Exam 2 Name_____

Minneapolis Community and Technical College w
C1152 Fall 2023 ...Boraas

Directions:

- Write your name at the top of this exam.
- Record your answer to each multiple choice question in the space provided at left.
- You can write on this exam booklet. Additional scratch paper is available on request.
- Return this exam and all materials with your answer sheet. Failure to do so will result in a zero for the exam.
- You will have 3 hours to complete the exam. Sharing calculators is not allowed.

1. _____**(Thermo)** Which of the following statements is NOT correct?

a. The entropy of the universe increases for all spontaneous processes

b. Spontaneous process are often exothermic

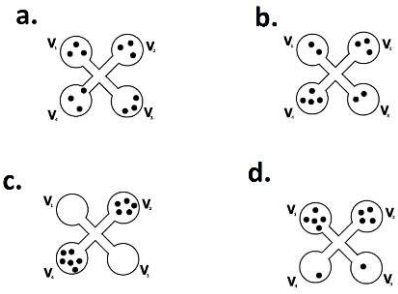
c. The entropy of the process always increases if it's spontaneous

d. The entropy of the Sun is greater than the entropy of the moon.

e. To make a non-spontaneous process happen, entropy somewhere else must increase

f. Spontaneous process can be either fast or slow

2. _____ **(Thermo)** Rank the systems at right in order of **increasing** entropy



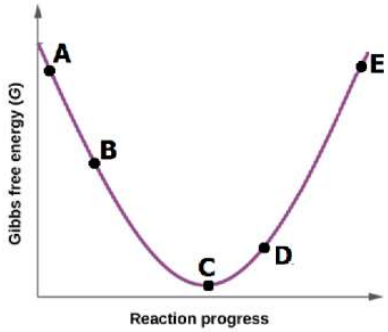
a. $S_a < S_b < S_c < S_d$ b. $S_b < S_d < S_c < S_a$

c. $S_b < S_a < S_d < S_c$ d. $S_c < S_d < S_b < S_a$

e. $S_b < S_d < S_a < S_c$ f. $S_c < S_d < S_a < S_b$

3. _____**(Thermo)** When ΔG is positive, the process is ALWAYS spontaneous.
a. True b. False

4. _____ **(Thermo)** A reaction is known to be at position D (figure at right).



Which of the following statements is true?

a. The reaction is at equilibrium and no shift will occur

b. The reaction will shift left and stop at point C

c. The reaction will shift left and stop at point B

d. The reaction will shift left and stop at point A

e. The reaction will shift right and stop at point E

f. The reaction will swing wildly from left to right and then back again.

5. _____**(Thermo)** Calculate $\Delta S°_{rxn}$ for the following reaction. The S° for each species is shown below the reaction.

	$A_2B_{2(g)}$	+	$B_{2(g)}$	→	$A_2B_{4(g)}$
S°(J/mol·K)	200.9		130.7		219.3

a. -112.3 J/K b. +112.3 J/K c. +550.9 J/K d. +337.1 J/K e. -550.9 J/K

6. _____ **(Thermo)** Which of the following is true of lake water as the lake freezes solid in the winter?

a. $\Delta S_{H2O} < 0$ $\Delta S_{surroundings} < 0$ and $\Delta S_{universe} > 0$

b. $\Delta S_{H2O} < 0$ $\Delta S_{surroundings} > 0$ and $\Delta S_{universe} < 0$

c. $\Delta S_{H2O} > 0$ $\Delta S_{surroundings} > 0$ and $\Delta S_{universe} > 0$

d. $\Delta S_{H2O} < 0$ $\Delta S_{surroundings} > 0$ and $\Delta S_{universe} > 0$

e. $\Delta S_{H2O} > 0$ $\Delta S_{surroundings} < 0$ and $\Delta S_{universe} < 0$

7. _____ **(Thermo)** Estimate $\Delta G°_{rxn}$ for the following reaction at 502 °C. (Closest answer please)

$2\ X_{(g)} + Y_{2(g)} \rightarrow 2\ XY_{(s)}$ $\Delta H° = -304.2$ kJ $\Delta S° = -414.2$ J/K

a. +17 kJ b. -110 kJ c. -625 kJ d. -181 kJ e. +321 kJ

8. _____**(Thermo)** Under what temperature conditions is the following reaction spontaneous?

$2\ ACB_{3(aq)} + CB_{(g)} \rightarrow 3\ CB_{2(g)} + A_2B_{(l)}$ $\Delta H_{rxn} = -136.5$ kJ $\Delta S_{rxn} = -287.5$ J/K

a. Spontaneous above 39.2 K
b. Spontaneous below 39.2 K
c. Spontaneous above 151 K
d. Spontaneous below 151 K
e. Spontaneous above 475 K
f. Spontaneous below 475 K
g. This reaction is nonspontaneous at all temperatures.
h. The reaction is spontaneous at all temperatures.

9. _____**(Thermo)**Which of the following reactions experiences a decrease in entropy?

a. $2\ NO_{(g)} + O_{2(g)} \rightarrow 2\ NO_{2(g)}$

b. $COCl_{2(g)} \rightarrow CO_{(g)} + Cl_{2(g)}$

c. $CH_3OH_{(l)} \rightarrow CO_{(g)} + 2H_{2(g)}$

d. $NaClO_{3(s)} \rightarrow Na^+_{(aq)} + ClO_3^-{}_{(aq)}$

10. _____ **(REDOX)** What is the oxidation state of "X" in the fictional polyatomic cation $H_3X_2O_3^+$?

a. +8 b. +7 c. +6 d. +5
e. +4 f. +3 g. +2 h. +1

11. _____ **(REDOX)** Balance the following redox reaction if it occurs in **Acidic** solution.

What are the coefficients for **X_2** and **H^+** in the completely balanced reaction?

$X_{2(l)} \rightarrow XO_3^-{}_{(aq)} + X^-_{(aq)}$

a. X_2 : 3 H^+ : 6
b. X_2 : 6 H^+ : 12
c. X_2 : 1 H^+ : 5
d. X_2 : 8 H^+ : 10
e. X_2 : 1 H^+ : 4

12. _____ **(REDOX)** When the reaction below is balanced, what is the value for "n"?

$Cr_{(s)} + Fe^{2+}_{(aq)} \rightarrow Fe_{(s)} + Cr^{2+}_{(aq)}$

a. n = 1 b. n =2 c. n =3 d. n =4 e. n =5 f. n = 6

13. _____ (REDOX) Given the following abbreviated cell diagram, determine the net cell reaction from the list below.

$$Ni_{(s)} \mid Ni^{2+}_{(aq)} \parallel Ag^{+}_{(aq)} \mid Ag_{(s)}$$

a. $Ni_{(s)} + Ni^{2+}_{(aq)} \rightarrow Ag^{+}_{(aq)} + Ag_{(s)}$

b. $Ni_{(s)} + Ag^{+}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + Ag_{(s)}$

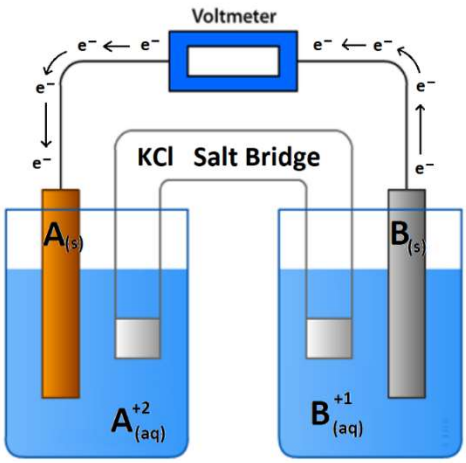
c. $Ni_{(s)} + 2\,Ag^{+}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + 2\,Ag_{(s)}$

d. $2Ni_{(s)} + Ag^{+}_{(aq)} \rightarrow 2\,Ni^{2+}_{(aq)} + Ag_{(s)}$

e. $2\,Ni^{2+}_{(aq)} + Ag_{(s)} \rightarrow 2Ni_{(s)} + Ag^{+}_{(aq)}$

f. $Ni^{2+}_{(aq)} + 2Ag_{(s)} \rightarrow Ni_{(s)} + 2Ag^{+}_{(aq)}$

14. _____ (REDOX) Which <u>one</u> of the following statements is true for the voltaic cell illustrated at right?



a. Reduction occurs in the "B" half cell

b. The anode is the left hand "A" electrode

c. Chloride ions pass from the salt bridge into the right hand "B" cell solution

d. The abbreviated cell diagram is: $A_{(s)} \mid A^{2+}_{(aq)} \parallel B^{1+}_{(aq)} \mid B_{(s)}$

e. The mass of the "B" electrode increases as the cell operates

f. n = 2

g. The net cell reaction is: $2B^{+1}_{(aq)} + A_{(s)} \rightarrow A^{+2}_{(aq)} + 2B_{(s)}$

15. _____ (REDOX) Determine how many electrons are required to balance the following half reaction and where should they be located.

$$\mathbf{AO_4^{2-}_{(aq)} + 4H^{+}_{(aq)} \rightarrow A(OH)_4\ _{(aq)}}$$

a. 2 electrons on the product side

b. 2 electrons on the reactant side

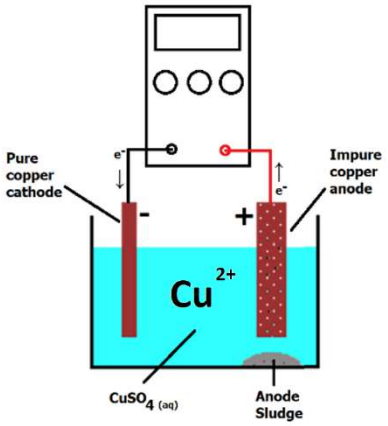
c. 4 electrons on the product side

d. 4 electrons on the reactant side

e. 1 electron on the reactant side

f. 1 electron on the product side

16. D _____ (REDOX) Impure copper metal can be refined using the electrolysis apparatus shown at right.



What mass (g) of pure copper metal would be collected after running the apparatus at 50.0 Amps for 45 seconds?

a. 0.0013 $grams_{Cu}$ b. 0.37 $grams_{Cu}$ c. 1.5 $grams_{Cu}$

d. 0.74 $grams_{Cu}$ e. 1.9 $grams_{Cu}$

17. _____ **(REDOX)** The following reaction will occur spontaneously as written.

a. True b. False

$Ti^{2+}_{(aq)} + Ni_{(s)} \rightarrow Ti_{(s)} + Ni^{2+}_{(aq)}$

$Ti^{2+}_{(aq)} + 2e^- \rightarrow Ti_{(s)}$ $E^o_{red} = -0.163$ V

$Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$ $E^o_{red} = -0.257$ V

18. _____ **(EA)** What is the minimum chloride ion concentration required to precipitate AgCl from a solution where the silver ion concentration is 3.55×10^{-5} M?

Useful information: AgCl: $K_{sp} = 1.77 \times 10^{-10}$

a. $[Cl^-] = 7.89 \times 10^{-5}$ M

b. $[Cl^-] = 6.28 \times 10^{-15}$ M

c. $[Cl^-] = 5.05 \times 10^{-7}$ M

d. $[Cl^-] = 4.99 \times 10^{-6}$ M

e. $[Cl^-] = 2.03 \times 10^{-1}$ M

19. _____ **(EA)** The system illustrated at right is a chemical buffer.

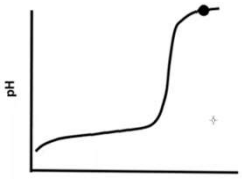
$CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

a. True b. False

20. _____ **(EA)** Which of the following solutions is a good buffer system?

a. A solution that is 0.10 M NaCl and 0.10 M HCl
b. A solution that is 0.10 M HCN and 0.10 M LiCN
c. A solution that is 0.10 M NaOH and 0.10 M HNO_3
d. A solution that is 0.10 M HNO_3 and 0.10 M KNO_3
e. A solution that is 0.10 M HCN and 0.10 M NaCl

21. _____ **(EA)**The picture at right shows the position of a buffer on its titration curve. In this position, the buffer is best positioned to guard against …



a. the addition of strong acids or strong bases equally
b. the addition of strong bases
c. the addition of strong acids
d. nothing. The buffer is exhausted
e. the most recent Taylor Swift album.

22. _____ **(EA)** Solid X_2Y is placed in a beaker of distilled water and stirred until the solution is saturated. If the concentration of **"Y"** is measured to be **1.39×10^{-3} M** determine the **K_{sp}** value for this salt.

a. $K_{sp} = 2.69 \times 10^{-9}$ b. $K_{sp} = 1.07 \times 10^{-8}$ c. $K_{sp} = 6.71 \times 10^{-10}$ d. $K_{sp} = 8.44 \times 10^{-11}$

23. _____ **(EA)** Give the expression for the solubility product constant for $PbCl_2$.

a. $\frac{[Pb^{2+}][Cl^-]^2}{[PbCl_2]}$ b. $\frac{[PbCl_2]}{[Pb^{2+}][Cl^-]^2}$ c. $[Pb^{2+}][Cl^-]^2$ d. $\frac{[Pb^{2+}][Cl^-]}{[PbCl_2]}$ e. $[Pb^{2+}]^2[Cl^-]$

24 _____ **(EA)** Which of the following fictitious 2:1 salts will be most soluble in pure water?

a. Z_2M $K_{sp} = 7.01 \times 10^{-13}$ b. A_2C $K_{sp} = 8.08 \times 10^{-11}$

c. X_2B $K_{sp} = 3.22 \times 10^{-5}$ d. A_2Y $K_{sp} = 4.92 \times 10^{-52}$

e. Z_2Y $K_{sp} = 1.88 \times 10^{-9}$

25. _____ (EA) In the laboratory, a buffer with pH= 5.7 is required.

Which of the following fictional weak acids is best suited for this buffer application?

a. HA $K_a = 1.66 \times 10^{-6}$ b. HB $K_a = 9.06 \times 10^{-10}$

c. HC $K_a = 6.49 \times 10^{-2}$ d. HD $K_a = 8.77 \times 10^{-8}$

26. _____ (EA) A chemical buffer can be created by adding small amounts of $KOH_{(aq)}$ solution to a 1.00 M $CH_3COOH_{(aq)}$ solution.

a. True b. False

27. _____(Nuclear) Which of the following correctly shows the alpha decay of $^{241}_{95}Am$.

a. $^{241}_{95}Am \rightarrow {}^{1}_{0}n + {}^{240}_{95}Am$ b. $^{241}_{95}Am \rightarrow {}^{4}_{2}He + {}^{245}_{97}Bk$

c. $^{241}_{95}Am \rightarrow {}^{0}_{-1}e + {}^{241}_{96}Cm$ d. $^{241}_{95}Am \rightarrow {}^{0}_{+1}e + {}^{241}_{94}Pu$

e. $^{241}_{95}Am \rightarrow {}^{4}_{2}He + {}^{237}_{93}Np$

28. _____ (Nuclear) Identify the missing product particle in the following nuclear decay equation: $^{214}_{82}Pb \rightarrow {}^{0}_{-1}e + ?$

a. $^{215}_{81}Tl$ b. $^{214}_{81}Tl$ c. $^{213}_{82}Pb$ d. $^{215}_{82}Pb$ e. $^{214}_{83}Bi$

29. _____ (Nuclear) Calculate the mass defect for Fe-56 if it's measured mass is 55.921 amu.
(Ignore electron masses. Closest answer please)

Useful information: Proton mass: 1.00728 amu Neutron mass 1.008665 amu. Electron mass: 0.000548 amu

a. 3.507 amu b. 0.528 amu c. 0.564 amu d. 1.056 amu e. 0.079 amu

30. _____ (Nuclear) The half-life of a radioactive sample is known to be 6 minutes.
What percentage of the sample is left after 24 minutes?
a. 50% b. 25% c. 12.5% d. 6.25% e. 3.125%

31. _____ (Nuclear) What is the N/P ratio for Tin - 100 and what type of nuclear decay will it undergo (if any)?
a. 1:1 Beta emission
b. 1.15 : 1 Alpha emission
c. 1:1 Electron capture
d. 1.15 : 1 Electron capture
e. None of the above.

32. _____ (Nuclear) During a nuclear decay reaction, the nucleus loses mass. What accompanies this mass loss?
a. A release of energy b. A gain in energy c. Decreasing entropy d. shouts of joy

33. _____ (Nuclear) Heavy Nuclides above the valley of stability become more stable through a process known as …

a. neutron bombardment b. positron emission c. alpha emission
d. electron capture e. beta emission

34. _____(Nuclear) Which of the following is considered generally true of cancer cells?

a. They reproduce more frequently than healthy cells.
b. They are more likely to be in a vulnerable state of cell division than healthy cells
c. They are less able to repair themselves than healthy cells
d. All of the above are true.

35. _____ **(Nuclear)** By exposing a cancerous tumor to external radiation sources from many different directions, the risk of damage to the healthy, surrounding tissue is reduced.
a. True b. False

36. _____ **(Nuclear)** Which of the following statements are TRUE?
a. Positrons are similar in ionizing power and penetrating power to beta particles.
b. A positron is the antiparticle of the electron.
c. Beta decay occurs when a neutron changes into a proton while emitting an electron.
d. An alpha particle is a helium 2+ ion.
e. All of the above are true.

37. _____ **(Thermo)** Goldfish are ...

a. the best cracker b. horrible without tartar sauce c. responsible for 90% of all surfing fatalities
d. capable of surviving on land for hours at a time e. a close cousin of the tardigrade

38. _____ **(REDOX)** Oxidation must be accompanied by reduction
a. True b. False

39. _____ **(EA)** Adding NaCl solution to a chemical buffer _____ the pH of the buffer.
a. increases b. decreases c. has no effect on

40. _____ **(Nuclear)** Nuclear decay is a _____ order process.
a. zeroth b. first c. second d. third

"I blame entropy."

41. (6 points) A voltaic cell is constructed using the following two ½ cells and an NaCl salt bridge:

Half cell #1: Chromium rod in 4.45 M chromium III chloride solution $CrCl_{3(aq)}$.

Half cell #2: Manganese rod in 0.0250 M manganese chloride solution $MnCl_{2\,(aq)}$.

a. Write the net cell reaction for this cell.

b. Write the complete abbreviated cell diagram for this cell.

c. Determine: E^{o}_{cell} =

d. Determine: n =

e. Determine : Q =

f. Determine: E_{cell} =

42. (5 points) ***Show all work <u>neatly</u> for full credit.***
Answers must be circled, adjusted for significant figures and appear with correct units.

In the treatment of prostate cancer, small radioactive iodine-125 pellets or "seeds" (see picture at right) are permanently implanted in the cancerous tissue.

a. If iodine-125 has a half-life of 60 days, how many days must pass for 99.99 % of the original Iodine to decay?

b. Iodine-125 decays via electron capture.
What is the nuclear decay equation for this process?

43. (5 pts) ***Show all work <u>neatly</u> for full credit.***
Answers must be circled, adjusted for significant figures and appear with correct units.

Calculate @ 25°C:

a. $\Delta G°_{rxn}$

b. K_{eq} for the forward reaction

c. K_{eq} for the reverse reaction

		$2\ HNO_{3(aq)}$ +	$NO_{(g)}$ →	$3\ NO_{2(g)}$ +	$H_2O_{(l)}$
$\Delta H°_f$	*(kJ/mol)*	-207.0	91.3	33.2	-285.8
$S°$	*(J/mol·K)*	146.0	210.8	240.1	70.0

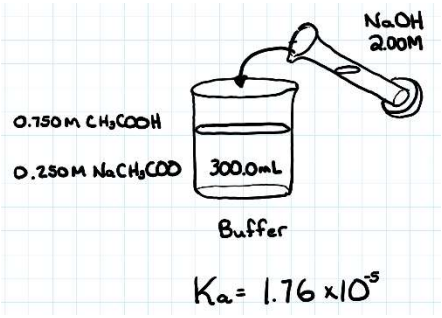
44. (5 pts) ***Show all work <u>neatly</u> for full credit.***
Answers must be circled, adjusted for significant figures and appear with correct units.

2.00 M NaOH is added to the buffering system at right.

Determine the following:

a. The initial pH of the buffer.

b. The pH of the buffer after 50.0 mL of NaOH are added.



Bonus Questions:

45. (1 pt) Why does copper metal dissolve in nitric acid (HNO_3) and not hydrochloric acid (HCl)?

46. (1 pt) Automobile internal combustion engines are approximately 30% efficient. What does this mean?

47. (1 pt) What are the advantages and disadvantages of solar/wind power generation?

48. (1 pt) What is the gram solubility of copper (II) hydroxide in a 0.75 M NaOH solution. ($K_{sp} = 2.20 \times 10^{-20}$)

49. (1pt) Referring to problem #44, determine the pH of the buffer after 150. mL of NaOH are added.