

Appendix A

THERMODYNAMIC TABLES

7/11/12

	ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol		ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol
Aluminum				CCl ₄ (l)	-135.44	216.40	-65.21
Al(s)	0	28.28	0	CHCl ₃ (l)	-134.47	201.7	-73.66
Al ³⁺ (aq)	-531	-321.7	-485	Cl ₂ CO(g)	-220.08	283.80	-205.89
AlCl ₃ (s)	-705.63	109.29	-630.02	CH ₄ (g)	-74.87	186.25	-50.77
AlF ₃ (s)	-1510.4	66.48	-1431.1	C ₂ H ₂ (g)	226.73	200.96	209.20
Al ₂ O ₃ (s)	-1675.7	50.95	-1582.3	C ₂ H ₄ (g)	52.47	219.33	68.42
Arsenic				C ₂ H ₆ (g)	-84.68	229.60	-32.82
As(s)	0	35.1	0	C ₃ H ₈ (g)	-104.70	270.31	-24.31
AsH ₃ (g)	66.44	222.78	68.93	C ₄ H ₁₀ (g)	-125.60	309.91	-16.34
AsCl ₃ (l)	-305.0	216.3	-259.4	CO(g)	-110.53	197.65	-137.16
Barium				CO ₂ (g)	-393.52	213.80	-394.39
Ba(s)	0	62.48	0	CO ₂ (aq)	-413.80	117.6	-385.98
Ba ²⁺ (aq)	-537.64	9.6	-560.77	HCO ₃ ⁻ (aq)	-691.99	91.2	-586.77
BaCO ₃ (s)	-1216.3	112.1	-1137.6	CO ₃ ²⁻ (aq)	-677.14	-56.9	-527.81
BaCl ₂ (s)	-858.56	123.67	-810.29	HCO ₂ H(aq)	-425.43	163	-372.3
BaO(s)	-548.10	72.07	-520.38	HCO ₂ ⁻ (aq)	-425.55	92	-351.0
BaSO ₄ (s)	-1473.2	132.2	-1362.2	H ₂ CO(g)	-115.90	218.95	-109.92
Boron				CH ₃ OH(l)	-238.66	126.8	-166.27
B(s)	0	5.83	0	CH ₃ OH(g)	-200.66	239.81	-161.96
B ₂ H ₆ (g)	41.00	233.17	91.85	CH ₃ OH(aq)	-245.93	133.1	-175.31
BF ₃ (g)	-1135.6	254.36	-1119.0	CS ₂ (l)	89.70	151.34	65.27
B ₂ O ₃ (s)	-1271.9	53.95	-1192.8	CS ₂ (g)	116.94	237.98	66.82
H ₃ BO ₃ (s)	-1094.0	88.74	-968.52	CH ₃ CO ₂ H(aq)	-485.76	178.7	-396.46
Bromine				CH ₃ CO ₂ ⁻ (aq)	-486.01	86.6	-369.31
Br ₂ (l)	0	152.21	0	C ₂ H ₅ OH(l)	-277.69	160.7	-174.78
Br ₂ (g)	30.91	245.39	3.13	C ₂ H ₅ OH(g)	-235.10	282.70	-168.49
Br ₂ (aq)	-2.59	130.5	3.93	C ₂ H ₅ OH(aq)	-288.3	148.5	-181.64
Br(g)	111.86	175.02	82.37	HCN(g)	135.14	201.83	124.72
Br ⁻ (aq)	-121.55	82.4	-103.96	HCN(aq)	107.1	124.7	119.7
HBr(g)	-36.44	198.70	-53.51	CN ⁻ (aq)	150.6	94.1	172.4
Calcium				CH ₃ NH ₂ (g)	-22.97	243.41	32.16
Ca(s)	0	41.59	0	CH ₃ NH ₂ (aq)	-70.17	123.4	20.77
Ca ²⁺ (aq)	-542.83	-53.1	-553.58	Chlorine			
CaCO ₃ (s)	-1206.9	92.9	-1128.8	Cl ₂ (g)	0	223.08	0
CaCl ₂ (s)	-795.80	104.60	-748.07	Cl(g)	121.30	165.19	105.31
CaO(s)	-635.09	38.21	-603.50	Cl ⁻ (aq)	-167.16	56.5	-131.23
CaSO ₄ (s)	-1434.1	106.7	-1321.8	ClO ₂ (g)	97.00	256.84	114.84
Carbon				Cl ₂ O(g)	81.00	271.72	97.08
C(graphite)	0	5.74	0	HCl(g)	-92.31	186.90	-95.30
C(diamond)	1.90	2.38	2.90	HClO(aq)	-120.9	142	-79.9
				ClO ⁻ (aq)	-107.1	42	-36.8

	ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol		ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol
Copper				LiCl(s)	-408.27	59.30	-384.02
Cu(s)	0	33.16	0	Magnesium			
Cu ⁺ (aq)	71.67	40.6	49.98	Mg(s)	0	32.67	0
Cu ²⁺ (aq)	64.77	-99.6	65.49	Mg ²⁺ (aq)	-466.85	-138.1	-454.8
CuO(s)	-156.06	42.59	-128.29	MgCO ₃ (s)	-1111.7	65.85	-1028.1
CuS(s)	-53.1	66.5	-53.6	MgCl ₂ (s)	-641.62	89.63	-592.09
Cu ₂ S(s)	-79.5	120.9	-86.2	MgO(s)	-601.24	26.92	-568.94
Fluorine				Mg(OH) ₂ (s)	-924.66	63.24	-833.65
F ₂ (g)	0	202.79	0	Mercury			
F(g)	79.39	158.75	62.29	Hg(l)	0	76.03	0
F ⁻ (aq)	-332.63	-13.8	-278.79	Hg ²⁺ (aq)	171.1	-32.2	164.40
HF(g)	-272.55	173.78	-274.65	Hg ₂ ²⁺ (aq)	172.4	84.5	153.52
HF(aq)	-320.08	88.7	-296.82	HgCl ₂ (s)	-230.12	144.49	-184.02
Hydrogen				Hg ₂ Cl ₂ (s)	-264.93	192.54	-210.48
H ₂ (g)	0	130.68	0	HgO(s)	-90.79	70.27	-58.49
H(g)	218.00	114.72	203.28	HgS(s)	-58.2	82.4	-50.6
H ⁺ (aq)	0	0	0	Nitrogen			
Iodine				N ₂ (g)	0	191.61	0
I ₂ (s)	0	116.14	0	NH ₃ (g)	-45.90	192.77	-16.37
I ₂ (g)	62.42	260.68	19.32	NH ₃ (aq)	-80.29	111.3	-26.50
I(g)	106.76	180.79	70.17	NH ₄ ⁺ (aq)	-132.51	113.4	-79.31
I ⁻ (aq)	-55.19	111.3	-51.57	NH ₄ Cl(s)	-314.55	94.86	-203.09
HI(g)	26.36	206.59	1.56	N ₂ H ₄ (l)	50.63	121.54	149.44
ICl(g)	17.51	247.57	-5.74	N ₂ H ₄ (aq)	34.31	138	128.1
Iron				NO(g)	90.29	210.76	86.60
Fe(s)	0	27.32	0	N ₂ O(g)	82.05	219.96	104.18
Fe ²⁺ (aq)	-89.1	-137.7	-78.90	NO ₂ (g)	33.10	240.03	51.26
Fe ³⁺ (aq)	-48.5	-315.9	-4.7	N ₂ O ₄ (s)	-35.05	150.29	99.60
FeO(s)	-272.04	60.75	-251.43	N ₂ O ₄ (g)	9.08	304.38	97.79
Fe(OH) ₂ (s)	-574.04	87.86	-491.97	NO ₃ ⁻ (aq)	-205.0	146.4	-108.74
Fe ₂ O ₃ (s)	-825.50	87.40	-743.52	CINO(g)	51.71	261.68	66.10
FeCl ₂ (s)	-341.83	117.95	-302.34	Oxygen			
Lead				O ₂ (g)	0	205.15	0
Pb(s)	0	64.78	0	O ₂ (aq)	-11.7	110.9	16.4
Pb ²⁺ (aq)	-1.7	10.5	-24.43	O ₃ (g)	142.67	238.93	163.18
PbO(s)	-219.41	66.32	-189.28	H ₂ O(l)	-285.83	69.95	-237.14
PbO ₂ (s)	-274.47	71.80	-215.40	H ₂ O(g)	-241.83	188.83	-228.58
PbS(s)	-98.32	91.34	-96.68	OH ⁻ (aq)	-229.99	-10.75	-157.24
PbSO ₄ (s)	-919.94	148.57	-813.14	H ₂ O ₂ (aq)	-191.17	143.9	-134.03
Lithium				Phosphorus			
Li(s)	0	29.08	0	P(s) (white)	0	41.08	0
Li ⁺ (aq)	-278.49	13.4	-293.31	PH ₃ (g)	5.44	210.24	7.19

	ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol		ΔH_f° kJ/mol	S° J/K·mol	ΔG_f° kJ/mol	
$\text{PCl}_3(g)$	-288.70	311.68	-269.61	Sulfur	$\text{S}(s) (\alpha)$	0	32.06	0
$\text{PCl}_5(g)$	-360.18	364.29	-290.27		$\text{S}^{2-}(aq)$	33.1	-14.6	85.8
$\text{P}_4\text{O}_{10}(s)$	-3009.9	228.78	-2723.3		$\text{HS}^-(aq)$	-17.6	62.8	12.08
$\text{H}_3\text{PO}_4(aq)$	-1288.3	158.2	-1142.5		$\text{H}_2\text{S}(g)$	-20.50	205.76	-33.33
$\text{H}_2\text{PO}_4^-(aq)$	-1296.3	90.4	-1130.3		$\text{H}_2\text{S}(aq)$	-39.7	121	-27.83
$\text{HPO}_4^{2-}(aq)$	-1292.1	-33.5	-1089.2		$\text{SO}_2(g)$	-296.84	248.21	-300.12
$\text{PO}_4^{3-}(aq)$	-1277.4	-222	-1018.7		$\text{SO}_2(aq)$	-322.98	161.9	-300.68
Potassium					$\text{HSO}_3^-(aq)$	-626.22	139.7	-527.73
$\text{K}(s)$	0	64.67	0		$\text{SO}_3^{2-}(aq)$	-635.5	-29	-486.5
$\text{K}(l)$	2.27	71.40	0.26		$\text{SO}_3(g)$	-395.76	256.77	-371.02
$\text{K}(g)$	89.00	160.34	60.48		$\text{HSO}_4^-(aq)$	-887.34	131.8	-755.91
$\text{K}^+(aq)$	-252.38	102.5	-283.27		$\text{SO}_4^{2-}(aq)$	-909.27	20.1	-744.53
$\text{KCl}(s)$	-436.68	82.55	-408.76		$\text{SO}_2\text{Cl}_2(g)$	-354.80	311.10	-310.32
$\text{KClO}_3(s)$	-397.73	143.1	-296.25		$\text{S}_2\text{Cl}_2(l)$	-58.16	223.84	-39.27
$\text{KBr}(s)$	-393.80	95.94	-380.43		Tin			
$\text{KNO}_3(s)$	-494.63	133.05	-394.86		$\text{Sn}(s)$	0	51.55	0
$\text{KOH}(s)$	-424.72	78.91	-378.90		$\text{SnO}(s)$	-285.8	56.5	-256.9
Selenium					$\text{SnO}_2(s)$	-580.7	52.3	-519.6
$\text{Se}(s)$	0	42.44	0		$\text{SnCl}_4(l)$	-511.3	258.6	-440.1
$\text{H}_2\text{Se}(g)$	29.7	219.02	15.9		Zinc			
Silicon					$\text{Zn}(s)$	0	41.72	0
$\text{Si}(s)$	0	18.82	0		$\text{Zn}^{2+}(aq)$	-153.89	-112.1	-147.06
$\text{SiH}_4(g)$	34.31	204.65	56.83		$\text{ZnCl}_2(s)$	-415.05	111.46	-369.40
$\text{SiF}_4(g)$	-1614.94	282.76	-1572.71	$\text{ZnO}(s)$	-348.28	43.64	-318.30	
$\text{SiCl}_4(g)$	-662.75	330.94	-662.78	$\text{ZnS}(s)$	-205.98	57.7	-201.29	
$\text{SiO}_2(s)$	-905.49	50.05	-853.64					
Silver								
$\text{Ag}(s)$	0	42.55	0					
$\text{Ag}^+(aq)$	105.58	72.68	77.11					
$\text{AgCl}(s)$	-127.07	96.2	-109.79					
$\text{Ag}_2\text{CO}_3(s)$	-505.8	167.4	-436.8					
$\text{Ag}_2\text{O}(s)$	-31.05	121.3	-11.20					
Sodium								
$\text{Na}(s)$	0	51.46	0					
$\text{Na}(l)$	2.41	57.86	0.50					
$\text{Na}^+(aq)$	-240.12	59.0	-261.90					
$\text{NaCl}(s)$	-411.12	72.12	-384.02					
$\text{NaBr}(s)$	-361.41	86.82	-349.27					
$\text{NaOH}(s)$	-425.93	64.44	-379.74					
$\text{Na}_2\text{CO}_3(s)$	-1130.8	138.80	-1048.0					
$\text{NaHCO}_3(s)$	-950.81	101.7	-851.0					
$\text{NaNO}_3(s)$	-467.85	116.52	-367.00					

Appendix D**ANSWERS TO
END-OF-CHAPTER PROBLEMS****Chapter 1**

- FTFTFFFT
- a. 104.6 b. 2,490 c. 0.204
- 98.6 °F, 310.2 K
- 1,079 mph

Chapter 2

- TTTTTF
- TTFTFTTTT
- FTTTTF
- a. 116 b. 20 c. 31 d. 16 e. 6 f. 19
- a. Br b. Ar c. Li d. 5 e. 2 f. Rb g. He i. F (F₂)
- 107.869 u
- 60.04% or 60.0% (There are two ways of doing this problem.)

Chapter 3

- TTFT
- a. V³⁺ b. P³⁻
- a. 24 b. 39
- a. Te b. Pd

Chapter 4

- TTTTFF
- TTFFFF
- TTTFTT
- KNO₃, NH₄F
- SiO₂, ClF₃, B₂H₆
- K₂O, CaCO₃
- a. 2+ b. 1- c. 2-
- a. 2 b. 25 c. 1-
- a. 18 b. 78 c. 1-
- a. AuI b. C₄H₁₀ c. K₂CrO₄ d. NI₃
- a. Se₂S₆ b. Ni(NO₃)₃ c. H₂O₂ d. NaHCO₃
- a. SO₃ b. Co₂(SO₄)₃ c. NaNO₂ d. Al₂O₃
- a. PCl₅ b. LiH c. Ba(CH₃CO₂)₂ d. Fe(CN)₃
- a. lithium nitride b. chromium(III) perchlorate c. silicon dioxide d. methane
- a. chlorine trifluoride b. ammonium bisulfate or ammonium hydrogen sulfate
c. copper(I) sulfite d. mercury(I) nitrate
- a. iron(II) oxalate b. potassium phosphate c. lead(IV) oxide d. disulfur dichloride

17. a. hydrogen sulfide chlorate b. calcium thiosulfate c. nitrogen dioxide d. manganese(III)

Chapter 5

1. F T T T
2. a. 260.0 b. 96.09 c. 209.98
3. a. 301.43 u b. 166.90 u
4. a. 48.11 g b. 319.1 g c. 239.6 g
5. a. 154.96 g b. 257.83 g
6. 9.689 g
7. a. 0.04444 mol b. 1.606×10^{23} C atoms
8. a. 33.37% b. 43.71%
9. a. BCl b. B_4Cl_4
10. a. H_2SiF b. $H_4Si_2F_2$

Chapter 6

1. a. $B_2H_6 + 6 HF \rightarrow 2 BF_3 + 6 H_2$
 b. $PCl_5 + 4 H_2O \rightarrow H_3PO_4 + 5 HCl$
 c. $Cl_2SO + H_2O \rightarrow SO_2 + 2 HCl$
 d. $2 K_3AsO_4 + 3 CaCO_3 \rightarrow Ca_3(AsO_4)_2 + 3 K_2CO_3$
2. a. $5 F_2CO + 2 SbCl_5 \rightarrow 5 Cl_2CO + 2 SbF_5$
 b. $Fe_2O_3 + 6 HBr \rightarrow 2 FeBr_3 + 3 H_2O$
 c. $2 H_2S + 3 O_2 \rightarrow 2 H_2O + 2 SO_2$
 d. $2 AgNO_3 + H_2C_2O_4 \rightarrow Ag_2C_2O_4 + 2 HNO_3$
3. a. $Mg_2SiO_4 + 8 HF \rightarrow 2 MgF_2 + 4 H_2O + SiF_4$
 b. $2 C_2H_3Cl + 5 O_2 \rightarrow 4 CO_2 + 2 HCl + 2 H_2O$
 c. $PbI_2 + 2 KHSO_4 \rightarrow PbSO_4 + 2 KI + H_2SO_4$
 d. $COCl_2 + 4 KOH \rightarrow 2 KCl + K_2CO_3 + 2 H_2O$
4. a. $AlCl_3 + Na_3PO_4 \rightarrow AlPO_4 + 3 NaCl$
 b. $Co(CH_3CO_2)_2 + (NH_4)_2S \rightarrow CoS + 2 NH_4CH_3CO_2$
 c. $ClF_3 + 4 NaOH \rightarrow NaClO_2 + 3 NaF + 2 H_2O$
5. $2 C_3H_9Al + 12 O_2 \rightarrow 6 CO_2 + 9 H_2O + Al_2O_3$
6. $C_{12}H_{22}O_{11} + 12 O_2 \rightarrow 12 CO_2 + 11 H_2O$
7. First step: $CaCO_3 + 2 HCl \rightarrow CaCl_2 + H_2CO_3$
 Second step: $H_2CO_3 \rightarrow CO_2 + H_2O$
 Overall: $CaCO_3 + 2 HCl \rightarrow CaCl_2 + CO_2 + H_2O$
 H_2CO_3 is the intermediate.

Chapter 7

1. 8.765 g
2. 35.34 g
3. 2.53 g

4. 10.2 g
5. 66.10 g
6. 38.40 g
7. 7.08 g
8. 194 g

Chapter 8

1. T T T
2. 8.963 g
3. a. 19.0 g b. 23.6 g c. 10.5 g
4. 95.6%
5. 88.3%

Chapter 9

1. 0.486 M
2. 0.754 M
3. 21.8 g
4. 41 g
5. 11.6 g
6. 573 mL
7. 5.780 g
8. 8.235 g
9. 49.1 g

Chapter 10

1. T F F T F
2. H_3O^+ , H_5O_2^+

Chapter 11

1. T T F F T T F
2. F F T F T F T
3. a, b, e
4. $\text{Al}(\text{OH})_3$, CuCl , CaC_2O_4
5. NH_4HS , $\text{Fe}(\text{NO}_3)_3$, MgSO_4 , CuClO_4 , $\text{K}_2\text{S}_2\text{O}_3$
6. a. CaSO_4 b. CoCO_3 c. CuC_2O_4 d. NiCrO_4
7. $2 \text{AgNO}_3(\text{aq}) + \text{ZnBr}_2(\text{aq}) \rightarrow 2 \text{AgBr}(\text{s}) + \text{Zn}(\text{NO}_3)_2(\text{aq})$
 $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$
8. $(\text{NH}_4)_2\text{CO}_3(\text{aq}) + \text{Mg}(\text{CH}_3\text{CO}_2)_2(\text{aq}) \rightarrow 2 \text{NH}_4\text{CH}_3\text{CO}_2(\text{aq}) + \text{MgCO}_3(\text{s})$
 $\text{CO}_3^{2-}(\text{aq}) + \text{Mg}^{2+}(\text{aq}) \rightarrow \text{MgCO}_3(\text{s})$
9. $\text{Hg}(\text{ClO}_4)_2(\text{aq}) + \text{K}_2\text{S}(\text{aq}) \rightarrow 2 \text{KClO}_4(\text{aq}) + \text{HgS}(\text{s})$
 $\text{Hg}^{2+}(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{HgS}(\text{s})$
10. Precipitates: AgCl , PbCl_2
 Spectator ions: K^+ , ClO_4^- , NO_3^-

11. Strong acids: HI, H₂SO₄, HBr

Weak acids: HClO, HNO₂, H₃PO₄, CH₃CO₂H

12. H⁺(aq) (or specifically, H₃O⁺(aq) and H₅O₂⁺(aq)), and NO₃⁻(aq)

13. Ions: H⁺(aq) (or specifically, H₃O⁺(aq) and H₅O₂⁺(aq)), and ClO₂⁻(aq)

Neutral molecules: HClO₂(aq)

Chapter 12

1. F F T T T F

2. T T T T T T

3. a. HF b. H₂C₂O₄ c. HClO d. H₂CO₃

4. a. hydrobromic acid b. nitrous acid c. arsenic acid d. hydrocyanic acid

5. a. LiNO₃ b. NH₄Cl c. NaCH₃CO₂ d. CaCl₂

6. KOH(aq) + HBr(aq) → KBr(aq) + H₂O(l)

OH⁻(aq) + H⁺(aq) → H₂O(l)

7. NaOH(aq) + HClO₂(aq) → NaClO₂(aq) + H₂O(l)

OH⁻(aq) + HClO₂(aq) → ClO₂⁻(aq) + H₂O(l)

8. NH₃(aq) + HF(aq) → NH₄F(aq)

NH₃(aq) + HF(aq) → NH₄⁺(aq) + F⁻(aq)

9. H₃PO₄(aq) + KOH(aq) → KH₂PO₄(aq) + H₂O(l)

H₃PO₄(aq) + 3 KOH(aq) → K₃PO₄(aq) + 3 H₂O(l)

10. Na₂SO₃(aq) + 2 HClO₄(aq) → 2 NaClO₄(aq) + H₂O(l) + SO₂(g)

SO₃²⁻(aq) + 2 H⁺(aq) → H₂O(l) + SO₂(g)

11. BaCO₃(s) + 2 HBr(aq) → BaBr₂(aq) + H₂O(l) + CO₂(g)

BaCO₃(s) + 2 H⁺(aq) → Ba²⁺(aq) + H₂O(l) + CO₂(g)

Chapter 13

1. T F F T F F F

2. a. H: +1 As: +3 O: -2 b. Na: +1 O: -1/2

c. Sn: +2 Cl: -1 d. S: +1 O: -2

3. a. Ca: +2 Se: +4 O: -2 b. C: -1/3 H: +1 Cl: -1

c. H: +1 S: -2/3 d. Te: +4 O: -2 F: -1

4. a. Cr²⁺ b. MnO₄⁻ c. MnO₄⁻ d. Cr²⁺

5. a. Br₂ b. SO₄²⁻ c. SO₄²⁻ d. Br₂

6. a. V²⁺ b. IO₆⁵⁻ c. IO₆⁵⁻ d. V²⁺

Chapter 14

1. a. H₃PO₂ + 2 Cu²⁺ + 2 H₂O → H₃PO₄ + 2 Cu + 4 H⁺

b. 2 HNO₂ + 2 H⁺ + 2 Cl⁻ → N₂O + H₂O + 2 HClO

c. 2 BrO₃⁻ + 8 OH⁻ + 5 Zn → Br₂ + 4 H₂O + 5 ZnO₂²⁻

2. a. 2 Co³⁺ + NO₂⁻ + H₂O → 2 Co²⁺ + NO₃⁻ + 2 H⁺

b. 2 S₂O₆²⁻ + 2 H₂O + IO⁻ → 4 SO₂ + IO₃⁻ + 4 OH⁻

c. 2 ClO₂ + 8 H⁺ + 5 Co → 2 Cl⁻ + 4 H₂O + 5 Co²⁺

3. a. 2 b. 6 c. 6

Chapter 15

1. 7.14 g CaC_2O_4
2. 22.7 g KNO_3
3. 0.1669 g
4. 0.5378 g, 6.72% by mass
5. 2.09 g PbCl_2
6. 7.91 g $\text{Ba}(\text{ClO}_3)_2$
7. 73%
8. 64%

Chapter 16

1. T F T T F F
2. 0.042 mol
3. 0.585 atm
4. 3.06 L
5. 1.52 atm
6. Cl_2 , BF_3 , SF_4
7. 0.760 g/L
8. C_2F_4
9. 0.790 atm
10. 46.6%
11. 0.702 g/L

Chapter 17

1. T T F T T
2. T T F T F
3. 6.08 L
4. 158 Torr
5. 0.296 atm
6. 1.99 atm
7. $a < d < c < b < e$
8. 642 m/s
9. 1,920 m/s
10. 87.8 g/mol

Chapter 18

1. T F T F F
2. T T F F F
3. -140 kJ
4. 41 cal

Chapter 19

- T F T T T T
- For example: $\text{He}(g)$, $\text{Ne}(g)$, $\text{Ar}(g)$, $\text{Kr}(g)$, $\text{Xe}(g)$, $\text{H}_2(g)$, $\text{N}_2(g)$, $\text{O}_2(g)$, $\text{F}_2(g)$, $\text{Cl}_2(g)$, $\text{Br}_2(l)$, $\text{I}_2(s)$, $\text{C}(\text{graph})$
- $\text{Zn}(s) + \text{N}_2(g) + 3 \text{O}_2(g) \rightarrow \text{Zn}(\text{NO}_3)_2(s)$
 - $2 \text{C}(\text{graph}) + 5/2 \text{H}_2(g) + 1/2 \text{I}_2(s) \rightarrow \text{C}_2\text{H}_5\text{I}(l)$
 - $1/2 \text{H}_2(g) + 1/2 \text{Cl}_2(g) + 3/2 \text{O}_2(g) \rightarrow \text{HClO}_3(l)$
 - $1/2 \text{Br}_2(l) + 1/2 \text{N}_2(g) + 1/2 \text{O}_2(g) \rightarrow \text{BrNO}(l)$
 - $2 \text{Hg}(l) + 1/2 \text{O}_2(g) \rightarrow \text{Hg}_2\text{O}(s)$
- 617.2 kJ
- 2,844.94 kJ
- 103.0 kJ
- 88.32 kJ
- 646.24 kJ
- 269 kJ
- 1,786 Cal
- 86.3 kJ
- 153 kJ
- 103 g

Chapter 20

- F F T F T
- F F T F T
- $5.45 \times 10^{-16} \text{ J}$
- 587 kJ
120. kJ
- $-2.42 \times 10^{-19} \text{ J}$
- $-3.49 \times 10^{-17} \text{ J}$
- $2.91 \times 10^{-19} \text{ J}$
- $5.01 \times 10^{-19} \text{ J}$, 397 nm
- $-1.55 \times 10^{-19} \text{ J}$, 1,280 nm

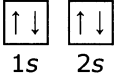
Chapter 21

- T T T T T T
- T T T T F F
- Different colors arise from different transition energies. This will cause absorption of photons which have different energies and different wavelengths.
- l b. m_l
- 4 b. 9 c. 5
- 25 b. 6 c. s
- 2d, 4g

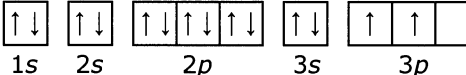
Chapter 22

1. T F F T T

2. F T T T F

3. a. $1s^2 2s^2$ b. $1s^2 2s^2 2p^6 3s^2 3p^2$ 4. a. 

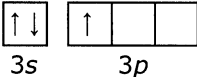
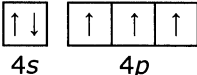
Be has zero unpaired electrons.

b. 

Si has two unpaired electrons.

Chapter 23

1. T T F F F

2. S: $1s^2 2s^2 2p^6 3s^2 3p^4$ S^{2-} : $1s^2 2s^2 2p^6 3s^2 3p^6$ 3. Ca: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ Ca^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6$ 4. a. $[He]2s^2 2p^3$ b. $[Kr]5s^2 4d^2$ c. $[Xe]6s^2 4f^{14} 5d^6$ d. $[Ar]4s^2 3d^5$ 5. a. $[He]2s^2 2p^1$ b. $[Ar]4s^2 3d^1$ c. $[Xe]6s^2 4f^{14} 5d^{10} 6p^3$ d. $[Rn]7s^2 5f^5$ 6. a. $[Ar]$ b. $[Kr]$ c. $[Ar]3d^5$ d. $[Ne]$ 7. a. $[Xe]$ b. $[Kr]4d^{10}$ c. $[Xe]4f^{14} 5d^5$ d. $[Ar]$ 8. 9. 

10. a. 2 valence, 18 core b. 5 valence, 46 core c. 4 valence, 78 core d. 7 valence, 2 core

11. a. Al b. 4 c. Rh

12. a. Sn b. Te c. P

13. a. 6 b. I c. Pd

14. a. He b. K c. Cl

15. a. N b. Be c. O

16. Cl

17. Na^+ **Chapter 24**

1. T T F T F

2. T T T F F

3. In^{3+} , Hg^{2+} , Sn^{4+} 4. Ca, Ca^{2+} , Mg^{2+} , Cd^{2+} 5. Al^{3+} , Zn^{2+}

6. a. 4 b. 2 c. 5 d. 1

7. a. 4 b. 2 c. 0 d. 4

8. a. Mo, Ru b. Ba c. Mg

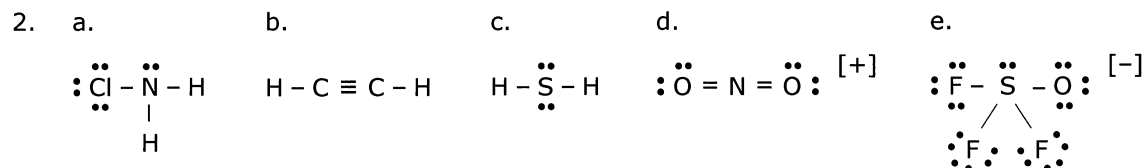
9. Br

10. Te^{2-} **Chapter 25**

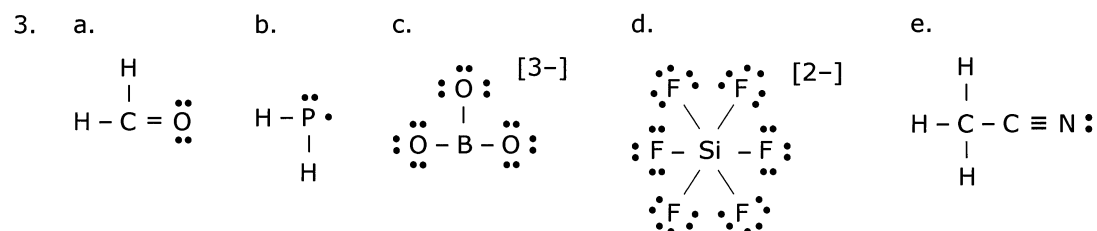
1. F F T T T F F T
2. MgO
3. Si-P
4. P
5. As-F

Chapter 26

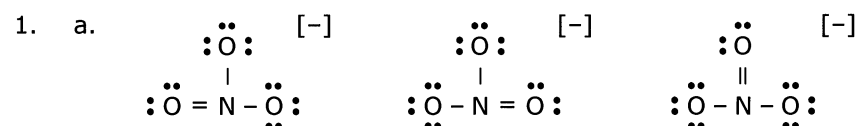
1. T T F F



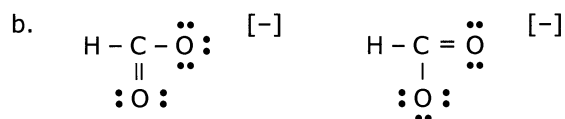
- a. One NCl single bond, two NH single bonds. Three lone pairs on Cl, one lone pair on N.
- b. Two CH single bonds, one CC triple bond. No lone pairs.
- c. Two HS single bonds. Two lone pairs on S.
- d. Two NO double bonds. Two lone pairs on each O.
- e. Three SF single bonds, one SO single bond. Three lone pairs on each F, three lone pairs on O, one lone pair on S.



PH_2 has an odd number of electrons. BO_3^{3-} is electron deficient. SiF_6^{2-} has expanded valence.

Chapter 27

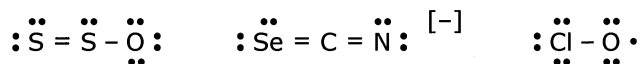
The average NO bond order is $4/3$ (1.33).



The average CO bond order is $3/2$ (1.5).

2. The estimate using bond energies is -106 kJ. The actual ΔH° is -90.13 kJ. Although the estimate is high, bond energies still make up the major portion of the actual ΔH° .
3. a. ON: +2 on C, -2 on O. FC: -1 on C, +1 on O.
b. ON: -2 on O, +1 on each H. FC: +1 on O, zero on each H.

- c. ON: +3 on B, -1 on each H. FC: -1 on B, zero on each H.
 d. ON: +3 on Br, -1 on each F. FC: -1 on Br, zero on each F.
 e. ON: +5 on N, -2 on each O. FC: +1 on N, -1 on each O.
4. a. b. c.



Chapter 28

1. a. trigonal planar OLR, bent shape b. tetrahedral OLR, trigonal pyramidal shape
 c. trigonal planar OLR and shape d. tetrahedral OLR, bent shape
 e. tetrahedral OLR and shape f. linear OLR and shape
2. a. trigonal pyramidal b. linear c. trigonal planar d. bent e. tetrahedral
 f. bent

Chapter 29

1. a. octahedral OLR, square planar shape b. tbp OLR, seesaw shape
 c. tbp OLR and shape d. tbp OLR, linear shape
 e. octahedral OLR and shape f. tbp OLR, T-shape
 g. octahedral OLR, square pyramidal shape
2. a. square planar b. linear c. tbp d. octahedral e. T-shaped
3. N is trigonal pyramidal. C (next to N) is tetrahedral. C (with O's) is trigonal planar. O is bent.
4. a. 180° b. 120° c. 109.5° d. $90^\circ, 120^\circ, 180^\circ$ e. $90^\circ, 180^\circ$
5. $\text{PF}_3, \text{O}_3, \text{BrF}_3$
6. $\text{PF}_3, \text{SeCl}_2, \text{BrF}_3$
7. $\text{Cl}_2\text{SO}, \text{XeO}_2, \text{H}_2\text{CO}, \text{ClF}_3\text{O}$

Chapter 30

1. T T F F F F
2. a. sp^2 b. sp^3 c. sp^2 d. sp^3 e. sp^3 f. sp
3. a. O, sp^3 b. N, sp^3 c. Ge, sp^2 d. Al, sp^2
4. a. Each SiH bond orbital derives from $(\text{Si})sp^3 + (\text{H})1s$. There are no lone pairs.
 b. The II bond orbital derives from $(\text{I})5p + (\text{I})5p$. Each I holds three lone pairs in the remaining 5s and 5p atomic orbitals.
 c. Each GaBr bond derives from $(\text{Ga})sp^2 + (\text{Br})4p$. Each Br holds three lone pairs in its remaining 4s and 4p orbitals.

Chapter 31

1. F T T F F
2. a. Three σ bonds. b. One σ bond.
 c. Two σ bonds and two π bonds. d. Three σ bonds and two π bonds.
3. a. The NO triple bond results from one σ and two π interactions. The σ bond is due to $(\text{N})sp + (\text{O})sp$ while the π bonds arise from $(\text{N})2p + (\text{O})2p$.
 b. The ClC single bonds are σ type and each arises from $(\text{Cl})3p + (\text{C})sp^2$. The CS double bond is composed of one σ bond from $(\text{C})sp^2 + (\text{S})sp^2$ and one π bond from $(\text{C})2p + (\text{S})3p$.

4. a. The C's are trigonal planar, trigonal planar and linear.
- b. The hybridizations are C sp^2 ; C sp^2 ; C sp and N sp .
- c. The first CC bond is composed of one σ bond (from (C) sp^2 + (C) sp^2) and one π bond (from (C) $2p$ + (C) $2p$). The second CC bond is σ type and it arises from (C) sp^2 + (C) sp . All CH bonds are σ type and arise from (C) sp^2 + (H) $1s$. The CN bond is composed of one σ bond (from (C) sp + (N) sp) and two π bonds (from (C) $2p$ + (N) $2p$).
- d. The lone pair on N is in an sp hybrid orbital.

Chapter 32

1. $(\sigma_{1s})^2(\sigma_{1s}^*)^1$, bond order = 0.5, one unpaired electron
2. The configuration is $(\sigma_{2s})^1$ and the bond order is one-half, so it can exist.

Chapter 33

1. F T F T F F T
2. a. $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2p})^4$ Bond order = 2; diamagnetic; zero unpaired electrons
- b. $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4(\pi_{2p}^*)^2$ Bond order = 2; paramagnetic; two unpaired electrons
- c. $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\pi_{2p})^4(\sigma_{2p})^2(\pi_{2p}^*)^1$ Bond order = 2.5; paramagnetic; one unpaired electron
- d. $(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p})^2(\pi_{2p})^4(\pi_{2p}^*)^3$ Bond order = 1.5; paramagnetic; one unpaired electron
3. a. Bond order = 1.5; one unpaired electron b. Bond order = 0.5; one unpaired electron
- c. Bond order = 3; zero unpaired electrons d. Bond order = 2.5; one unpaired electron

CONVERSIONS AND CONSTANTS

Length units	inch (in) = 2.54 cm (exact) mile (mi) = 1.609 km
Volume units	L = 1.057 qt
Mass units	lb = 453.6 g $u = 1.6605 \times 10^{-24}$ g
Pressure units	atm = 760 Torr = 14.7 psi
Energy units	$J = \text{kg} \cdot \text{m}^2/\text{s}^2 = \text{V} \cdot \text{C}$ cal = 4.184 J (exact) Cal (nutritional) = 4.184 kJ (exact)
Avogadro's number	6.022×10^{23}
Gas constant	$R = 0.08206 \text{ L} \cdot \text{atm}/(\text{mol} \cdot \text{K}) = 8.314 \text{ J}/(\text{mol} \cdot \text{K})$
Speed of light (in vacuum)	$c = 3.00 \times 10^8 \text{ m/s}$
Planck's constant	$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$
Coulomb	$C = 6.242 \times 10^{18}$ charges
Faraday constant	96,485 C/mol
Mass-energy	$u = 931.5 \text{ MeV}$