100%. Great!

Thermodynamics Test V1 Name: ANSWERS

You may use your formula sheet, blue sheet of $\Delta H°_{formation}$, periodic table.

Part A. Multiple Choice Questions. Mark your answer as a CAPITAL letter in the space provided. (4 each)

1. A beaker contains 600 cm^3 of water at 50°C. If 200 cm^3 of water at 10°C is added, what will be the final temperatu of the water after mixing?
   A. 30°C
   B. 35°C
   C. 40°C
   D. 45°C

$600(x-50) = -200(x-10)$

$600x - 30000 = -200x + 2000$ or

$800x = 32000$

$x = 40°$

$600(x-50) = -200(x$

$3(x-50) = -(x-$

$3x - 150 = -x +$

$4x = 160$

$x = 40$

2. A swimming pool contains 1.20×10^5 L of water at a temperature of 20.0°C. The water then absorbs 4.02×10^6 kJ of energy from the sun. What will be the final temperature of the water?
   A. 31.6°C
   B. 28.0°C
   C. 23.2°C
   D. 8.0°C

$4.02 \times 10^9 = 1.20 \times 10^8 (4.19)(x-20)$

$33.5 = 4.19(x-20)$

$8 = x - 20$

$x = 28$

3. A calorimeter contains 60.0 mL of 1.0 mol/L $NaOH_{(aq)}$ at an initial temperature of 21.7°C. To this solution, 30.0 m of 2.0 mol/L $HCl_{(aq)}$ is added at the same temperature. After the neutralization reaction comes to completion, the final temperature of the resulting solution is 29.5°C. What is the molar heat of neutralization of $HCl_{(aq)}$? *(Assume the density and specific heat for all solutions to be equal to that of water.)*
   A. 1.5 kJ/mol
   B. -2.9 kJ/mol
   C. -16 kJ/mol
   D. -49 kJ/mol

$Q = mc\Delta t$

$= 90(4.19)(29.5 - 21.7)$

$Q_w = 2.941$ kJ

$Q_{rxn} = -2.941$

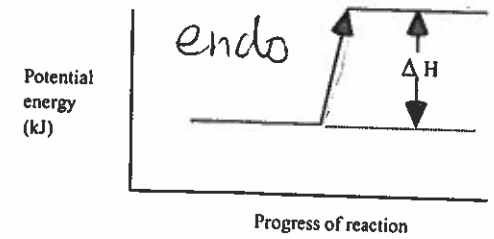
$\frac{2 \text{ mol HCl}}{x} = \frac{1000 \text{ mL}}{30}$

$x = 0.06$ mol of HCl

$\Delta H = \frac{Q}{n} = \frac{-2.941}{0.06} = -49$

4. Among the equations below, which represent the following energy graph?

   1. $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286$ kJ
   2. $\frac{1}{2} N_2(g) + O_2(g) + 34kJ \rightarrow NO_2(g)$ $\Delta H = +34$ kJ
   3. $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$ $\Delta H = -2044$ kJ
   4. $H_2O(g) + C(s) \rightarrow H_2(g) + CO(g)$ $\Delta H = 132$ kJ



A. 1 and 2 B. 1 and 3 C. 2 and 4 D. 3 And 4

5. A 3.88 g of ammonium nitrate (NH_4NO_3), are dissolved in 60.0g of water. The temperature of the water changes fr 23.0°C to 18.4°C. Calculate the molar enthalpy of dissolution of NH_4NO_3.

① $Q = mc\Delta T$

$Q = 60.0g(4.19 J/g°C)(18.4°C - 23.0°C)$

$Q = -1156.44$ J

$Q = -1.15644$ kJ

② $\frac{1 \text{ mol of } NH_4NO_3}{x} = \frac{80.06 \text{ g of } NH_4NO_3}{3.88 \text{ g of } NH_4NO_3}$

$x = 0.048463652$

③ $\Delta H = \frac{-Q}{\text{mol}}$

$\Delta H = -(-1.15644 kJ)$ / 0.048463652

$\Delta H = 23.86200693$

$+23.9$ kJ/mol NH_4NO_3

MC	
1	C
2	B
3	D
4	C

6. USE THE BLUE THERMODYNAMIC TABLE SHOWING ΔH_f° to calculate the enthalpy of the combustion reaction below. Express you answer of kJ per mole of C_2H_5OH

$C_2H_5OH_{(l)} + 2\ O_{2\ (g)} \rightarrow CO_{2\ (g)} + 3\ H_2O_{(g)}$

ΔH = products - reactants

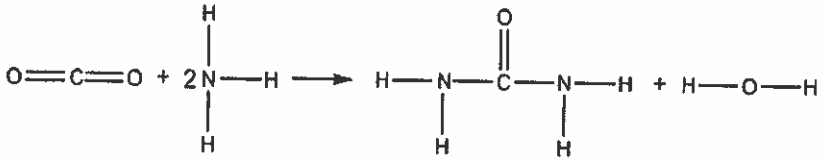
$= (-393.5 + 3(-241.8)) - (-277.6 + 2(0))$

$= -1118.9 - (-277.6)$

$= -841.3 kJ/mol$

-841.3 kJ/mol C_2H_5O

7. Use the table of bond energies to calculate the heat of reaction for the reaction below.



	Bond Enthalpy $\frac{kJ}{mol}$
C–N	305
C–O	358
C=O	745
C=O (in CO_2)	799
O–H	467
N–H	391

ΔH = bonds broken - bonds formed

$\Delta H = (2(799) + 2(3(391))) - (4(391) + 2(305) + 745 + 2(467))$

$\Delta H = 3944 - 3853$

$\Delta H = +91$

$+91$ kJ/mol CO

8. Given the following equations,

$(\times 2)\ CH_{4\ (g)} \rightarrow C_{(s)} + 2\ H_{2\ (g)}$ $\quad \Delta H = +79.5$ kJ

$2\ C_{(s)} + 3\ H_{2\ (g)} \rightarrow C_2H_{6\ (g)}$ $\quad \Delta H = -48.8$ kJ

Calculate change in ΔH_{rxn} per mole of CH_4: $2\ CH_{4\ (g)} \rightarrow 1\ C_2H_{6\ (g)} + H_{2\ (g)}$

$2CH_4 \rightarrow 2C + 4H_2$ $\quad \Delta H = 159$ kJ

$2C + 3H_2 \rightarrow C_2H_6$ $\quad \Delta H = -48.8$ kJ

$2CH_4 \rightarrow C_2H_6 + H_2$ $\quad \Delta H = 110.2$ kJ

$+155.1$ kJ/mol CH_4

Thermodynamics Test V2 Name:

10896

You may use your formula sheet, blue sheet of $\Delta H°_{formation}$, periodic table.

Part A. Multiple Choice Questions. Mark your answer as a CAPITAL letter in the space provided. (4 each)

1. A student mixes 200 g of water at 80°C with 400 g of water at 20°C. What will the final temperature of the wate be after mixing?

   A. 30°C
   B. 40°C
   C. 50°C
   D. 60°C

$m_1\Delta t = -m_2\Delta t$

$(200)(T_f - 80) = -400(T_f - 20)$

$200T_f - 16000 = -400T_f + 8000$

$600T_f = 24000$

2. Determine the final temperature of water, after the combustion of methane, $CH_{4(g)}$, in a bomb calorimeter, give the following data:

Mass of methane burned:	1.00 g
Volume of water in the bomb calorimeter:	800.0 mL
Heat released from the combustion of the gas:	50.4 kJ
Initial temperature of the water:	27.0°C

$50400 = 800(4.19)(T_f - 27)$

$15.04 = x - 27$

$x = 42.0\ldots$

   A. 15.4°C
   B. 25.7°C
   C. 42.0°C
   D. 52.5°C

3. A calorimeter contains 60.0 mL of 1.0 mol/L $NaOH_{(aq)}$ at an initial temperature of 21.7°C. To this solution, 30.0 mL of 2.0 mol/L $HCl_{(aq)}$ is added at the same temperature. After the neutralization reaction comes to completion, the final temperature of the resulting solution is 29.5°C. What is the molar heat of neutralization of $HCl_{(aq)}$? *(Assume the density and specific heat for all solutions to be equal to that of water.)*

   A. 1.5 kJ/mpl
   B. -2.9 kJ/mol
   C. -16 kJ/mol
   D. -49 kJ/mol

$Q = mc\Delta t$

$= (90)(4.19)(29.5 - 21.7)$

$= 2941.39\ J$

$= -2.94138\ kJ$ (because exothermic)

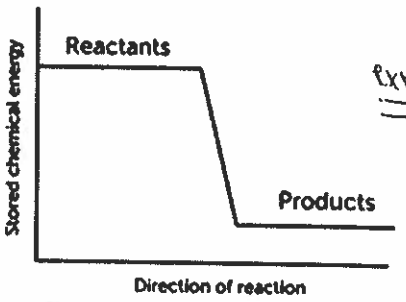
$\frac{2\ mol}{1\ L} = \frac{x}{0.03}$ $x = 0.06$

$\Delta H = \frac{Q}{n} = \frac{-2.941}{0.06} = -49$

4. The enthalpy diagram to the right could represent which of the following reactions?

   i. $C_{(s)} + H_2O \rightarrow CO_{(g)} + H_{2(g)}$ $\Delta H = +132$ kJ
   ii. $2\ HCl_{(g)} + 185\ kJ \rightarrow H_{2(g)} + Cl_{2(g)}$
   iii. $H_2O_{(l)} \rightarrow H_2O_{(s)} + 6.02$ kJ
   iv. $N_{2(g)} + 2O_{2(g)} \rightarrow 2\ N_2O_{(g)}$ $\Delta H = -68$ kJ

   A. i and ii
   B. ii and iii
   C. iii and iv
   D. i and iii



exothermic

5. A 3.88 g of ammonium nitrate (NH_4NO_3), are dissolved in 60.0g of water. The temperature of the water changes fr 23.0°C to 18.4°C. Calculate the molar enthalpy of dissolution of NH_4NO_3.

23.9 kJ/mol NH_4NO_3

(1) $Q_w = mc\Delta t$

$= (60)(4.19)(18.4 - 23.0)$

$= -1156.44\ J$

$Q_w = -1.1564$ kJ

$Q_{rxn} = 1.1564$ kJ

(2) $\frac{1\ mol}{80.06\ g} = \frac{x\ mol}{3.88\ g}$

$x = 0.04846$ mol of NH_4NO_3

(3) $\Delta H = Q/n$

$= 1.1564 / 0.04846$

$= 23.8698$ kJ/

MC	
1	B
2	C
3	D
4	C

21

6. USE THE BLUE THERMODYNAMIC TABLE SHOWING ΔH_f° to calculate the enthalpy of the combustion reaction below. Expr you answer of kJ per mole of CH_3OH.

$CH_3OH_{(l)} + 1.5\ O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\ H_2O_{(g)}$

ΔH = products − reactants

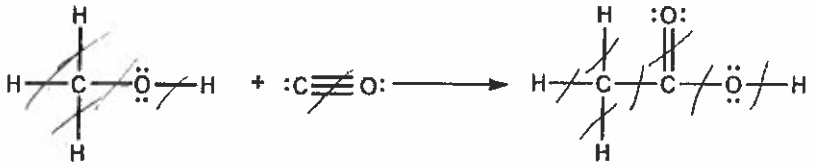
$= (-393.5 + 2(-241.8)) - (-238.6 + 1.5(0))$

$= -877.1 - (-238.6)$

$= -638.5$ kJ ✓

-638.5 kJ/mol CH_3OH

7. Use the table of bond energies to calculate the heat of reaction for the reaction below.



Bond	Energy
H-H	436 kJ/mol
H-O	460 kJ/mol
C-H	413 kJ/mol
C-C	347 kJ/mol
C=C	607 kJ/mol
C-O	358 kJ/mol
C=O	498 kJ/mol
C≡O	1077 kJ/mo

ΔH = broken − formed

$= (3(413) + 358 + 460 + 1077) - (3(413) + 347 + 498 + 358 + 460)$

$= 2134 - 2902$

$= 232$ kJ/mol

232 kJ/mol CH_3O

✓

8. Given the following equations,

$H_2SO_{4(l)} \rightarrow H_2O_{(l)} + SO_{3(g)}$ $\quad \Delta H = +80$ kJ

$SO_{3(g)} \rightarrow S_{(s)} + 3/2\ O_{2(g)}$ $\quad \Delta H = +395$ kJ

$H_2O_{(l)} \rightarrow H_{2(g)} + 1/2\ O_{2(g)}$ $\quad \Delta H = +286$ kJ

Calculate change in ΔH_{rxn} per mole of $S_{(s)}$: $\quad S_{(s)} + H_{2(g)} + 2\ O_{2(g)} \rightarrow H_2SO_{4(l)}$

$H_2O + SO_3 \rightarrow H_2SO_4$ $\quad \Delta H = -80$ kJ

$S + 3/2\ O_2 \rightarrow SO_3$ $\quad \Delta H = -395$ kJ

$1/2\ O_2 + H_2 \rightarrow H_2O$ $\quad \Delta H = -286$ kJ

$S + H_2 + 2O_2 \rightarrow H_2SO_4$ $\quad \Delta H = -761$ kJ

✓

-761 kJ/mol S

Thermodynamics Test V3 Name:

You may use your formula sheet, blue sheet of $\Delta H°_{formation}$, periodic table.

Part A. Multiple Choice Questions. Mark your answer as a CAPITAL letter in the space provided. (4 each)

1. If a mixture is made consisting of 100.0 mL of water at 90.0°C and 100.0 mL of water at 25.0°C, what will the fina temperature of the mixture be? (Assume no heat loss to the surroundings.)

   (A.) 57.5°C ✓
   B. 37.0°C ×
   C. 52.5°C ×
   D. 50.0°C ×

   $Q = -Q$

   $m_1 c_1 (T_f - T_{1i}) = -m_2 c_2 (T_f - T_{2i})$

   $(T_f - 90) = -(T_f - 25)$

   $2T_f = 115 \quad T_f = 57.5\ °C$

2. Determine the final temperature of water, after the combustion of methane, $CH_{4(g)}$, in a bomb calorimeter, give the following data:

Mass of methane burned:	1.00 g
Volume of water in the bomb calorimeter:	800.0 mL
Heat released from the combustion of the gas:	50.4 kJ
Initial temperature of the water:	27.0°C

   ∴ Q = ⊕ w H_2O (absorbed)

   A. 15.4°C ×
   B. 25.7°C ×
   (C.) 42.0°C ✓
   D. 52.5°C ×

   $Q = mc\Delta T$

   $50400 = (800)(4.19)(T_f - 2$

   $50400 = 3352T_f - 90504$

   $140904 = 3352T_f$

   $T_f = 42.0°C$

3. A calorimeter contains 60.0 mL of 1.0 mol/L $NaOH_{(aq)}$ at an initial temperature of 21.7°C. To this solution, 30.0 m of 2.0 mol/L $HCl_{(aq)}$ is added at the same temperature. After the neutralization reaction comes to completion, the final temperature of the resulting solution is 29.5°C. What is the molar heat of neutralization of $HCl_{(aq)}$? *(Assume the density and specific heat for all solutions to be equal to that of water.)*

   A. 1.5 kJ/mpl ×
   B. -2.9 kJ/mol ×
   C. -16 kJ/mol ×
   (D.) -49 kJ/mol ✓

   $Q = mc\Delta T$

   $Q = (90)(4.19)(29.5 - 21.7)$

   $Q = 2941.38\ J$

   $Q = 2.94138\ kJ$ (⊖!)

   $\frac{2\ mol.}{1000\ mL} = \frac{x}{30.0\ mL}$ $x = 0.06$ m of H

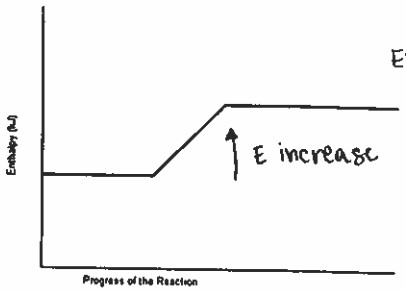
   ∴ $\Delta H = Q/n$ $\Delta H = -49$

   $\Delta H = -2.94138/0.06$ n

4. The enthalpy diagram to the right could represent which of the following reactions?

   i. $C_{(s)} + H_2O \rightarrow CO_{(g)} + H_{2(g)}$ $\Delta H = +132$ kJ ✓
   ii. $2\ HCl_{(g)} + 185\ kJ \rightarrow H_{2(g)} + Cl_{2(g)}$ ✓
   iii. $H_2O_{(l)} \rightarrow H_2O_{(s)} + 6.02$ kJ ×
   iv. $N_{2(g)} + 2O_{2(g)} \rightarrow 2\ N_2O_{(g)}$ $\Delta H = -68$ kJ ×

   (A.) i and ii ✓
   B. ii and iii ×
   C. ii and iv ×
   D. i and iii ×



Endotherm

$\Delta H = ⊕$

5. A 3.88 g of ammonium nitrate (NH_4NO_3), are dissolved in 60.0g of water. The temperature of the water changes fr 23.0°C to 18.4°C. Calculate the molar enthalpy of dissolution of NH_4NO_3.

① $Q = mc\Delta T$

$Q = (60)(4.19)(18.4 - 23.0)$

$Q = -1156.44\ J$

$Q = -1.15644\ kJ$

② $Q_{rxn} = -Q_{surroundings}$

$Q_{rxn} = 1.15644\ kJ$

③ $\frac{1\ mol.\ of\ NH_4NO_3}{x\ mol.\ of\ NH_4NO_3} = \frac{80.06\ g}{3.88\ g}$

$x = 0.048464\ mol.\ of\ NH_4NO_3$

④ $\Delta H_d = Q/n$

$\Delta H_d = 1.15644/0.048464$

$\Delta H_d = 23.9\ kJ/mol.\ of\ NH_4NO_3$

23.9 kJ/mol NH_4NO_3

MC	
1	A
2	C
3	D
4	A

6. USE THE BLUE THERMODYNAMIC TABLE SHOWING ΔH_f° to calculate the enthalpy of reaction for the reaction below. Expre you answer of kJ per mole of ~~$Ca(OH)_2$~~. MgO

$MgO_{(s)} + 2\,HCl_{(g)} \rightarrow MgCl_{2(s)} + H_2O_{(l)}$
$-601.8 \quad -92.3 \quad -641.8 \quad -285.8$

$\Delta H_{rxn} = \Delta H_f^\circ(\text{products}) - \Delta H_f^\circ(\text{reactants})$

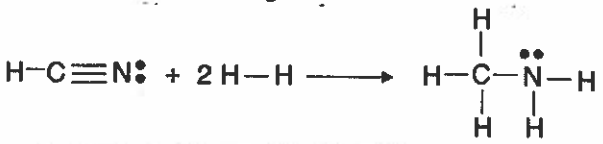
$\Delta H_{rxn} = (-285.8 - 641.8) - (2(-92.3) - 601.8)$

$\Delta H_{rxn} = -927.6 - (-786.4)$

$\Delta H_{rxn} = -141.2$ kJ/mol. of MgO

-141.2 kJ/mol Mg

7. Use the table of bond energies to calculate the heat of reaction for the reaction below.



Bond	Energy in kJ/mol
C–C	347
C–N	305
C=N	615
C≡N	891
C–H	413
H–H	432
N–H	391
N–N	160
N–O	201
N=N	418

$\Delta H_{rxn} = \Sigma \text{broken} - \Sigma \text{formed}$

$\Delta H_{rxn} = (413 + 891 + 2(432)) - (3(413) + 305 + 2$

$\Delta H_{rxn} = 2168 - 2326$

$\Delta H_{rxn} = -158$ kJ/mol. of HCN

-158 kJ/mol HCN

8. Given the following equations,

$2 \times (CH_{4(g)} \rightarrow C_{(s)} + 2\,H_{2(g)})$ $\quad 2 \times (\Delta H = +79.5\text{ kJ})$

$2\,C_{(s)} + 3\,H_{2(g)} \rightarrow C_2H_{6(g)}$ $\quad \Delta H = -48.8\text{ kJ}$ Same

Calculate change in ΔH_{rxn} per mole of CH_4: $2\,CH_{4(g)} \rightarrow C_2H_{6(g)} + H_{2(g)}$

$2\,CH_{4(g)} \rightarrow 2C_{(s)} + 4H_{2(g)}$ $\quad \Delta H = 159$ kJ

$+ \quad 2C_{(s)} + 3H_{2(g)} \rightarrow C_2H_{6(g)}$ $\quad \Delta H = -48.8$ kJ

$2\,CH_{4(g)} \rightarrow C_2H_{6(g)} + H_{2(g)}$ $\quad \Delta H = 110.2$ kJ

$\therefore \Delta H_{rxn} = 110.2\text{ kJ} \div 2$

$\Delta H_{rxn} = 55.1$ kJ/mol. of CH_4

55.1 kJ/mol CH_4