Winter Holiday Homework - Answers

25

Chapter 10:

7. Temperature is a measure of the average kinetic energy of a system.
+1 Heat is the form of energy transferred between two systems at different temperature
Heat flows from systems at higher temperatures to systems at lower temperatures.

8. Burning is the result of a ~~transfer~~ of heat to human skin. Since the temperature of hot tea (a little less than 80 °C) is higher than the temperature of human
+1 skin (about 37 °C), heat is transferred ~~from~~ the hot tea to the skin, causing it to burn. In contrast, iced tea (about 0 °C) has a lower temperature than human skin, so heat is ~~transferred~~ to the cold tea NOT to the skin, so the skin does not burn.

9. The thermal energy of an object represents the kinetic energy of the
+1 microscopic particles consituting the object. This includes kinetic energy of molecules freely translating, vibrating, or rotating in random motion.

10. The thermal energy of a system is directly proportional to its temperature.
+1 The higher the thermal energy of a system, the higher its temperature.

31. Heat transferred = (mass of sample) × (specific heat of sample) × (change in temperatur

+1 $q = mS\Delta T$

$$S = \frac{q}{m\Delta T} = \frac{69.5 \times 10^3\ J}{(1012\ g)(11.40\ ^\circ C)} = 0.00602 \times 10^3 = 6.02\ J/g\,^\circ C$$

33. $q = mS\Delta T$

+1 $$m = \frac{q}{S\Delta T} = \frac{0.595 \times 10^3\ J}{(0.45\ J/g\,^\circ C)(45\ ^\circ C - 25\ ^\circ C)} = 66.11\ g\ Fe$$

↓ from table 10.1

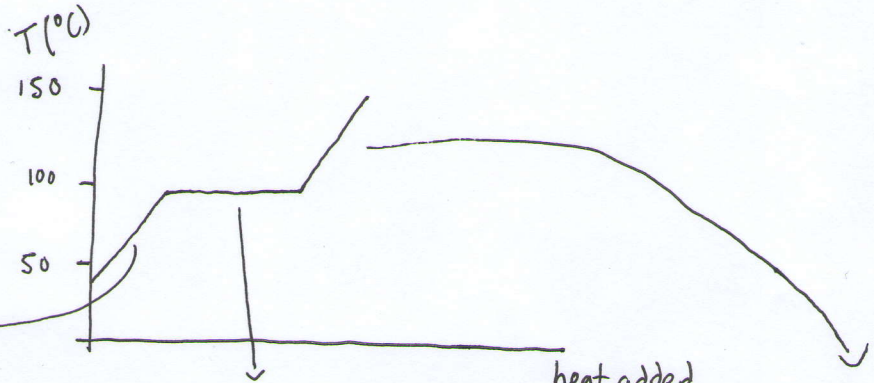
35. $q = mS\Delta T$

+1 $q = (55\ g)(0.13\ J/g\,^\circ C)(45\ ^\circ C - 20\ ^\circ C) = 180.375\ J$

Chapter 14:

5.

+3

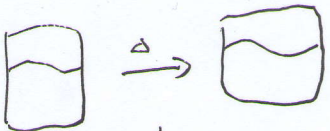


Heating Water

Microscopic:

Water molecules move faster, increasing kinetic energy.

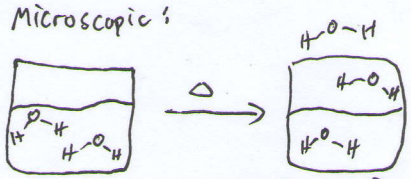
Macroscopic:



No visible change.

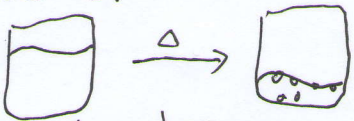
Boiling

Microscopic:



Gas molecules escape from surface of liquid.

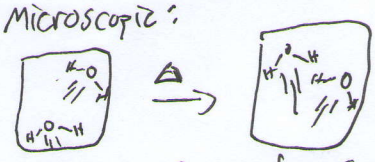
Macroscopic:



Liquid volume decreases as it evaporates. Bubbles form.

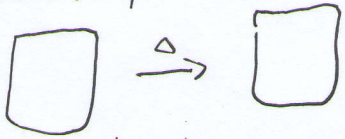
Heating Gas

Microscopic:



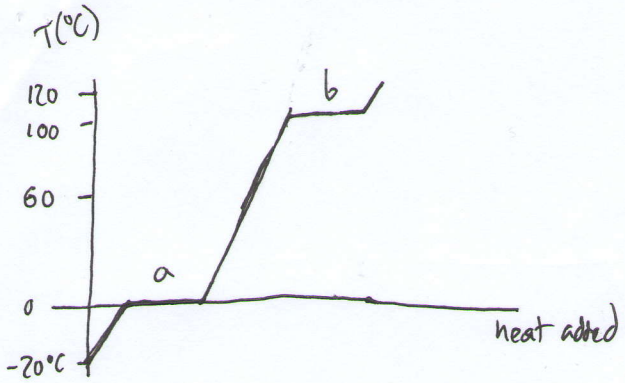
Kinetic energy (speed) of gas molecules increases.

Macroscopic:



No visible change.

6. +1

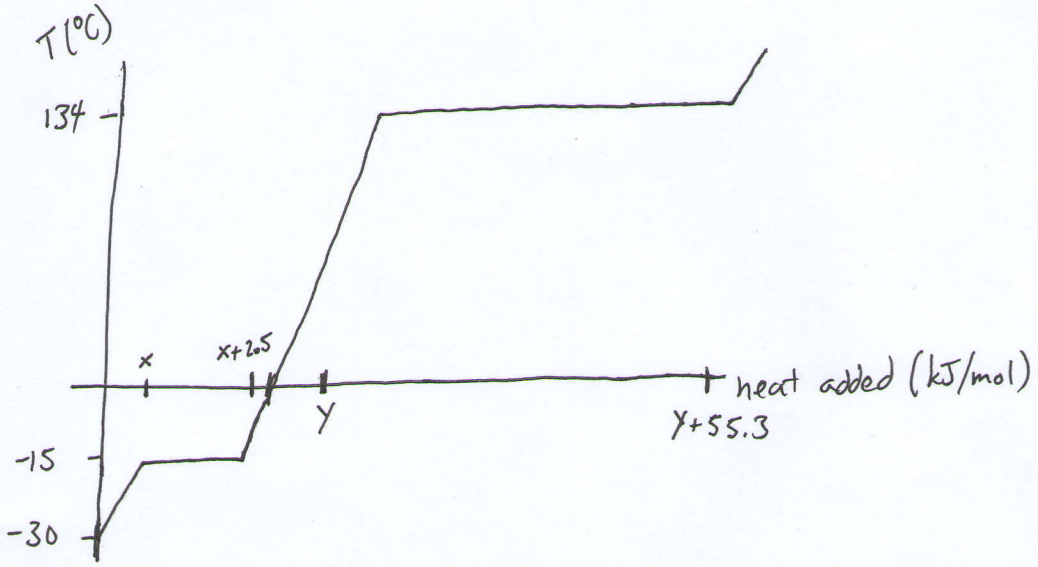


a) melting of solid

b) boiling of liquid

12. +2 The energy required to melt 1 mole of a solid substance is called the substance's molar heat of fusion. The energy required to convert 1 mole of a liquid substance to the gaseous state is called the substance's molar heat of vaporization.

13. +2



* Note: to find x and y, we need to know the specific heat and molar mass of the sample. Convince yourself this is true. *

16. $\Delta H_{fusion} = 6.02\ kJ/mol$; $\Delta H_{vap} = 40.6\ kJ/mol$; $s(H_2O_\ell) = 4.18\ J/g°C$

+3 To melt 25.0 g of ice at 0°C, heat needed is...

$$q = n\Delta H_{fus} = \left(25.0\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.0158\ g\ H_2O}\right)\left(6.02\ \frac{kJ}{mol\ H_2O}\right) = 8.35\ kJ$$

To vaporize 37.5 g of liquid water at 100°C, heat needed is...

$$q = n\Delta H_{vap} = \left(37.5\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.0158\ g\ H_2O}\right)\left(40.6\ \frac{kJ}{mol\ H_2O}\right) = 84.51\ kJ$$

To warm 55.2 g of liquid water from 0°C to 100°C, heat needed is...

$$q = ms\Delta T = (55.2\ g)(4.18\ J/g°C)(100°C - 0°C) = 23.07\ kJ$$

* Note: for change of phase, calculate heat using $q = n\Delta H$.
for heating/cooling, calculate heat using $q = ms\Delta T$.

17. $s(H_2O_s) = 2.06\ J/g°C$; $s(H_2O_g) = 2.03\ J/g°C$

+2 Heat evolved when 10 g of steam at 200°C is condensed, cooled, and frozen to ice at -50°C given by...

$$q_{total} = q_{cool\ gas} + q_{condense\ gas} + q_{cool\ water}^{liquid} + q_{freeze\ water}^{liquid} + q_{cool\ ice}$$

$$= ms_{gas}\Delta T + n\Delta H_{vap} + ms_{liquid}\Delta T + n\Delta H_{fus} + ms_{ice}\Delta T$$

$$= \underbrace{(10_g)(2.03\ J/g°C)(200°C - 100°C)}_{\text{cool gas}} + \underbrace{\left(\frac{10\ g}{18\ g/mol}\right)(40.6\times10^3\ J/mol)}_{\text{condense gas to liquid}} + \underbrace{(10_g)(4.18\ J/g°C)(100°C - 0°C)}_{\text{cool liquid}}$$

$$+ \underbrace{\left(\frac{10\ g}{18\ g/mol}\right)(6.02\times10^3\ J/mol)}_{\text{freeze liquid to ice}} + \underbrace{(10_g)(2.06\ J/g°C)(-50°C - (-50)°C)}_{\text{cool ice}}$$

$$= 2030\ J + 22555.56\ J + 4180\ J + 3344.44\ J + 1030\ J$$

$$= 33140\ J$$

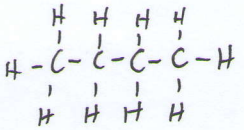
$$= 33.14\ kJ \text{ total heat evolved}$$

* Note: heats of phase change are usually much higher than heats of cooling/heating. *

35. The more volatile a substance, the higher the vapor pressure of that substance. The higher the vapor pressure, the more molecules of gas exist above a liquid of a substance. The more molecules of gas, the easier it is for molecules in the liquid to separate from each other. The easier molecules can separate, the weaker the intermolecular forces in a substance.

+3

a) $C_4H_{10}(\ell)$ vs $H_2O(\ell)$



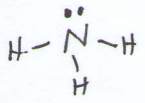
LDF

LDF, DD, HB

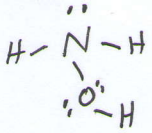
$\Rightarrow$ H_2O has greater IMFs

H_2O is less volatile

b) $NH_3(\ell)$ vs $NH_2OH(\ell)$



LDF, DD, HB



LDF, DD, HB

Same IMF's

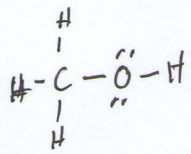
$\Rightarrow$ NH_2OH has greater IMFs

NH_2OH is less volatile.

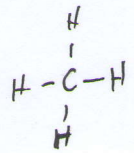
Total e^-: 8 (14) Higher LDF

H-Bonding: $\Delta EN(N-H)$ > $\Delta EN\ (O-H)$ Higher H-bonding

c) $CH_3OH(\ell)$ vs $CH_4(\ell)$



LDF, DD, HB



LDF

$\Rightarrow$ CH_3OH has greater IMFs

CH_3OH has lower volatility.