Chemistry 534

Name: Answer Key

+HE endo

S → L → G

All Questions 4 Marks Each

1 Name the following compounds:

A) N_2S_5 C — dinitrogen pentasulfide

B) Mg_3N_2 I — magnesium nitride

C) Cu_2CO_3 I TM — copper (I) carbonate

D) NH_4OH I — ammonium hydroxide

↑ "gR IA"

2 Indicate the formulae for the following:

A) sodium phosphate — $Na_3^{+}PO_4^{3-}$

B) aluminum acetate — $Al^{3+}(CH_3COO)_3^{-}$ OR $Al(C_2H_3O_2)_3$

C) nickel (III) sulfate — $Ni_2^{3+}(SO_4)_3^{2-}$

D) OF_2 — oxygen difluoride

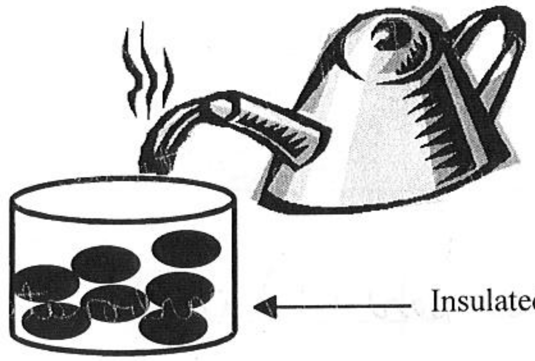
3 Indicate how the following compounds split up in water:

A) Fe_2S_3 → $2Fe^{2+}_{(aq)} + 3S^{2-}_{(aq)}$

B) $Ca(ClO_4)_2$ → $Ca^{2+}_{(aq)} + 2ClO_4^{-}{}_{(aq)}$

4

During a hot stone massage, smooth pieces of black volcanic rock that absorb and retain heat well are used to relax and prepare muscles for deep tissue treatments. The stones, stored at a room temperature of 21.0°C, must be sanitized and brought to the ideal temperature of 63.0°C by pouring boiling water at 100.0°C over them. Each treatment requires 3.0 kg of stones. The specific heat capacity of the stones is 0.84 J/g°C.



What volume of boiling water must be prepared? Not T_f ∴ not T_f formula!

(Assume complete heat transfer between the water and the stones.)

H water	C stone
$m_H = ?$	$m_C = 3.0\,kg$
$C_H = 4.19\,\frac{J}{g \cdot C}$	$C_C = 0.84\,\frac{J}{g \cdot C}$
$T_H = 100.0°C$	$T_C = 21.0°C$

$T_f = 63.0°C$

$-Q = +Q$

$-m_H C_H \Delta T_H = m_C C_C \Delta T_C$

$$m_H = \frac{-(3.0\,kg \times \frac{1000\,g}{1\,kg})(\frac{0.84\,J}{g \cdot C})(63.0°C - 21.0°C)}{(\frac{4.19\,J}{g \cdot C})(63.0°C - 100.0°C)}$$

$m_H = 680\,g$ $\qquad \frac{1}{\frac{1}{g}} = g$

Answer: $680\,g$ of water $\times \frac{1\,mL}{1\,g} = 680\,mL\ H_2O$

5 Four processes are shown below.

KE on left

(1.) Sunlight + 6 $CO_{2(g)}$ + 6 $H_2O_{(l)}$ → $C_6H_{12}O_{6(aq)}$ + 6 $O_{2(g)}$

2. $NaOH_{(s)}$ → $Na^+_{(aq)}$ + $OH^-_{(aq)}$ exo = B in H_2O

3. $CH_{4(g)}$ + 2 $O_{2(g)}$ → $CO_{2(g)}$ + 2 $H_2O_{(g)}$ exo = combustion

(4.) $H_2O_{(l)}$ → $H_2O_{(g)}$ L → G = endo

Which of these processes are endothermic?

A) 1 and 3

(C)) 1 and 4

B) 2 and 3

D) 2 and 4

6 You have set up a lemonade stand on your street. After a few hours, a customer complained that his lemonade was too warm. You took the temperature of the remaining 250.0 mL and agreed that lemonade at 24.0°C was indeed unpleasant to drink. Instead of throwing the lemonade out, you simply added 2.0 L of fresh lemonade from the fridge at 4.0 °C.

What was the final temperature of the lemonade?

(Assume the density and specific heat capacity of lemonade are the same as water.)

$$T_f = \frac{m_H T_H + m_C T_C}{m_H + m_C}$$

1 g H_2O = 1 mL H_2O

H	C
$m_H = 250.0$ "mL"	$m_C = 2.0$ "L"
~~$C_H = 4.19$ J/g·°C~~	~~$C_C = 4.19$ J/g·°C~~
$T_H = 24.0°C$	$T_C = 4.0°C$

$T_f = ?$

$$= \frac{(250.0g)(24.0°C) + (2\bar{0}00g)(4.0°C)}{(250.0g + 2\bar{0}00g)}$$

$$= \frac{14\,000\ g°C}{2250g}$$

$T_f = 6.2°C$

Answer: 6.2 °C

7 Everyday phenomena take place all around us.

Which of the following may be identified as exothermic processes?

1. Dew forming on blades of grass
2. Melting snow and ice on a driveway by adding salt
3. Drying a wet T-shirt on a clothesline
4. Freezing meat to preserve it
5. Burning propane gas in a stove

A) 2 and 3

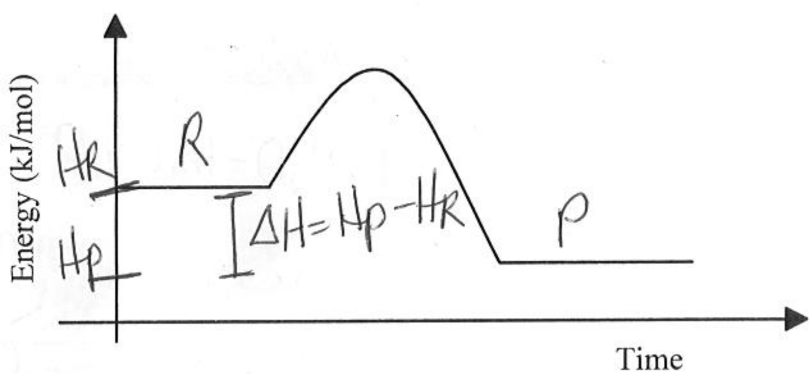
B) 4 and 5

C) 1, 2 and 3

D) 1, 4 and 5

8 The enthalpy diagram below shows the energy involved in the formation of $CO_{2(g)}$.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$$



Once the reaction above has been initiated, which of the following statements is true?

A) The formation of $CO_{2(g)}$ constitutes an endothermic reaction.

B) The formation of $CO_{2(g)}$ does not result in energy from the system being transferred into the surroundings.

C) The formation of $CO_{2(g)}$ results in energy from the system being transferred into the surroundings.

D) In the formation of $CO_{2(g)}$ the enthalpy of the products will be greater than the enthalpy of the reactants.

9 Ethanol, the active ingredient in wine or beer, can be used as a fuel in the following manner:

$$1\ C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g) + 1428\ kJ$$

exo

obey mole ratio

If 6.00 g of oxygen gas reacted, how much heat energy was available?

doesn't tell you − or +!

$$\Delta H = \frac{-1428\ kJ}{3\ mol\ O_2}$$

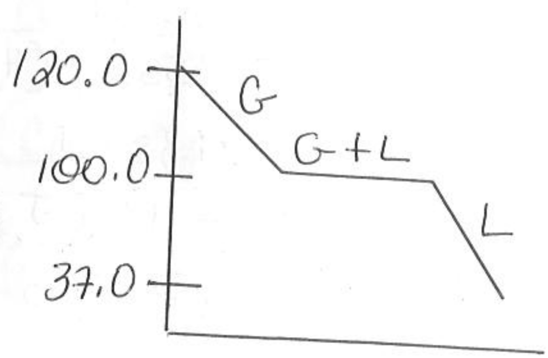
$$6.00g\ O_2 \times \frac{1\ mol\ O_2}{32g\ O_2} \times \frac{-1428\ kJ}{3\ mol\ O_2} = 89.3\ kJ$$

Answer: −89.3 kJ

10 0.12 L of water vapour are cooled from 120.0 °C to 37.0 °C.

$$0.12L \times \frac{1000mL}{1L} \times \frac{1g}{1mL} = 120g$$

How much heat energy was involved?



1) $Q = mc\Delta T$

$= 120g\left(1.996 \frac{J}{g \cdot C}\right)(100.0°C - 120.0°C)$

$= -4790J$

2) $Q = n\Delta H = (120g)\left(\frac{1mol}{18g}\right)\left(\frac{-40.8kJ}{1mol}\right)$

$= -272\ kJ \times \frac{1000J}{1kJ} = 272\ 000\ J$

3) $Q = mc\Delta T$

$= (120g)\left(4.19 \frac{J}{g \cdot C}\right)(37.0°C - 100.0°C) \cong 31700J$

Answer: 310 000J

$(3.1 \times 10^5 J)$

$(3.1 \times 10^2 kJ)$

$Q_T = (-4790J)$
$+ (-272000J)$
$+ (-31700J)$

$-310\ 000J$

11 In order to determine how much heat is released during the combustion of candle wax, $C_{25}H_{52}$, a burning candle is used to heat some water in a metal can that serves as a calorimeter.

The following data is obtained:

Volume of water heated	355.0 mL
Initial mass of candle	136.0 g
Final mass of candle	112.0 g
Initial temperature of the water	15.4°C
Final temperature of the water	23.0°C

$\times \frac{1g}{1mL} = 355.0g$

$\times \frac{1mol}{3} = 0.3182mol$

$\Delta T = T_f - T_i$
$= 23.0°C - 15.4°C$
$\Delta T = 7.6°C$

Calculate the molar heat of combustion of the candle wax.

i) $Q_{water} = mc\Delta T$
$= (355.0g)(4.19 \frac{J}{g \cdot C})(7.6°C)$
$= 11300 J$

ii) $Q_{sub} = -11300J$

iii) $n_{sub} = 0.3182mo$

iv) $\Delta H = \frac{Q}{n} = \frac{-11300J}{0.3182 mol}$
$= -36 \frac{kJ}{mol}$

Answer: $-36 \frac{kJ}{mol\ wax}$

12 Compare and contrast the Bucket of 50 °C water vs the Cup of T at 100 °C. **Use point form.**

- 50°C = slow moving particles / 100°C = fast moving
- bucket = large # particles / cup = small # particles
- bucket has more HE than the cup
- HE depends on speed of particles + # of particles +

4 lines means 4 lines!! STOP now!

(specific heat capacity = type of material)