 2 the students are responsible.
1.2.2 Class 2.
1.2.3 There may be a variety of answers for this. Most likely it will be like Class 1.
1.2.4 They will likely answer Class 2. Section 1.1 was set up to be conducted in groups with the students figuring out the 1st Law of Thermodynamics themselves without it being defined by the instructor.
1.2.5 You will get a variety of answers. The answers to this question provide an opportunity to discuss the teaching philosophy for this class.
1.2.6 You will get a variety of answers. The answers to this question provide an opportunity to discuss the teaching philosophy for this class.
1.2.7 You will get a variety of answers. The answers to this question provide an opportunity to discuss the teaching philosophy for this class.

Chapter 2 GI Answers

2.1 Types of Materials

2.1.1 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about the different types of materials. Possible answers include:

Metal: steel, aluminum, iron, etc.
Polymer: polyethylene, polypropylene, polystyrene, etc.
Ceramic: glass, diamond, etc.

Note that they also may provide answers that are applications, rather than types of materials, e.g. a soda can for a metal, milk jug for polymer, etc.

2.1.2 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about how the different types of materials differ. Possible answers include:

Metal: strong, electrically conductive, stiff, shiny.
Polymer: light, flexible, easily molded, electrical insulator, thermal insulator.
Ceramic: transparent (some of them), electrical insulator, thermal insulator, strong, stiff.

2.1.3 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about how different properties affect possible uses. Possible answers include:

Metals: airplanes, bridges, electrical wires.
Polymers: packaging, beverage containers, toys.
Ceramics: high temperature electrical insulators, containers for hot beverages, other thermal insulators.

2.1.4 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about how different applications require different properties. Possible answers include: strong, stiff, cheap, corrosion resistant.

2.1.5 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about how different applications require different properties. Possible answers include: strong, stiff, biocompatible.

2.1.6 There are many possible answers. The point of this question is not for the students to get a correct answer, but to get them thinking about how different applications require different properties. Possible answers include: electrically conductive, thermally resistant, shock resistant.

2.1.7 airplane wing: metal; soda bottle: polymer; spark plug: ceramic

2.1.8 airplane wing: structural; soda bottle: structural; spark plug: electronic

2.1.9 There are many possible answers. Possible answers include:

Airplane wing: strong, stiff, fracture resistant.
Soda bottle: light weight, good gas barrier, cheap, easily molded.
Spark plug insulator: electrical insulator, high melting temperature, thermal resistance.

2.1.10 There are many possible answers: Electronic Materials Age, Semiconductor Age, Green Materials Age, etc.

2.2 The MSE Triangle

2.2.1 Experiment 1: No processing involved.

Experiment 2: Heat to 740° C, cool rapidly to room temperature.

Experiment 3: Heat to 740° C, cool rapidly to room temperature, heat to 300° C, cool to room temperature.

2.2.2 Experiment 1: It can be bent without breaking.

Experiment 2: Before the experiment it can be bent without breaking; after it breaks easily when bent.

Experiment 3: Before the experiment it can be bent without breaking; after it can also be bent without breaking.

2.2.3 99 wt% Fe, 1 wt% C

2.2.4 It is the same, because you never heated it above the boiling temperature, or even the melting temperature.

2.2.5 Something changed about the way the atoms were arranged or bonded together. This change was caused by the high temperature.

Chapter 3 GI Answers

3.1 Electronegativity

3.1.1 2.5
3.1.2 0.9
3.1.3 fluorine
3.1.4 cesium or francium
3.1.5 Electronegativity increases as you move up and to the right.
3.1.6 chlorine
3.1.7 chlorine
3.1.8 No they are not the same. The electrons are more equally distributed in the carbon-chlorine bond, but still closer to the chlorine. For the sodium-chlorine bond the electrons are mostly localized at the chlorine atom.
3.1.9 They are distributed equally between the two atoms.

3.2 Primary Bonds

3.2.1 ionic
3.2.2 one with low electronegativity and one with high electronegativity
3.2.3 covalent
3.2.4 both types of atoms are high electronegativity
3.2.5 metallic
3.2.6 low electronegativity
3.2.7 A pair of atoms, one with low electronegativity and one with high electronegativity.
3.2.8 A pair of atoms with high electronegativity.
3.2.9 Atoms with low electronegativity.
3.2.10 Low average electronegativity.
3.2.11 High average electronegativity.
3.2.12 High difference.
3.2.13 Small difference.
3.2.14 There are 7 compounds on the line. The calculations for all 7 are:
AsH_3: $\Delta EN = 0.1$; ionic character = 0.25%
ZnS: $\Delta EN = 0.9$; ionic character = 18%
$AlCl_3$: $\Delta EN = 1.5$; ionic character = 57%
AlN: $\Delta EN = 1.5$; ionic character = 57%
Be_3N_2: $\Delta EN = 1.5$; ionic character = 57%
ZnO: $\Delta EN = 1.9$; ionic character = 59%
BeO: $\Delta EN = 2$; ionic character = 63%
3.2.16 No, there is no single value for either electronegativity difference or ionic character that defines the boundary.
3.2.15 Clearly you can't use either the difference in electronegativity or the ionic character, because there is no consistent number to define the boundary between ionic and covalent. The way to do it is to use the bond type triangle: calculate the average electronegativity and electronegativity difference, and then see where that falls on the triangle.