Name: _____ Student number: _____

Chemistry 1A03 **Test 2** **Nov. 9, 2012**

McMaster University **VERSION 1**

Instructors: D. Brock, G. Goward, J. Landry

Duration: 120 minutes

This test contains 18 numbered pages printed on both sides. There are **30** multiple-choice questions appearing on pages numbered 3 to 14. Pages 15 and 16 are extra space for rough work. Page 17 includes some useful data and equations, and there is a periodic table on page 18. You may tear off the last page to view the periodic table and the data provided.

You must enter your name and student number on this question sheet, as well as on the answer sheet. Your invigilator will be checking your student card for identification.
You are responsible for ensuring that your copy of the question paper is complete. Bring any discrepancy to the attention of your invigilator.

All questions are worth 2 marks the total marks available are 60. There is **no** additional penalty for incorrect answers.
BE SURE TO ENTER THE CORRECT VERSION OF YOUR TEST (shown near the top of page 1), IN THE SPACE PROVIDED ON THE ANSWER SHEET.

<u>ANSWER ALL QUESTIONS</u> ON THE ANSWER SHEET, IN PENCIL.
Instructions for entering multiple-choice answers are given on page 2.
SELECT <u>ONE AND ONLY ONE</u> ANSWER FOR EACH QUESTION from the answers **(A)** through **(E). No work written on the question sheets will be marked**. The question sheets may be collected and reviewed in cases of suspected academic dishonesty.

Academic dishonesty may include, among other actions, communication of any kind (verbal, visual, *etc*.) between students, sharing of materials between students, copying or looking at other students' work. If you have a problem please ask the invigilator to deal with it for you. Do not make contact with other students directly. Try to keep your eyes on your own paper – looking around the room may be interpreted as an attempt to copy.

Only Casio FX 991 electronic calculators may be used; but they must NOT be transferred between students. Use of periodic tables or any aids, other than those provided, is not allowed.

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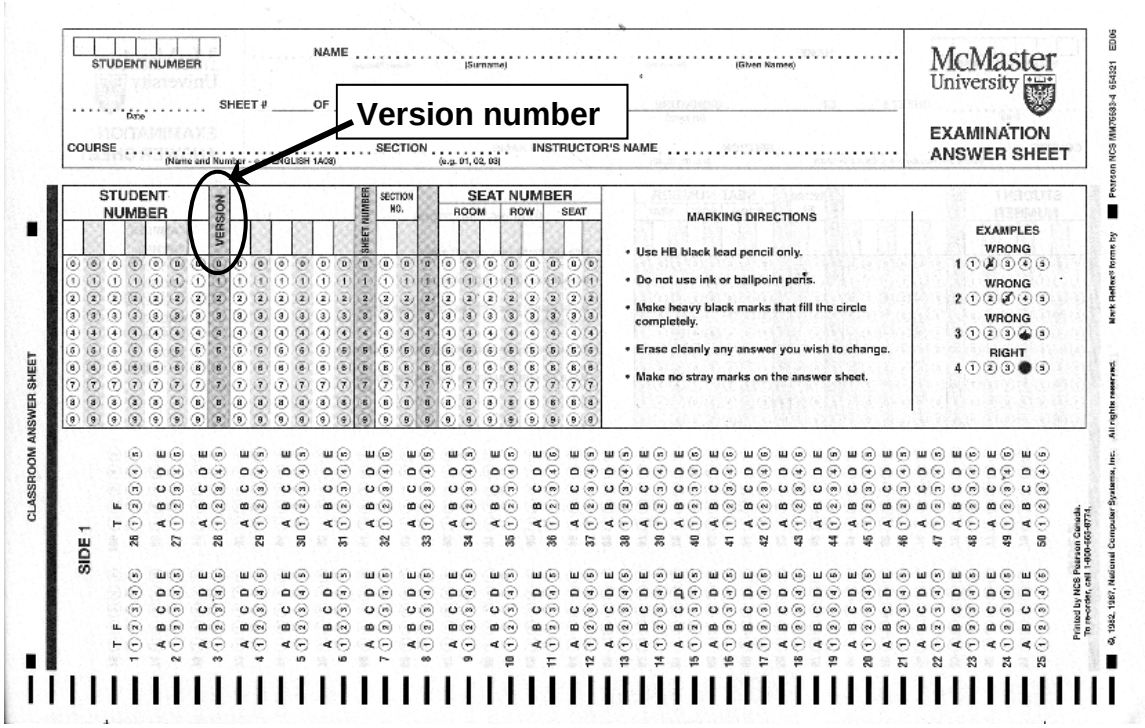
OMR EXAMINATION – STUDENT INSTRUCTIONS

NOTE: IT IS YOUR RESPONSIBILITY TO ENSURE THAT THE ANSWER SHEET IS PROPERLY COMPLETED: YOUT EXAMINIATION RESULT DEPENDS UPON PROPER ATTENTION TO THESE INSTRUCTIONS.

The scanner, which reads the sheets, senses the bubble shaded areas by their non-reflection of light. A heavy mark must be made, completely filling the circular bubble, with an HB pencil. Marks made with a pen will **NOT** be sensed. Erasures must be thorough or the scanner will still sense a mark. Do **NOT** use correction fluid on the sheets. Do **NOT** put any unnecessary marks or writing on the sheet.

1. On SIDE 1 (**red side**) of the form, in the top box, *in pen*, print your student number, name, course name, and the date in the spaces provided. Then you **MUST** write your signature, in the space marked SIGNATURE.
2. In the second box, *with a pencil*, mark your student number, **exam version number** in the space provided and <u>fill in the corresponding bubble numbers underneath</u>.
3. Answers: mark only **ONE** choice from the alternatives (A,B,C,D,E) provided for each question. The question number is to the left of the bubbles. Make sure that the number of the question on the scan sheet is the same as the number on the test paper.
4. Pay particular attention to the Marking+ Directions on the form.
5. Begin answering the question using the first set of bubbles, marked "1".



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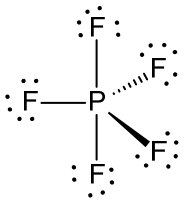
1. Select the correct sequence of elements in order of **increasing atomic size**.

   A) O < Ne < Ga < P
   B) Ga < O < P < Ne
   C) Ga < P < Ne < O
   D) O < Ne < P < Ga
   E) Ne < O < P < Ga

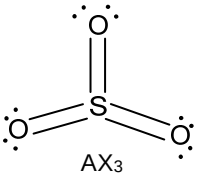
   Atomic radius increases down a group and from right to left.

2. Which of the following molecules is **polar**?

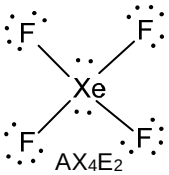
   A) PF_5
   B) SO_3
   C) XeF_4
   D) SO_2Cl_2
   E) CO_2



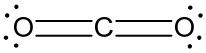
AX_5



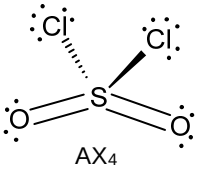
AX_3



AX_4E_2



AX_2



AX_4

3. How many **grams** of calcium oxide, CaO, can be produced from 4.20 g of calcium metal and 1.60 g of oxygen gas?

   A) 2.90
   B) 5.88
   C) 5.61
   D) 2.94
   E) 5.80

   $2\ Ca + O_2 \rightarrow 2CaO$

   moles of Ca = 4.20 g of Ca /40.078 g/mol = 0.104_8mol
   moles of O_2 = 1.60 g of O_2 /31.998 g/mol = 0.0500_0mol
   But 2 moles of Ca are required for every mole of O_2.
   Therefore, O_2 is the limiting reagent.

Moles of CaO = 0.0500_0mol × 2 = 0.100_0 mol (2:1 ratio of moles of CaO to moles of O_2)
Mass of CaO = 0.100_0 mol × 56.078 g/mol = 5.61g

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4. Which of the following VSEPR types would have **non "ideal" angles** (assuming all X atoms are the same)?

A) AX_6 octahedral, no lone pairs to distort angles
B) AX_3E_2 T-shape, 2 lone pairs both located in the plane repel axial atoms
C) AX_2E_3 linear, 3 lone pairs all located in the plane cancel each other
D) AX_4E_2 square planar, lone pairs cancel each other's effect
E) AX_3 trigonal planar, no lone pairs to distort angles

5. What are the total numbers of **neutrons, protons, and electrons,** respectively in the $^{37}Cl^-$ ion?

A) 17, 20, 18
B) 18, 18, 17
C) 20, 17, 16
D) 37, 17, 18
E) 20, 17, 18

Atomic number of Cl = # protons = 17

Mass Number = 37 = #protons + # neutrons
Therefore # neutrons = 20

A neutral Cl atom would contain the same number of electrons as protons (i.e. 17), the negative charge indicates 1 extra electron (i.e. 18)

6. Which of the following atoms/ions would be **paramagnetic in its ground state**?

A) Ne [He] $2s^2 2p^6$ all electrons paired, diamagentic
B) K^- [Ar] $4s^2$ all electrons paired, diamagentic
C) Cl^- [Ne] $3s^2 3p^6$ all electrons paired, diamagentic
D) S^{2-} [Ne] $3s^2 3p^6$ all electrons paired, diamagentic
E) Se [Ar] $4s^2 3d^{10} 4p^4$ 2 unpaired p-electrons, paramagentic

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7. For which of the following reactions would the equilibrium be **unchanged** by an increase in the volume of the reaction vessel?

i) $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$

ii) $CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$

iii) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

iv) $4KO_2(s) + 2\ CO_2\ (g) \rightleftharpoons 2\ K_2CO_3\ (s) + 3\ O_2(g)$

A) i, ii
B) ii, iii
C) ii, iv
D) i, iv
E) i, iii

A volume change will only shift a reaction towards products or reactants if there is a change in number of moles of gas. In ii & iii, there is not a change in number of moles of gas and therefore it will not be affected by a volume change of the reaction vessel.

8. The following exothermic gas-phase reaction is at equilibrium.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H < 0$

Which of the following changes **decrease** the amount of $SO_2(g)$ present?

i) The temperature is raised.
ii) More $O_2(g)$ is added.
iii) A catalyst is added.
iv) The product is condensed to the liquid phase by lowering the temperature.

A) i, ii
B) ii, iii
C) iii, iv
D) ii, iv
E) i, iv

The reaction is exothermic and therefore heat can be treated like a product.
i) Increasing heat is like adding products and will shift towards reactants, increasing SO_2.
ii) Increasing O_2 is adding more reactants and will shift towards products, decreasing SO_2.
iii) A catalyst has no effect on the equilibrium position and will not change the amount of SO_2.
iv) Removing product causes more reactants to shift to replace the products, decreasing SO_2.

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9. Which of the following pairs is **NOT** a correct formulation of the equilibrium constant, *K*, for the given reaction

A) $CaCO_3\,(s) + 2HCl(aq) \rightleftharpoons CO_2(g) + Ca^{2+}(aq) + 2Cl^-(aq) + H_2O(l)$

$$K = \frac{P_{CO_2}\left[Ca^{2+}\right]\left[Cl^-\right]^2}{\left[HCl\right]^2}$$

B) $S(aq) \rightleftharpoons S(org)$

$$K_{ow} = \frac{\left[S_{org}\right]}{\left[S_{aq}\right]}$$

C) $NH_2COONH_4\,(s) \rightleftharpoons 2NH_3\,(g) + CO_2\,(g)$

$$K = \frac{P_{NH_3}^2 P_{CO_2}}{[NH_2COONH_4]}$$

Activity of solids is 1, therefore
$K = (P_{NH3})^2(P_{CO2})$

D) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2\,(g)$

$$K = P_{CO_2}$$

E) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

$$K = \frac{P_{NH_3}^2}{P_{H_2}^3 P_{N_2}}$$

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10. In an experiment hydrogen iodide was found to be 24.0% dissociated at 731 K. Calculate ***K*** for 2 HI(g) $\rightleftharpoons$ H_2(g) + I_2(g) at this temperature.

A) 0.295
B) 0.0411
C) 0.0535
D) 0.638
E) 0.0249

	$2HI(g)$ $\rightleftharpoons$	$H_2(g)$ +	$I_2(g)$
I	100	0	0
C	-2x	+x	+x
E	100-2x	+x	+x

If you assume an initial pressure of 100 atm and 24% is dissociated, then 2x = 24; x = 12

$K = P_{H2}P_{I2}/(P_{HI})^2 = x^2/(100-2x)^2 = 12^2/76^2 = 0.0249$

11. A chemical company is studying the following reaction at 1233 K, and under high pressure:

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$

The equilibrium pressures of the gases are found to be $P_{(CH_4)}$ = 563 atm; $P_{(H_2S)}$ = 1125 atm, $P_{(CS_2)}$ = 247 atm; $P_{(H_2)}$ = 178 atm.

What is the equilibrium constant, ***K***, at this temperature?

A) 8.53×10^{-3}
B) 3.48×10^{2}
C) 2.79×10^{16}
D) 5.21×10^{5}
E) 1.36×10^{8}

$K = P_{(CS_2)}(P_{(H_2)})^4 / P_{(CH_4)}(P_{(H_2S)})^2$
$= (247)(178)^4/(563)(1125)^2$
$= 3.48 \times 10^2$

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12. A gas phase reaction begins with 8.0 atm of gas AB, and has an equilibrium constant, $K = 0.25$.

Determine the **equilibrium partial pressures for AB, and A,** in this reaction.

$2AB \rightleftharpoons AB_2 + A$

	AB(atm)	A(atm)
A)	6.0	1.0
B)	3.5	2.5
C)	4.8	1.5
D)	4.0	2.0
E)	2.0	5.0

	$2AB(g)$	$\rightleftharpoons AB_2(g)$	$+ A(g)$
I	8	0	0
C	-2x	+x	+x
E	8-2x	+x	+x

$K = P_A P_{AB2}/(P_{AB})^2 = x^2/(8-2x)^2$

$0.25 = x^2/(8-2x)^2$ (sqrt both sides, perfect square)

$0.5 = x/(8-2x)$

$4-x = x$

$x = 2$; therefore $P_A = 2$ atm, $P_{AB} = 8-2(2) = 4$ atm

13. Which of the following is **insoluble** in water?

A)	Na_2O	rule 1: soluble
B)	KCl	rule 1: soluble
C)	NH_4ClO_4	rule 1: soluble
D)	$AgNO_3$	rule 2: soluble
E)	$PbSO_4$	rule 3: insoluble

14. The following redox reaction occurs in **basic** solution.

$ClO_2(g) \rightarrow ClO_3^-(aq) + Cl^-(aq)$

The source of hydroxide is a saturated solution $Ca(OH)_2$ ($K_{sp} = 5.5 \times 10^{-6}$). If the reaction consumed all of the hydroxide in solution while going to completion, what was the **concentration of ClO_3^-** produced?

A)	0.057 M	Ox) $ClO_2 + 2OH^- \rightarrow ClO_3^- + 1\ e^- + H_2O$
B)	0.061 M	Red) $ClO_2 + 5e^- + 2H_2O \rightarrow Cl^- + 4OH^-$
C)	0.025 M	5 Ox) + Red)
D)	0.0098 M	$6ClO_2 + 6OH^- \rightarrow 5ClO_3^- + 3H_2O + Cl^-$
E)	0.019 M	

	$Ca(OH)_2(s)$	$\rightleftharpoons Ca^{2+}(aq)$	$+ 2OH^-(aq)$
I	Y	0	0
C	-x	+x	+2x
E	Y-x	+x	+2x

$K_{sp} = [Ca^{2+}][OH^-]^2 = [x][2x]^2$

$5.5 \times 10^{-6} = 4x^3$; $x = ½[OH^-] = 0.011_1M$

$6OH^- : 5ClO_3^- = 0.022_2M$: **0.019M**

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15. When strontium nitrate and sodium sulfate are mixed, the **net ionic** equation is:

A) Sr^{2+} (aq) + SO_4^{2-} (aq) → $SrSO_4$ (s)
B) 2 Sr^{+} (aq) + SO_4^{2-} (aq) → Sr_2SO_4 (s)
C) $Sr(NO_3)_2$ (aq) + Na_2SO_4 (aq) → $NaNO_3$ (aq) + $SrSO_4$ (s)
D) Na^{+} (aq) + NO_3^{-} (aq) → $NaNO_3$ (s)
E) 2 $SrNO_3$ (aq) + $NaSO_3$ (aq) → Sr_2SO_3 (s)

Only ions involved in forming a new solid, liquid or gas are included in a net ionic equation.

16. **How many electrons** are transferred during the following redox reaction occurring in **basic** solution?

$Fe(OH)_3$ (s) + OCl^{-} (aq) → FeO_4^{2-} (aq) + Cl^{-} (aq)

A) 2
B) 4
C) 6
D) 3
E) 1

Ox) $Fe(OH)_3 + 5OH^- \rightarrow FeO_4^{2-} + 3e^- + 4H_2O$
Red) $OCl^- + 2e^- + H_2O \rightarrow Cl^- + 2OH^-$

2 Ox) + 3 Red) = $6e^-$ transferred

$2Fe(OH)_3 + 4OH^- + 3OCl^- \rightarrow 2FeO_4^{2-} + 3Cl^- + 5H_2O$

17. Determine the **FALSE** statement.

A) The oxidation state of vanadium in VO_4^{3-} is +5.
B) Water is considered a strong electrolyte. Water is a weak to non-electrolyte.
C) In a disproportionation reaction, the oxidizing agent and the species being oxidized are the same.
D) $MgCO_3$ is insoluble in water.
E) At equal concentrations, $MgCl_2$(aq) would be a stronger electrolyte than NaCl(aq).

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18. A train containing the 5 chemicals listed below (as solids) derails and one chemical is spilled. A Chemistry 1A03 student is backpacking, comes upon this, and using items found in their backpack, makes the following observations.

    1) The substance is soluble in water.
    2) When salt pills (NaCl) were added to an aqueous solution of the chemical, no change was observed.
    3) When a piece of magnesium (from a fire starting kit) is placed in an aqueous solution of the chemical, a redox reaction takes place and a brown gas is evolved.

    What is the chemical that spilled?

    A) $Pb(ClO_4)_2$ $PbCl_2$ forms a precipitate. (Eliminated in 2)
    B) AgCl Insoluble in water. (Eliminated in 1)
    C) $Zn(NO_3)_2$ Would liberate brown NO_2 gas in the presence of Mg. (Think lab)
    D) $Mg(OH)_2$ Insoluble in water. (Eliminated in 1)
    E) NaOH Would not react with Mg (Eliminated in 3) (See reduction potentials/ionization energies)

19. Given the following half-reactions, identify the **strongest reducing agent.**

    $U^{3+}(aq) + 3\,e^- \rightarrow U(s)$ $E^o_{red} = -1.66$ V
    $Cd^{2+}(aq) + 2\,e^- \rightarrow Cd(s)$ $E^o_{red} = -0.40$ V
    $Ag^+(aq) + e^- \rightarrow Ag(s)$ $E^o_{red} = +0.80$ V

    A) Ag(s)
    B) $Cd^{2+}(aq)$
    C) Cd(s)
    D) $Ag^+(aq)$
    E) U(s)

A reducing agent gets oxidized. Flip all of the equations and change the sign of E^o to make them oxidations then choose the largest positive value.

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20. What is ***K*** for the reaction $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$, given $E°_{cell}$ is 1.1 V at 25 °C for the electrochemical cell, $Zn(s) \mid Zn(NO_3)_2(aq) \parallel Cu(NO_3)_2(aq) \mid Cu(s)$?

A) 3.9×10^{46}
B) 7.1×10^{-9}
C) 1.5×10^{37}
D) 2.8×10^{15}
E) 6.2×10^{28}

$E^o = RT/zF \ln K$
$1.1V = 0.0257/z \ln K = 0.0257/2 \ln K$
$1.1V = 0.0257/2 \ln K$
$K = 1.5 \times 10^{37}$

21. Given the following data, which statement below is **FALSE**?

$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$ $E°_{red} = -0.126$ V
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$ $E°_{red} = -0.403$ V

A) A reaction will occur if a piece of Cd is dropped into a solution containing $Pb^{2+}(aq)$.
B) $E°_{cell} = 0.277$ V
C) In a galvanic (spontaneous) cell, Pb would be oxidized.
D) In a galvanic (spontaneous) cell, the direction of current flow in the external circuit would be from Cd to Pb.
E) In a galvanic (spontaneous) cell, Pb would be the cathode.

In a spontaneous cell, Pb would be the cathode and would therefore be reduced, not oxidized.

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22. In an electrochemical cell, chlorine gas is reduced by I^-. The concentrations of Cl^- (aq) and I^- (aq) are 0.58 M and 0.26 M, respectively, and the observed cell potential (E_{cell}) is 0.807 V. Given the following standard reduction potentials, calculate the **partial pressure of Cl_2(g) (in atm)** at 25.00 °C.

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$ $E^o_{red} = +1.360$ V $2I^-(aq) + Cl_2(g) \rightarrow 2Cl^-(aq) + I_2(s)$
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$ $E^o_{red} = +0.530$ V

$E^o = E^o_{red} + E^o_{ox} = 1.360 - 0.530 = 0.830$ V

A) 0.96
B) 2.2
C) 0.058
D) 1.3
E) 0.83

$E = E^o - RT/zF \ln Q = E^o - 0.0257/z \ln Q$
$0.807 = 0.830 - 0.0257/2 \ln Q$
$Q = 5.98875$

$Q = 5.98875 = [Cl^-]^2/([I^-]^2 \cdot P_{Cl2}) = (0.58)^2/[(0.26)^2 \cdot P_{Cl2}]$
$P_{Cl2} = 0.83$

23. Given the following standard reduction potentials, select the **correct cell diagram** for the voltaic (spontaneous) cell.

$Co^{3+}(aq) + e^- \rightarrow Co^{2+}(aq)$ $E^o_{red} = +1.82$ V
$Ag^+(aq) + e^- \rightarrow Ag(s)$ $E^o_{red} = +0.80$ V

A) $Ag(s) | Ag^+(aq, 1 M) || Co^{3+}(aq), Co^{2+}(aq, 1M) | Pt(s)$
B) $Ag(s) | Ag^+(aq, 1 M) || Co^{2+}(aq) | Pt(s) | Co^{3+}(aq, 1M)$
C) $Pt(s) | Co^{2+}(aq), Co^{3+}(aq, 1M) || 3 Ag^+(aq, 1 M) | 3 Ag(s)$
D) $Pt(s) | Co^{2+}(aq), Co^{3+}(aq, 1M) || Ag^+(aq, 1 M) | Ag(s)$
E) $Ag(s) | Ag^+(aq, 1 M) || Pt(s) | Co^{2+}(aq), Co^{3+}(aq, 1M)$

Ag^+ has a lower reduction potential relative to Co^{3+} makes silver the anode. Electrodes always remain on the outside of a cell diagram and the ions ordered in the direction of the reaction taking place.

24. Find the **FALSE** statement about the voltaic cell represented by the following shorthand diagram: $Ti(s) | Ti^{2+}(aq) || MnO_4^-(aq), Mn^{2+}(aq), H^+(aq) | Pt(s)$.

A) MnO_4^-(aq) is the strongest oxidizing agent present.
B) Oxidation occurs at the Ti(s) electrode.
C) Electrons flow from Ti(s) towards Pt(s).
D) Pt(s) is an electrode which loses mass in this cell.
E) Anions in the salt bridge flow towards the Ti^{2+} solution.

Pt is an inert electrode and only acts as a surface for reduction of manganese ions.

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25. During the course of the day a student pulls a warm cookie off a baking tray, ices their knee with a cold pack and puts their soup in a thermos for lunch.
Which item is representative of an open system (OS), closed system (CS) and isolated system (IS)?

	OS	CS	IS
A)	cold pack	thermos	baking tray
B)	cold pack	baking tray	thermos
C)	baking tray	cold pack	thermos
D)	thermos	cold pack	baking tray
E)	baking tray	thermos	cold pack

A baking tray would allow both heat and material to transfer between the system and the surroundings. A cold pack transfers heat but keeps the reactants inside the pack (a closed system). A thermos prevents heat/cold as well as matter from transferring between it and the surroundings.

26. In an ice calorimeter, 0.3233 g of Mn are oxidized to Mn^{2+} in an exothermic reaction. As a result, 3.87 g of ice melts, producing water. Calculate how much **heat (in kJ)** was released **per mole of Mn**. (Heat of fusion for melting ice is 333.55 J/g)

A) 3.99
B) 70.8
C) 108
D) 219
E) 1.29

moles of Mn = 0.3233 g of Mn / 54.938 g/mol = 0.00588_5mol

q = ΔH = Heat of fusion for melting ice is 333.55 J/g x 3.87 g
= 1290.8 J

Heat per mole = 1280.8 J / 0.005885mol x (1kJ/1000mol)
= 219 kJ/mol

27. Determine the **FALSE** statement:

A) On a macroscopic scale, heat cannot transfer from a cold body to a hot body.
B) Methane, CH_4, would have a lower heat capacity than isobutane, $CH_3CH(CH_3)CH_3$.
C) Thermal energy is caused by atomic level kinetic energy.
D) In an endothermic reaction, heat enters into a system.
E) In general, the energy to power the human body is taken directly from the sun.

Only plants and photosynthetic organisms (and Superman) receive their energy directly from the sun. Humans receive their energy from plants and animals and indirectly receive energy from the sun.

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28. A student creates a calibration curve relating the absorbance of $FeSCN^{2+}$ (aq) to the concentration of $FeSCN^{2+}$ (aq). The slope of this plot is 1.68 and the equilibrium constant for the reaction was found to be 6.7. When the student mixes 10. ml of 0.20 mol L^{-1} Fe^{3+} (aq) with 10. mL of an unknown concentration of SCN^- (aq) an absorbance of 0.084 is observed. What is the **concentration of the SCN^- (aq) solution (in mol L^{-1})** that was added?

Absorbance = $[FeSCN^{2+}]$ x slope
0.084 = $[FeSCN^{2+}]$ x 1.68
$[FeSCN^{2+}]$ = 0.05

A) 0.30
B) 0.15
C) 0.75
D) 0.40
E) 0.60

	Fe^{3+}(aq) +	SCN^-(aq)	$\rightleftharpoons$	$FeSCN^{2+}$
I	0.10	Y		0
C	-x	+x		+x
E	0.10-x	Y-x		+x

(Note: initial conc. of Fe^{3+} is only half the stock solution added because it is diluted to 20 mL when the SCN^- is added)

But x = $[FeSCN^{2+}]$ = 0.05, therefore $[Fe^{3+}]$ = 0.05 and $[SCN^-]$ = Y-0.05

K_{sp} = $[FeSCN^{2+}]/([Fe^{3+}][SCN^-])$
6.7= 0.05/(0.05x(Y-0.5))
Y = 0.20

Note: initial conc. of SCN^- is 0.20 M but was diluted to 20 mL when added to Fe^{3+} solution. Therefore, the original solution conc. added is given by:

$C_1V_1 = C_2V_2$
C_1(10.0 mL) = (0.20M)(20.mL)
C_1 = 0.40M

29. **Identify the chemicals/condition, in appropriate order**, needed to convert elemental copper into copper(II) oxide.

A) HNO_3, zinc metal
B) HCl, NaOH, Heat
C) NaOH, HNO_3, Heat
D) HNO_3, NaOH, Heat
E) HNO_3, Heat

HNO_3 converted copper into $Cu(NO_3)_2$, the NaOH converted the $Cu(NO_3)_2$ into $Cu(OH)_2$, the heat eliminated water resulting in converted the CuO.

30. A reaction is carried out in aqueous solution, in a constant pressure ('coffee-cup') calorimeter. The temperature of the solution is observed to decrease. We can **therefore conclude that the reaction is:**

A) endothermic We can only conclude that heat was absorbed and hence endothermic.
B) a precipitation
C) exothermic
D) evolving gas
E) a neutralization reaction

Extra space for rough work:

Extra space for rough work:

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- **Some general data are provided on this page.**
- **A Periodic Table with atomic weights is provided on the next page.**

STP = 273.15 K, 1 atm
$R = 8.3145\ \text{J K}^{-1}\ \text{mol}^{-1} = 0.08206\ \text{L atm K}^{-1}\ \text{mol}^{-1}$
$c = 2.9979 \times 10^{8}$ m/s
$m_e = 9.10 \times 10^{-31}$ kg
Specific heat of water = 4.184 J / g·°C
$\Delta H^{o}_{vap}[H_2O] = 44.0\ \text{kJ mol}^{-1}$

$F = 96485$ C/mol
$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$
$h = 6.6256 \times 10^{-34}$ Js
density(H_2O, l) = 1.00g/mL

1 atm = 101.325 kPa = 760 mm Hg
1 J = 1 kg m^2 s^{-2} = 1 kPa L = 1 Pa m^3
1 cm^3 = 1 mL
1 Hz = 1 cycle/s

0°C = 273.15 K
1 m = 10^6 µm = 10^9 nm = 10^{10} Å
1 g = 10^3 mg

De Broglie wavelength: $\lambda = \frac{h}{mu} = \frac{h}{p}$

$KE = ½mu^2$

Hydrogen atom energy levels:

$E_n = \frac{-R_H}{n^2} = -2.179 \times 10^{-18}\ \text{J} / n^2$

Nernst Equation:

$$E = E° - \frac{RT}{zF}\ln Q \quad = E° - \frac{0.0257\ \text{V}}{z}\ln Q \quad = E° - \frac{0.0592\ \text{V}}{z}\log_{10} Q$$

Entropy change: $\Delta S = \frac{q_{rev}}{T}$

Solubility Guidelines for Common Ionic Solids

TABLE 5.1 Solubility Guidelines for Common Ionic Solids

Follow the lower-numbered guideline when two guidelines are in conflict. This leads to the correct prediction in most cases.

1. Salts of group 1 cations (with some exceptions for Li^+) and the NH_4^+ cation are soluble.
2. Nitrates, acetates, and perchlorates are soluble.
3. Salts of silver, lead, and mercury(I) are insoluble.
4. Chlorides, bromides, and iodides are soluble.
5. Carbonates, phosphates, sulfides, oxides, and hydroxides are insoluble (sulfides of group 2 cations and hydroxides of Ca^{2+}, Sr^{2+}, and Ba^{2+} are slightly soluble).
6. Sulfates are soluble except for those of calcium, strontium, and barium.

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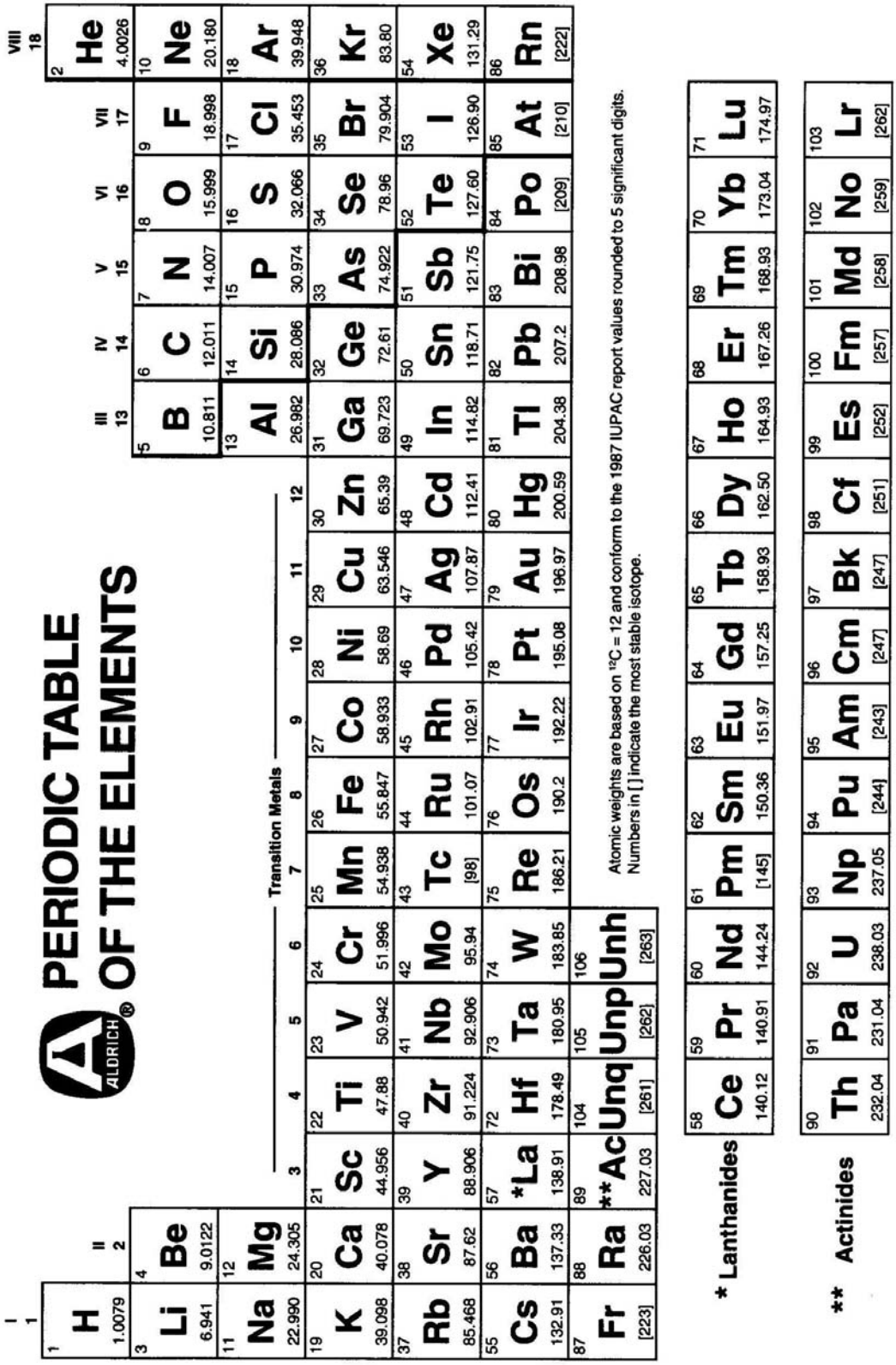

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