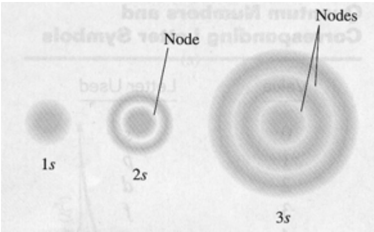
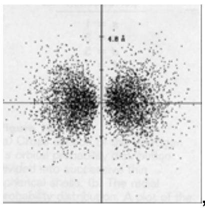
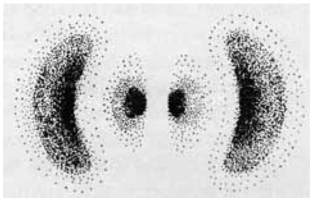
Answer 7: Atomic Orbitals

7-1



1s: 0, 2s: 1 and 3s: 2.

7-2

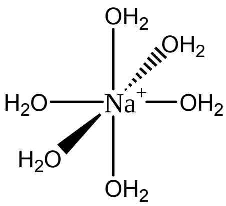
$2p_z$ , $3p_z$ 

There is one angular node for $2p_z$; one angular node and one spherical node for $3p_z$.

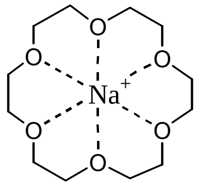
7-3 (0, 2, 4, 1, 3)

Answer 8: Intermolecular Forces

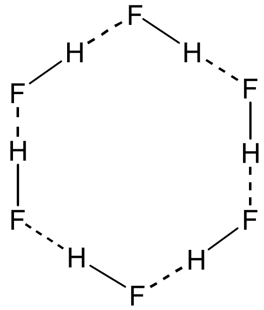
8-1-1



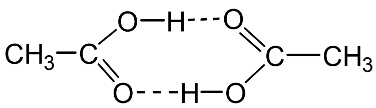
8-1-2



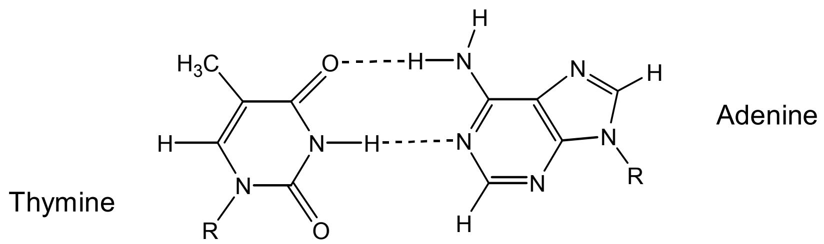
8-2-1

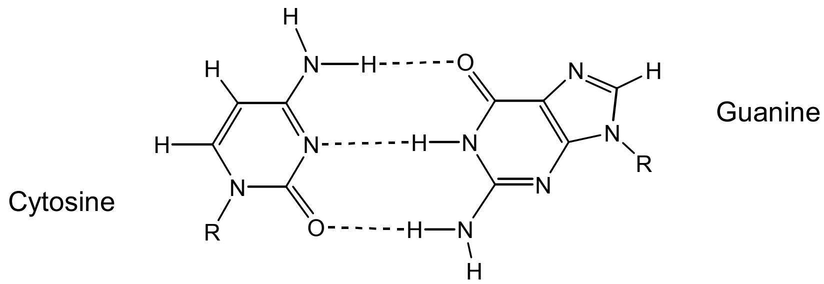


8-2-2



8-3





Answer 9: Crystal Packing

9-1 Simple cubic: 6, body-centered cubic: 8 and face-centered cubic: 12

9-2

For simple cubic, a = 2r, $f_v = \frac{\frac{4}{3}\pi r^3}{a^3} = 52.4\%$

For body-centered cubic, $\sqrt{3}a = 4r$, $f_v = \frac{2 \times \frac{4}{3}\pi r^3}{a^3} = 68\%$

For face-centered cubic, $\sqrt{2}a = 4r$, $f_v = \frac{4 \times \frac{4}{3}\pi r^3}{a^3} = 74\%$

9-3 $\sqrt{2}a = 4r$, $a = 2\sqrt{2}r = 407\,pm$

$$d = \frac{4 \times \frac{107.9}{6.02 \times 10^{23}}}{(407\ pm)^3} = 10.6\ \text{g/cm}^3$$

9-4

$$2d \sin\theta = \lambda$$

$$\lambda = 2 \times 201 \times \sin 17.34^{\circ} = 229\ \text{pm}$$

Answer 10: Applications of Transition Metals

10-1-1

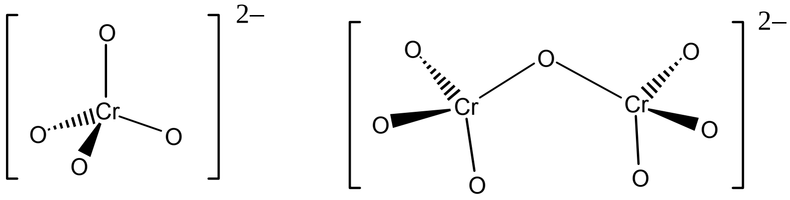
$$2\ CrO_4^{2-}\ (aq) \quad + \quad 2\ H^+\ (aq) \quad \rightleftharpoons \quad Cr_2O_7^{2-}\ (aq) \quad + \quad H_2O\ (l)$$

10-1-2 CrO_4^{2-}: + 6, $Cr_2O_7^{2-}$: +6.

10-1-3 This is not a redox reaction because the oxidation state in each metal center does not change.

10-1-4 Hydrogen ion concentration is the main factor to control the equilibrium position.

10-1-5



10-2-1

Cathode	$Cr_2O_7^{2-}$ + 14 H^+ + 12e^- ⟶ 2 Cr + 7 H_2O	
Anode	2 H_2O ⟶ O_2 + 4 H^+ + 4e^-	
Overall	$Cr_2O_7^{2-}$ (*aq*) + 2 H^+ (*aq*) ⟶ H_2O (*l*) + 2 Cr (*s*) + 3 O_2 (*g*)	

10-2-2 1.5 moles of oxygen gas will evolve.

Cathode	$Cr_2O_7^{2-}$ + 14 H^+ + 12e^- ⟶ 2 Cr + 7 H_2O	
Anode	(2 H_2O ⟶ O_2 + 4 H^+ + 4e^-) x 3	
Overall	$Cr_2O_7^{2-}$ (*aq*) + 2 H^+ (*aq*) ⟶ H_2O (*l*) + 2 Cr (*s*) + 3 O_2 (*g*)	

$$52 \text{ g Cr} \times \frac{1 \text{ mol Cr}}{52 \text{ g}} \times \frac{3 \text{ mol O2}}{2 \text{ mol Cr}} = 1.5 \text{ mol } O_2$$

10-2-3 16 h

$$52 \text{ g Cr} \times \frac{1 \text{ mol Cr}}{52 \text{ g}} \times \frac{6 \text{ F}}{\text{mol Cr}} \times \frac{96485 \text{ C}}{1 \text{ F}} \times \frac{1 \text{ sec}}{10 \text{ C}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 \text{ h}}{60 \text{ min}} = 16 \text{ h}$$

10-2-4 Chromium readily forms a thin, adherent, transparent coating of Cr_2O_3 in air, making the metal extremely useful as an attractive protective coating on easily corroded metals.

Answer 11: Electrochemistry of Inorganic Compounds

11-1 For the concentration cell: $Mn_{(s)}$ | $Mn^{2+}_{(aq)}$ (1M) || $Mn^{2+}_{(aq)}$ / $MnCO_3$ | $Mn_{(s)}$,

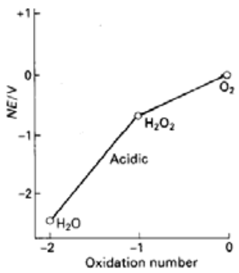
$E_{cell} = E^{o} – (0.0592 / 2) \log ([Mn^{2+}]_{right} / [Mn^{2+}]_{left})$

$K_{sp} = 1.8 \times 10^{-11} = [Mn^{2+}][CO_3^{2-}]$

$[Mn^{2+}]_{right} = 1.0 \times 10^{-8}$ M and $[Mn^{2+}]_{left}$= 1.0 M with E^{o} = 0.0 V (both are Mn)

$E_{cell} = 0.0 - (0.0592 / 2) \log (1.0 \times 10^{-8}$ M / 1.0 M) = 0.237 V

11-2



Reduction of O_2 to H_2O is obtained as (0.70V+1.76V) / 2 = 1.23 V,

for $O_2 + 4H^{+} + 4e^{-} \rightarrow 2 H_2O$ E^{o} = 1.23V

刪除: 2H2

The E^{o} value could be obtained directly from the diagram by dividing the differences (2.46) of O_2 and H_2O by the differences of the oxidation number (2).

For $H_2O_2 \rightarrow O_2 + H_2O$ E^{o} = 1.06 > 0.0

刪除: 00

The disproportionation reaction is spontaneous.

11-3 The number of electron pair should be 5 (trigonal bipyramidal) with three electron pairs in the equatorial plane, thus the molecular geometry of XeF_2 is linear.

$2 H_2O \rightarrow O_2 + 4H^{+} + 4e^{-}$ E^{o} = -1.23V

刪除: 2H

$XeF_{2(aq)} + 2H^{+}_{(aq)} + 2e^{-} \rightarrow Xe_{(g)} + 2HF_{(aq)}$ E^{o} = 2.32V

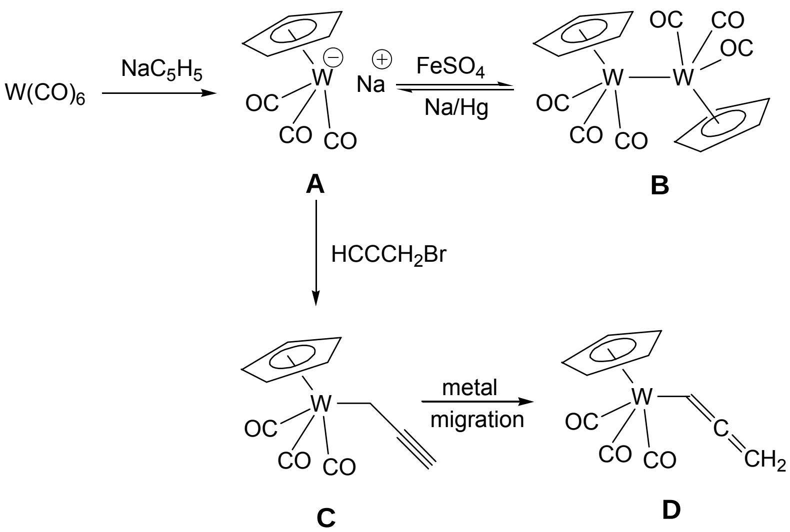
$2 XeF_{2(aq)} + 2H^{+}_{(aq)} + 2 H_2O \rightarrow 2 Xe_{(g)} + O_2 + 4HF_{(aq)}$ E^{o} = 1.09 V

The decomposition of XeF_2 in aqueous solution is favored in acidic solution.

Answer 12: Metal Carbonyl Compounds

12-1 Compound **A** is anionic, the absorption bands attributed to CO stretching appear at lower frequency because of stronger back donation of the anionic charge to the anti bonding orbital of CO thus weakening the CO bond. For the neutral species **B**, absorption bands appear at the higher frequency.

12-2



12-3