

Name \_\_\_\_\_ Section Number \_\_\_\_\_

Units, equations, etc.

$$1 \text{ ml} = 1 \text{ cc} = 1 \text{ cm}^3 \quad 1 \text{ L-atm} = 101 \text{ J}$$

$$1 \text{ meter} = 100 \text{ cm} = 10^9 \text{ nanometers} = 10^{10} \text{ \AA}$$

$$R = \text{gas constant} = 0.082 \text{ L-atm/K-mole} = 8.31 \text{ J/K-mole}$$

Gas Law  $PV=nRT$ 

$$w = -P_{\text{ext}}\Delta V \quad q = \Delta H \text{ at constant } P$$

$$\Delta E = q + w \quad \Delta E_{\text{universe}} = 0$$

$$\Delta G^\circ = -RT \ln K = \Delta H^\circ - T \Delta S^\circ \quad \Delta S^\circ_{\text{vap}} = \Delta H^\circ_{\text{vap}} / T_b$$

$$\Delta G = \Delta G^\circ + RT \ln Q \quad \Delta S_{\text{uni}} = \Delta S_{\text{sys}} + \Delta S_{\text{sur}}$$

**Please read the following before proceeding**

1. Materials: Turn off cell phones and wireless PDA devices. Clear all papers and books from your desk. You will need a pencil, a calculator and a Scantron answer form.
2. This exam is multiple-choice. It is highly recommended that you record your work on the actual exam (this document). There is no partial credit.
3. The exam will be Scantron scored. On the Scantron card, please make sure that you **bubble-in your GTid number**. In the space provided, write your **Name**. Write the **Color** of your exam in the Subject section and bubble-in the letter for the **Test Form (White=A, Green=B, Yellow=C)**. Write your **section number** in the Hour/Date section. See sample below.
4. Show your Buzz Card when you turn in your completed exam and Scantron card.
5. You must work alone. Give or take no assistance from other students. Recall the Georgia Tech Honor Code. "I pledge my honor that I have not violated the Honor Code during this examination."

Signed \_\_\_\_\_

**Sample Use Pencil Only Bubble-In GTid**

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NAME: **Last, First**  
SUBJECT: **Color of Exam**  
DATE: **Hour/Day/Section**

DIREC: **20123551**  
I.D. NUMBER: **20123551**

TEST FORM: **White**

EXAM NUMBER: **101010**

SIDE 1

1	A1	Hsiao
2	A2	Arnstein
3	A3	Phillips
4	A4	McGrier
5	B1	Hsiao
6	B2	Arnstein
7	B3	Phillips
8	B4	McGrier

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1. The First Law of Thermodynamics states that
- work and heat are interconvertable
  - energy is conserved
  - energy cannot be created or destroyed
  - all of the above (a-c)
  - none of the above

Answer: d

2. The heat gained from the surroundings in a process carried out at constant pressure is

- w
- $\Delta H$
- $\Delta T$
- $\Delta E$
- $\Delta S$

Answer: b

3. Which one of the following statements is **not** true concerning the equation below?



- The complete reaction of 1.0 mole of  $\text{H}_2$  produces 153 kJ of heat.
- The complete reaction of 1.0 mole of  $\text{N}_2$  requires 460 kJ of heat.
- The production of 1.0 mole of ammonia is accompanied by the production of 230 kJ of heat.
- The complete reaction of 1.38 mole of hydrogen requires 0.46 mole of nitrogen.
- All of these are true statements.

Answer: b

4. Which of the following is not a state function?

- q
- E
- H
- G
- All of these are state functions.

Answer: a

5. Which of the following processes has  $\Delta H > 0$ ?

- combustion of a hydrocarbon (gives off heat,  $\Delta H_{\text{comb}} < 0$ )
- dilution of concentrated hydrochloric acid with water (gives off heat,  $\Delta H < 0$ )
- freezing of liquid  $\text{N}_2$  (gives off heat,  $\Delta H < 0$ )
- vaporization of water (absorbs heat,  $\Delta H > 0$ )
- all have  $\Delta H > 0$

Answer: d

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Given the following enthalpies of formation:

Species	$\Delta H_f^\circ$ (kJ mol <sup>-1</sup> )
glucose [C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> (s)]	-1274
CO <sub>2</sub> (g)	-393
H <sub>2</sub> O(l)	-286

6. What is the standard enthalpy of combustion of glucose to form carbon dioxide and liquid water.

- a. -2800 kJ mol<sup>-1</sup>
- b. -1953 kJ mol<sup>-1</sup>
- c. -595 kJ mol<sup>-1</sup>
- d. 595 kJ mol<sup>-1</sup>
- e. none of these

Answer: a

7. In any process,  $\Delta E_{\text{univ}} =$

- a. 0
- b.  $\Delta E_{\text{sys}}$
- c.  $\Delta E_{\text{surr}}$
- d.  $-\Delta E_{\text{sys}}$
- e.  $-\Delta E_{\text{surr}}$

Answer: a

A gas is compressed from 45 L to 18 L at a constant external pressure of 5.0 atm. During this process 9.8 kJ of energy is released as heat.

8. The heat q for this process is

- a. 135 kJ
- b. -135 kJ
- c. -9.82 kJ
- d. 9.82 kJ
- e. 270 kJ

Answer: c

9. The work w for this process is

- a. 135 L atm
- b. -135 L atm
- c. -9.82 L atm
- d. 9.82 L atm
- e. 270 kJ

Answer: a

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10. Given the following  $\Delta H_f^\circ$  values:

SiH <sub>4</sub> (g)	34.3 kJ mol <sup>-1</sup>
SiO <sub>2</sub> (s)	-910.9 kJ mol <sup>-1</sup>
H <sub>2</sub> O(l)	-285.8 kJ mol <sup>-1</sup>

Also,

$$\text{H}_2\text{O} \quad \Delta H_{\text{vap}} = 44.0 \text{ kJ mol}^{-1}.$$

Calculate  $\Delta H_r^\circ$  for  $\text{SiH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightleftharpoons \text{SiO}_2(\text{s}) + 2\text{H}_2\text{O}(\text{s})$ .

- a. -1517 kJ mol<sup>-1</sup>
- b. -1429 kJ mol<sup>-1</sup>
- c. -1187 kJ mol<sup>-1</sup>
- d. This cannot be determined without additional information.
- e. none of these

Answer: d

11. The second law of thermodynamics states that

- a. energy is conserved in spontaneous processes.
- b. the heat content of the universe increases during a spontaneous process.
- c. the entropy of a perfect crystal is zero at absolute zero.
- d. the entropy of the universe increases during a spontaneous process.
- e. work and heat are interconvertible.

Answer: d

12. For the vaporization of a liquid at its normal boiling point  $T_b$ , the change in entropy and the change in enthalpy are related by

- a.  $\Delta S_{\text{vap}} = \Delta H_{\text{vap}}/T_b$
- b.  $\Delta S_{\text{vap}} = \Delta H_{\text{vap}}*T_b$
- c.  $\Delta S_{\text{vap}} = T_b/\Delta H_{\text{vap}}$
- d.  $T_b = \Delta H_{\text{vap}}*\Delta S_{\text{vap}}$
- e. There is no general relation covering these vaporization quantities.

Answer: a

13. If  $\Delta S_{\text{univ}}$  is positive for a process, the process is \_\_\_\_\_, if  $\Delta S_{\text{univ}}$  for a process is negative, the process is \_\_\_\_\_, and if the  $\Delta S_{\text{univ}}$  accompanying a process is zero, the process is \_\_\_\_\_.

- a. at equilibrium, spontaneous, nonspontaneous
- b. nonspontaneous, spontaneous, at equilibrium
- c. spontaneous, at equilibrium, nonspontaneous
- d. spontaneous, nonspontaneous, at equilibrium
- e. none of these

Answer: d

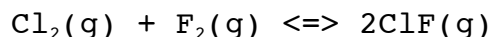
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14. A process can be spontaneous at low temperatures and non-spontaneous at high temperatures if

- both  $\Delta H$  and  $\Delta S$  are positive.
- both  $\Delta H$  and  $\Delta S$  are negative.
- $\Delta H$  is positive and  $\Delta S$  is negative.
- $\Delta H$  is negative and  $\Delta S$  is positive.
- This cannot be answered in such a general way.

Answer: b

15. For the reaction below,  $K = 8.6 \times 10^{19}$  at  $T = 298$  K and  $K = 1.09 \times 10^{15}$  at 398 K.



Assuming that  $\Delta H_r^\circ$  and  $\Delta S_r^\circ$  are independent of  $T$  over this range, sufficient information is given here to determine

- $\Delta S_r^\circ$ ,  $\Delta H_r^\circ$  and  $\Delta G_r^\circ$
- $\Delta S_r^\circ$  and  $\Delta H_r^\circ$  only
- $\Delta G_r^\circ$  only
- $\Delta S_{\text{sur}}$
- a and d

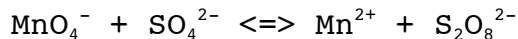
Answer: a

16. Oxidation is

- loss of electrons
- gain of electrons
- loss of protons
- gain of protons
- none of these

Answer: a

17. Which element is oxidized in the reaction (unbalanced),



- Mn
- O
- S
- None; this is not a redox reaction.
- This cannot be determined without balancing the equation.

Answer: c

18. When  $\text{CrO}_4^{2-}$  is converted to  $\text{Cr}^{3+}$ , \_\_\_\_\_ electrons are \_\_\_\_\_ by each chromium atom.

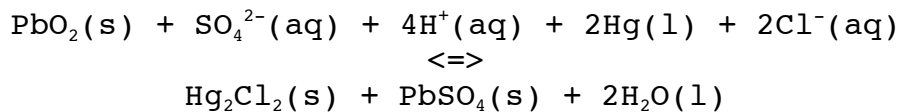
- 5, lost
- 5, gained
- 3, lost
- 3, gained
- none of these

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Answer: d

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19. Identify the correctly balanced oxidation half reaction for the reaction,



- a.  $\text{PbO}_2 + \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{PbSO}_4 + 2\text{H}_2\text{O}$
- b.  $2\text{Hg} + 2\text{Cl}^- \rightleftharpoons \text{Hg}_2\text{Cl}_2 + 2\text{e}^-$
- c.  $\text{PbSO}_4 + 2\text{H}_2\text{O} \rightleftharpoons \text{PbO}_2 + \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$
- d.  $\text{Hg}_2\text{Cl}_2 + 2\text{e}^- \rightleftharpoons 2\text{Hg} + 2\text{Cl}^-$
- e. none of these

Answer: b

20. I have followed the instructions on the first page. I have entered my GTid number, my Name, Exam Color (White=A, Green=B, Yellow=C), and section number.

- a. True
- b. False

Answer: a