Cem 151
Exam 2
October 21, 2022

Choose the best answer from the choices (7 points each)

1. Which of the following are **not** strong electrolytes?
   (a) hydrobromic acid   (d) nitrous acid   **(g) d and e**   (j) all of the above
   (b) sodium hydroxide   (e) chlorous acid   (h) c, d, e
   (c) ammonium acetate   (f) a, b, c   (i) none of the above

2. The net ionic equation for reaction of sodium bicarbonate and hydrochloric acid is:
   (a) $Na_2CO_{3(aq)} + 2HCl_{(aq)} \rightarrow H_2CO_{3(aq)} + 2NaCl_{(aq)}$
   (b) $NaHCO_{3(aq)} + HCl_{(aq)} \rightarrow H_2CO_{3(aq)} + NaCl_{(aq)}$
   (c) $2Na^{+1} + CO_3^{-2}{}_{(aq)} + 2H^+ + Cl^-{}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + 2Na^+ + 2Cl^{-2}{}_{(aq)}$
   (d) $CO_3^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$
   (e) $NaHCO_{3(aq)} + HCl_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + NaCl_{(aq)}$
   (f) $HCO_3^-{}_{(aq)} + H^+{}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$
   (g) None of the above

3. How many grams of sodium hydroxide must be added to fully neutralize 1.0 L of a 0.250 M solution of hydroiodic acid?
   (a) 10. g   (c) 32 g   (e) 56 g   (g) 12.5 g
   (b) 20. g   (d) 41.0 g   (f) 18 g   (h) 5.25 g

4. 0.420 L of hydroiodic acid solution is neutralized with 25.5 mL of a 0.75 M solution of sodium hydroxide. What was the concentration of the hydroiodic acid solution?
   (a) 0.420 M   (c) 0.0190 M   (e) 0.0692 M   (g) 0.0737 M
   (b) 0.750 M   **(d) 0.0455 M**   (f) 0.0261 M   (h) 0.091 M

5. Give the oxidation numbers, in order for N, H, P and O for ammonium phosphate:
   (a) -2, +1, +4, -2   **(c) -3, +1, +5, -2**   (e) -4, +4, -2, +2
   (b) +3, -1, +5, -2   (d) -4, +1, +6, -2   (f) +4, -4, +2, -2

6. Which of these species will be oxidized by strong acid (hint a table of activities is included)?
   (a) K   **(c) Na**   **(e) Fe^{2+}**   **(g) d and f**   **(i) None of the above**
   (b) Zn   **(d) Ag(s)**   **(f) Fe**   **(h) All but d and e**   **(j) All of the above**

7. When homogeneous solutions of sodium phosphate and lead nitrate are mixed, a precipitate is formed. Remembering that many phosphates are relatively insoluble, which of the following is the precipitant?
   (a) Sodium phosphate   (c) sodium hydroxide   (e) lead phosphite
   (b) Sodium bis phosphate   **(d) lead phosphate**   (f) none of the above

8. Smirnoff vodka is 80. proof (which is 40.% ethanol (C_2H_6O) by volume). If you assume that the density of vodka is 1.0 g/mL, and the density of ethanol is 0.79 g/mL calculate the molarity of the vodka.
   (a) 8.7 M   (c) 17.4 M   (e) 80. M   (g) 13.63 M
   (b) 4.35 M   (d) 3.43 M   **(f) 6.9 M**

9. A piston has an external pressure of 8.0 atm. How much work was done by the piston on the surroundings if the volume of the cylinder goes from 0.20 to 0.60 L?
   (a) 2.05 L·atm   (c) -2.05 L·atm   (e) 3.2 J   (g) -3.2 L·atm
   (b) 2.05 J   (d) -205 J   **(f) 3.2 L·atm** (h) -3.2 J

10. Find the ΔH_f of glucose ($C_6H_{12}O_{6(s)}$) using the following information:
   $$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)} \quad \Delta H_{rxn}\ \text{-2800 kJ}$$

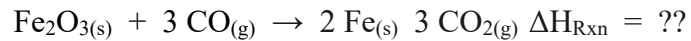| Substance	ΔH_f (kJ/mol)
$CO_{2(g)}$	-393.5
$H_2O_{(l)}$	-285.8

   (a) -2800 kJ/mole glucose   **(d) -1276 kJ/mole glucose**
   (b) 2800 kJ/mole glucose   (e) 2120.7 kJ/mole glucose
   (c) 1276 kJ/mole glucose   (f) -2120.7 kJ/mole glucose

11. The thermite reaction (given below) has a ΔH_{Rxn} of -850 kJ. How many kilograms of steel can be melted by the reaction of 1 mole of Aluminum in the thermite reaction with an initial T of 20 °C? (steel has a specific heat of about 0.50 J/g °C and a melting point of 1370 °C)

   $$Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3 + 2Fe \qquad \Delta H_{Rxn} = \text{-850 kJ}$$

   (a) 0.63 kg   (c) 1.26 kg.   (e) 850 kg   (g) 2.4 kg
   (b) 0.63 g   (d) 1.26 g   (f) 850 g   (h) 2.4 g

12. Put the following forms of electromagnetic radiation in the order of their *energy*, from highest to lowest (meaning energy of the photons of that light)
   (a) X-rays, ultraviolet, visible, microwave, radio waves
   (b) visible, microwave, ultraviolet, X-rays, radio waves
   (c) X-rays, ultraviolet, visible, radio waves, microwave
   (d) microwave, ultraviolet, visible, X-rays, radio waves
   (e) radio waves, microwave, visible, ultraviolet, X-rays

13. Standing waves have certain properties that make them good models for electrons bound to atoms. Which of the following represent those properties:
    (a) The frequency of a standing wave is quantized
    (b) The wave-like nature of electrons make it possible to describe them as standing waves.
    (c) The energy of the standing wave of an electron can be quantized.
    (d) All of the above
    (e) None of the above

14. The mass of an electron is $9.11×10^{-31}$ kg. If an electron in a hydrogen atom is moving at $1.73×10^6$ ms^{-1}, what is the de Broglie wavelength for the electron?
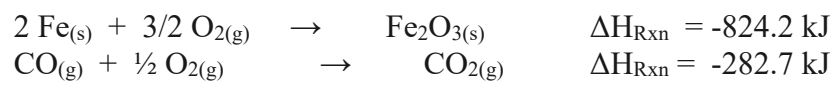
$$\lambda = \frac{h}{mv}$$

    (a) $4.21×10^{-8}$ cm   (c) $2.37×10^{11}$ cm   (e) $1.73×10^4$ m
    (b) $5.79×10^{-7}$ cm   (d) $4.21×10^{-10}$ cm   (f) none of the above

15. The new James Webb space telescope measures an interstellar signal at 3.2 µm. The detector is collecting $5.5×10^8$ photons per second. How much energy is deposited on the detector in 1 minute?
    (a) $2.24×10^{-16}$ (c) $6.21×10^{-20}$ **(e) $2.05×10^{-9}$**
    (b) $3.73×10^{-18}$ (d) $3.42×10^{-11}$ (f) $1.23×10^{-7}$

16. (10 points) Calculate the Enthalpy of reaction for:

$$Fe_2O_{3(s)} + 3 CO_{(g)} \rightarrow 2 Fe_{(s)} \ 3 CO_{2(g)} \ \Delta H_{Rxn} = ??$$

Using:

$$2 Fe_{(s)} + 3/2 O_{2(g)} \rightarrow Fe_2O_{3(s)} \qquad \Delta H_{Rxn} = -824.2 \ kJ$$
$$CO_{(g)} + \tfrac{1}{2} O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H_{Rxn} = -282.7 \ kJ$$

17. (15 points) Zinc metal reacts with hydrochloric acid according to the reaction:

$$Zn_{(s)} + 2\ HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$
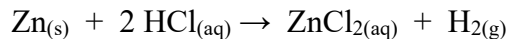
When 7.31 g of Zn(s) is combined with enough hydrochloric acid to make 125.0 mL of solution total in a coffee-cup calorimeter, all of the zinc reacts, raising the temperature of the solution from 22.5 °C to 56.7 °C. Find ΔH_{Rxn} for this reaction as written. (Use 1 g/mL for the density of the solution and 4.18 J/g °C for the specific heat of the solution.)

Metal	Oxidation Reaction			
Lithium	$Li(s)$	$\longrightarrow$	$Li^+(aq)$	$+$ e^-
Potassium	$K(s)$	$\longrightarrow$	$K^+(aq)$	$+$ e^-
Barium	$Ba(s)$	$\longrightarrow$	$Ba^{2+}(aq)$	$+$ $2e^-$
Calcium	$Ca(s)$	$\longrightarrow$	$Ca^{2+}(aq)$	$+$ $2e^-$
Sodium	$Na(s)$	$\longrightarrow$	$Na^+(aq)$	$+$ e^-
Magnesium	$Mg(s)$	$\longrightarrow$	$Mg^{2+}(aq)$	$+$ $2e^-$
Aluminum	$Al(s)$	$\longrightarrow$	$Al^{3+}(aq)$	$+$ $3e^-$
Manganese	$Mn(s)$	$\longrightarrow$	$Mn^{2+}(aq)$	$+$ $2e^-$
Zinc	$Zn(s)$	$\longrightarrow$	$Zn^{2+}(aq)$	$+$ $2e^-$
Chromium	$Cr(s)$	$\longrightarrow$	$Cr^{3+}(aq)$	$+$ $3e^-$
Iron	$Fe(s)$	$\longrightarrow$	$Fe^{2+}(aq)$	$+$ $2e^-$
Cobalt	$Co(s)$	$\longrightarrow$	$Co^{2+}(aq)$	$+$ $2e^-$
Nickel	$Ni(s)$	$\longrightarrow$	$Ni^{2+}(aq)$	$+$ $2e^-$
Tin	$Sn(s)$	$\longrightarrow$	$Sn^{2+}(aq)$	$+$ $2e^-$
Lead	$Pb(s)$	$\longrightarrow$	$Pb^{2+}(aq)$	$+$ $2e^-$
Hydrogen	$H_2(g)$	$\longrightarrow$	$2\,H^+(aq)$	$+$ $2e^-$
Copper	$Cu(s)$	$\longrightarrow$	$Cu^{2+}(aq)$	$+$ $2e^-$
Silver	$Ag(s)$	$\longrightarrow$	$Ag^+(aq)$	$+$ e^-
Mercury	$Hg(l)$	$\longrightarrow$	$Hg^{2+}(aq)$	$+$ $2e^-$
Platinum	$Pt(s)$	$\longrightarrow$	$Pt^{2+}(aq)$	$+$ $2e^-$
Gold	$Au(s)$	$\longrightarrow$	$Au^{3+}(aq)$	$+$ $3e^-$

Ease of oxidation increases