Name: _____ Pd____

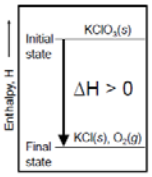
CHAPTER 4 – 5 PRACTICE QUIZ (Sections 4.5 – 4.6 & 5.1 – 5.4)

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

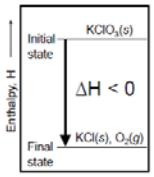
←Linked at 12:36

13. When solid potassium chlorate is heated in the presence of a catalyst, potassium chloride and oxygen gas are formed. Which of the following potential energy diagrams best illustrates this chemical reaction, including the change in enthalpy, ΔH?

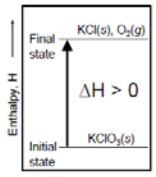
(A)



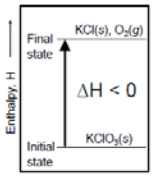
(B)



(C)



(D)



$$N_2(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g) \qquad \Delta H = -92.4\ kJ$$

14. The synthesis of ammonia is illustrated by the thermochemical equation shown above. Which of the following calculations is set up correctly to determine the mass of ammonia produced when 875 J of heat is released in this reaction?

(A) $\dfrac{(875)(92.4)(17.034)}{(1000)(2)}$

(B) $\dfrac{(875)(2)(17.034)}{(1000)(92.4)}$

(C) $\dfrac{(875)(1000)(92.4)(17.034)}{(2)}$

(D) $\dfrac{(875)(1000)(2)(17.034)}{(92.4)}$

$$Mg^{2+}(aq) + SO_4^{2-}(aq) \rightarrow MgSO_4(s) \qquad \Delta H = +96\ kJ$$

16. Use the information given in the thermochemical equation shown above to help you choose the best answer to the following question. What will happen when solid $MgSO_4$ is dissolved completely in water at 25°C?

(A) Heat will be absorbed by the system and the temperature of the water will increase.

(B) Heat will be released by the system and the temperature of the water will increase.

(C) Heat will be absorbed by the system and the temperature of the water will decrease.

(D) Heat will be released by the system and the temperature of the water will decrease.

CHAPTER 4 – 5 PRACTICE QUIZ (Sections 4.5 – 4.6 & 5.1 – 5.4)

FREE RESPONSE – CALCULATOR IS ALLOWED

←Linked at 21:36

2. A chemistry teacher needs to prepare a hydrochloric acid solution for a lab experiment.

(a) Calculate the volume of 6.0 *M* hydrochloric acid solution that is needed to prepare 500. mL of a 0.10 *M* hydrochloric acid solution. Show the setup for your calculations below. Round off your final answer to the proper number of significant figures.

(b) The experiment that was performed in the lab involved the addition of 50. mL of 0.10 *M* hydrochloric acid to 50. mL of 0.10 *M* sodium hydroxide. The temperature of the solution increased immediately after the two solutions were combined.

(i) The reaction between hydrochloric acid and sodium hydroxide should be classified as

(endothermic exothermic) because heat was (absorbed released)

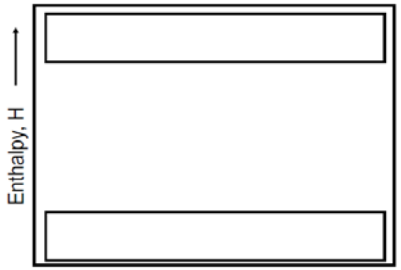
by the system. The thermometer in this experiment is considered to be part of the

(system surroundings).

(ii) It was determined that 279 J of heat was associated with the chemicals that reacted in this experiment. Calculate the value of ΔH (in units of kJ/mol_{rxn}) for the reaction that occurred in this experiment. Show the setup for your calculations below. Round off your final answer to the proper number of significant figures. The sign of ΔH should be consistent with your answer to (b)(i).

(c) Fill in the following missing information in the enthalpy diagram below.

- The chemical formulas of the reactants and the products, listed in the appropriate boxes, according to their relative enthalpy values
- An arrow indicating the direction of the reaction, from the reactants to the products



(d) Suppose that this experiment had been carried out by adding 50. mL of 0.20 *M* hydrochloric acid to 50. mL of 0.20 *M* sodium hydroxide.

(i) Would the magnitude of q for this experiment be less than, more than, or equal to 279 J? Justify your answer.

(ii) Would the magnitude of ΔH for this experiment be less than, more than, or equal to the magnitude of the ΔH value calculated in (b)(ii)? Justify your answer.

CHAPTER 5 – 6 PRACTICE QUIZ (Sections 5.5 – 5.7, 6.1 – 6.3, 6.5 – 6.8)

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

←Linked at 0:00

1. In an insulated cup of negligible heat capacity, 50. g of water at 40.°C is mixed with 30. g of water at 20.°C. The final temperature of the mixture is closest to

(A) 27°C
(B) 30.°C
(C) 33°C
(D) 38°C

2. A 100 g sample of a metal was heated to 100°C and then quickly transferred to an insulated container holding 100 g of water at 22°C. The final temperature of the water (and the metal) was equal to 35°C. Which of the following can be concluded?

(A) The metal temperature changed more than the water temperature did; therefore the amount of heat lost by the metal is greater than the amount of heat gained by the water.

(B) The metal temperature changed more than the water temperature did, but the amount of heat lost by the metal is equal to the amount of heat gained by the water.

(C) The metal temperature changed more than the water temperature did; therefore the specific heat of the metal is greater than the specific heat of the water.

(D) The metal temperature changed more than the water temperature did, but the specific heat of the metal is equal to the specific heat of the water.

$$K(s) + \tfrac{1}{2}\,Cl_2(g) \rightarrow KCl(s) \qquad \Delta H^\circ = -440\ kJ/mol_{rxn}$$

3. Based on the thermochemical equation shown above, how much heat is released or absorbed when 0.10 mol of $Cl_2(g)$ is formed from $KCl(s)$?

(A) 44 kJ is released
(B) 88 kJ is released
(C) 44 kJ is absorbed
(D) 88 kJ is absorbed

$$2\,Na_2O_2(s) + S(s) + H_2O(l) \rightarrow 4\,NaOH(aq) + SO_2(aq) \qquad \Delta H^\circ = -600\ kJ/mol_{rxn}$$

4. In a certain experiment, 7.8 g $Na_2O_2(s)$ is mixed with 3.2 g $S(s)$ along with excess water. Which of the following identifies the limiting reactant and the heat released, q, for this experiment?

	Limiting Reactant	q
(A)	Na_2O_2	30 kJ
(B)	Na_2O_2	60 kJ
(C)	S	30 kJ
(D)	S	60 kJ

$$4\,NH_3(g) + 3\,O_2(g) \rightarrow 2\,N_2(g) + 6\,H_2O(g)$$

Substance	ΔH_f°
$NH_3(g)$	–50 kJ/mol
$H_2O(g)$	–240 kJ/mol

5. Based on the information in the table above, what is the value of ΔH° for the reaction represented above?

(A) –1640 kJ
(B) –1240 kJ
(C) –290 kJ
(D) –190 kJ

$$\tfrac{1}{2}\,H_2(g) + \tfrac{1}{2}\,I_2(s) \rightarrow HI(g) \qquad \Delta H = 26\ kJ$$

$$\tfrac{1}{2}\,H_2(g) + \tfrac{1}{2}\,I_2(g) \rightarrow HI(g) \qquad \Delta H = -5\ kJ$$

6. Based on the information above, what is the enthalpy change for the sublimation of iodine?

(A) 21 kJ/mol
(B) 31 kJ/mol
(C) 42 kJ/mol
(D) 62 kJ/mol

$$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(l) \qquad \Delta H^\circ = -890\ kJ$$

ΔH_f° for $CO_2(g)$ = X kJ/mol and ΔH_f° for $H_2O(l)$ = Y kJ/mol

7. The value of ΔH° for the combustion of methane gas is equal to –890 kJ as shown above.
The standard enthalpy of formation for $CO_2(g)$ is equal to X kilojoules per mole.
The standard enthalpy of formation for $H_2O(l)$ is equal to Y kilojoules per mole.
In terms of X and Y, the standard enthalpy of formation for methane gas is equal to

(A) X + 2Y + 890
(B) X + 2Y – 890
(C) X + Y + 890
(D) X + Y – 890

$$H_2(g) + \tfrac{1}{2}\,O_2(g) \rightarrow H_2O(l) \qquad \Delta H^\circ = A$$

$$2\,Na(s) + \tfrac{1}{2}\,O_2(g) \rightarrow Na_2O(s) \qquad \Delta H^\circ = B$$

$$Na(s) + \tfrac{1}{2}\,O_2(g) + \tfrac{1}{2}\,H_2(g) \rightarrow NaOH(s) \qquad \Delta H^\circ = C$$

8. Based on the information above, what is the standard enthalpy change for the following reaction?

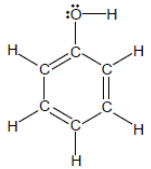
$$Na_2O(s) + H_2O(l) \rightarrow 2\,NaOH(s) \qquad \Delta H^\circ = ?$$

(A) A + B – C
(B) A + B – 2C
(C) C – A – B
(D) 2C – A – B

CHAPTER 5 – 6 PRACTICE QUIZ (Sections 5.5 – 5.7, 6.1 – 6.3, 6.5 – 6.8)

FREE RESPONSE – CALCULATOR IS ALLOWED

←Linked at 19:11



1. The structural formula of phenol is shown above. Answer the following questions concerning phenol.

   (a) Write a balanced chemical equation for the complete combustion of 1 mole of phenol.

   ⟶

   (b) In a calorimetry experiment, 2.00 g of pure solid phenol is completely burned in a bomb calorimeter. The temperature of the calorimeter increased from 25.00°C to 33.62°C. The heat capacity of the calorimeter is 7.54 kJ/°C.

   (i) Calculate the amount of heat (in units of kJ) that was released to the calorimeter during the combustion experiment. Show your work below in order to receive full credit.

   (ii) Calculate the enthalpy change, ΔH°_{comb}, for the chemical equation you wrote in part (a) in units of kJ/mol$_{rxn}$. Show your work below in order to receive full credit.

   (c) Use your answer from (b)(ii) and the data in the table below to calculate the standard enthalpy of formation for phenol (in units of kJ/mol). Show your work below in order to receive full credit.

Substance	Standard Enthalpy of Formation, ΔH°_f (kJ/mol)
$CO_2(g)$	–393.5
$H_2O(l)$	–285.8
phenol (s)	?

CHAPTER 19 PRACTICE QUIZ

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

←Linked at 0:00

1. Which of the following reactions is not thermodynamically favored at low temperatures but becomes favored as the temperature increases?

	Reaction	ΔH° (kJ/mol$_{rxn}$)	ΔS° (J/mol$_{rxn}$·K)
(A)	$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g)$	–566	–173
(B)	$2\ H_2O(g) \rightarrow 2\ H_2(g) + O_2(g)$	484	90.0
(C)	$2\ N_2O(g) \rightarrow 2\ N_2(g) + O_2(g)$	–164	149
(D)	$PbCl_2(s) \rightarrow Pb^{2+}(aq) + 2\ Cl^-(aq)$	23.4	–12.5

Skip #2.

$2\ K(s) + Cl_2(g) \rightarrow 2\ KCl(s) \qquad \Delta H^\circ = -872\ kJ/mol_{rxn}$

3. It is observed that the reaction shown above goes essentially to completion. Which of the following is a true statement about the thermodynamic favorability of the reaction?

   (A) The reaction is favorable and driven by an enthalpy change only.

   (B) The reaction is favorable and driven by an entropy change only.

   (C) The reaction is favorable and driven by both enthalpy and entropy changes.

   (D) The reaction is unfavorable due to both enthalpy and entropy changes.

4. Which of the following processes involves the greatest increase in entropy?

   (A) $SO_3(g) + H_2(g) \rightarrow SO_2(g) + H_2O(g)$

   (B) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

   (C) $C_2H_2(g) + 2\ H_2(g) \rightarrow C_2H_6(g)$

   (D) $MgSO_3(s) \rightarrow MgO(s) + SO_2(g)$

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$

5. The reaction above is thermodynamically favorable at 25°C. What are the signs of ΔH°, ΔS°, and ΔG° ?

	ΔH°	ΔS°	ΔG°
(A)	–	+	+
(B)	+	+	+
(C)	–	–	–
(D)	+	–	–

Skip #6.

7. Under which of the following conditions will an exothermic reaction be thermodynamically favorable?

   (A) when ΔG is positive

   (B) when ΔS is positive

   (C) when ΔS is negative and $T > \frac{|\Delta H|}{|\Delta S|}$

   (D) An exothermic reaction is thermodynamically favorable at all temperatures.

8. For which of the following processes does the value of ΔS decrease ($\Delta S < 0$) ?

   (A) Melting of glucose

   (B) Evaporation of liquid bromine

   (C) Precipitation of silver chloride

   (D) Sublimation of carbon dioxide

$$CH_3OH(g) \rightarrow CO(g) + 2\,H_2(g) \qquad \Delta H^\circ = +91\ kJ/mol_{rxn}$$

9. The reaction represented above goes essentially to completion. What can be inferred about ΔS° for the reaction at 298 K?

(A) It must be positive because the reaction is thermodynamically unfavorable at 298 K.

(B) It must be negative because there are more moles of products than reactants.

(C) It must be positive because ΔG° is negative and ΔH° is positive.

(D) It must be negative because ΔG° is positive and ΔH° is positive.

10. A certain reaction is thermodynamically favored at temperatures below 400. K, but it is not favored at temperatures above 400. K. The value of ΔH° for the reaction is –20 kJ/mol. What is the value of ΔS° for the reaction? (Assume that ΔH° and ΔS° do not change with temperature.)

(A) $-50\ J\ mol^{-1}\ K^{-1}$

(B) $-20\ J\ mol^{-1}\ K^{-1}$

(C) $-0.050\ J\ mol^{-1}\ K^{-1}$

(D) $50\ J\ mol^{-1}\ K^{-1}$

$$Pb(s) \rightleftharpoons Pb(l)$$

11. Which of the following is true for the process represented above at 327°C and 1 atm? The normal melting point of Pb is 327°C.

(A) $\Delta H = 0$

(B) $T\Delta S = 0$

(C) $\Delta H = T\Delta S$

(D) $\Delta S < 0$

CHAPTER 19 PRACTICE QUIZ

←Linked at 10:36

FREE RESPONSE – CALCULATOR IS ALLOWED

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) \qquad \Delta H^\circ_{rxn} = -63.7\ kJ/mol_{rxn}$$

1. Calcium oxide, CaO(*s*), has been proposed as a substance that can be used to heat water quickly for portable heating packs or for cooking. When placed in water, CaO(*s*) reacts as shown by the equation above.

(a) A student wants to design a heating pad that could heat a 150.0 g sample of water from 25.0°C to 60.0°C. Calculate the amount of heat, in joules, that the water must absorb for its temperature to change by this amount. Assume that the specific heat capacity of the water is 4.18 J/(g · °C).
Show the set-up for your calculations in order to receive full credit.
Round off your answer to three significant figures.

(b) Calculate the minimum mass of CaO(*s*) that the student would need to use in order to cause the temperature change described in part (a).
Show the set-up for your calculations in order to receive full credit.
Round off your answer to three significant figures.

(c) The student hypothesizes that the design of the heating pad could be changed to enable it to heat 150.0 g of water from 25.0°C to 90.0°C by using a greater mass of CaO(*s*).

(i) Use the data in the table below to determine the standard entropy change, ΔS°_{rxn}, in $J/(K \cdot mol_{rxn})$ for the reaction.

Substance	Absolute Entropy at 25°C (J/(K · mol)
CaO(*s*)	83
$H_2O(l)$	70.
$Ca(OH)_2(s)$	40.

(ii) Is the reaction thermodynamically favorable at 90.0°C? Justify your answer with a calculation. Assume that both ΔS°_{rxn} and ΔH°_{rxn} are constant between 25.0°C and 90.0°C.

$$C_2H_4(g) + NH_3(g) \rightarrow CH_3CH_2NH_2(g)$$

2. Ethylene, $C_2H_4(g)$, reacts with ammonia, $NH_3(g)$, to produce ethylamine, $CH_3CH_2NH_2(g)$ as shown by the equation above.

Substance	Enthalpy of Formation at 25°C (kJ/mol)	Absolute Entropy at 25°C (J/(K · mol)
$C_2H_4(g)$	52.3	219.4
$NH_3(g)$	–46.2	192.5
$CH_3CH_2NH_2(g)$	–47.5	283.8

(a) Use the data in the table above to help you determine each of the following quantities.

(i) ΔH°_{rxn} (in kJ/mol_{rxn}) for the reaction shown above

(ii) ΔS°_{rxn} (in $J/(K \cdot mol_{rxn})$ for the reaction shown above.

(b) Calculate the value of ΔG°_{rxn} for the reaction shown above at 25°C.
Show the set-up for your calculations in order to receive full credit.
Include units in your answer.

Skip part (c).

(d) Calculate the temperature (in °C) at which the value of ΔG_{rxn} would be equal to zero.
Assume that both ΔS_{rxn} and ΔH_{rxn} do not change with temperature.
Show the set-up for your calculations in order to receive full credit.
Round off your answer to the nearest 1°C.

(e) This reaction is thermodynamically favorable at 25°C. What drives this chemical reaction?
Circle one of the following options.

Enthalpy only Entropy only Both enthalpy and entropy

(f) Justify your selection in part (e) in terms of ΔG°_{rxn}.