

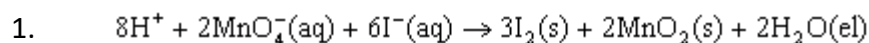


SCH4U Unit 5 - Practice Questions B [Answer Key]

SECTION 1: Short Answer

For each of the following questions:

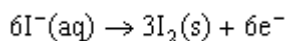
- Identify the reducing agent (1 mark)
- Identify the oxidizing agent (1 mark)
- Write balanced oxidation and reduction half-reactions (2 marks; 1 mark per half-reaction)



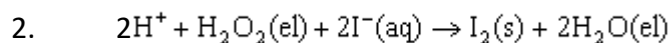
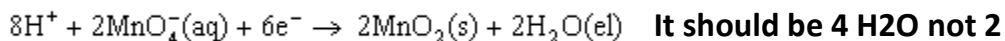
Oxidizing Agent: MnO4- Reducing Agent: I-

Balanced Half-Reactions

Oxidation Half-Reaction:



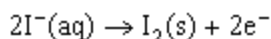
Reduction Half-Reaction:

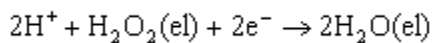


Oxidizing Agent: H2O2 Reducing Agent: I-

Balanced Half-Reactions

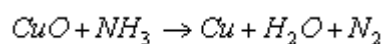
Oxidation Half-Reaction:



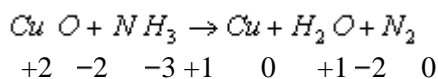
Reduction Half-Reaction:**SECTION 2: Short Answer**

Balance the following equation by the specific method. (T/I, 2 each) – 1 mark for correct method
Identify the oxidizing agent and reducing agent. (A, 1 each)

3. Balance the following equation using the **oxidation number** method:



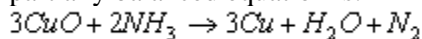
Oxidizing Agent: CuO **Reducing Agent:** NH3

Balanced Equation:

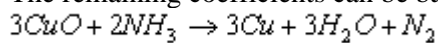
The change in the oxidation number of the oxidized element N = $(0) - (-3) = +3$

The change in the oxidation number of the reduced element Cu = $(0) - (+2) = -2$

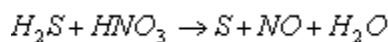
The lowest common multiple of 3 and 2 is 6. Thus in the balanced reaction two nitrogen atoms are needed for every three copper atoms. The increase and decrease in oxidation numbers will then be six for both. The partially balanced equation is:



The remaining coefficients can be balanced by inspection and the balanced equation is:

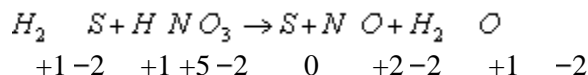


4. Balance the following equation using the **oxidation number** method:



Oxidizing Agent: HNO3 Reducing Agent: H2S

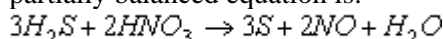
Balanced Equation:



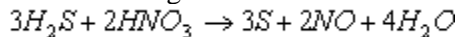
The change in the oxidation number of the oxidized element S = (0) - (-2) = +2

The change in the oxidation number of the reduced element N = (+2) - (+5) = -3

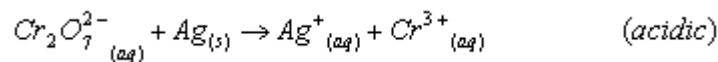
The lowest common multiple of 2 and 3 is 6. Thus in the balanced reaction three sulfur atoms are needed for every two nitrogen atoms. The increase and decrease in oxidation numbers will then be six for both. The partially balanced equation is:



The remaining coefficients can be balanced by inspection and the balanced equation is:



5. Balance the following equation using the **half-reactions** method in **acidic solution**:



Oxidizing Agent: Cr2O7²⁻ Reducing Agent: Ag

Balanced Equation:

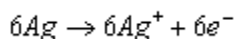
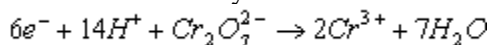
The unbalanced reduction half-cell reaction is: $Cr_2O_7^{2-} \rightarrow Cr^{3+}$

The unbalanced oxidation half-cell reaction is: $Ag_{(s)} \rightarrow Ag^+_{(aq)}$

The balanced reduction half-cell reaction is: $6e^- + 14H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O$

The balanced oxidation half-cell reaction is: $Ag \rightarrow Ag^+ + e^-$

Balance the number of electrons in the balanced two half-cell reactions above by multiplying the oxidation half-cell reaction by 6:



The net algebraic sum of the two half-cell reactions is the balanced equation for the reaction in question:





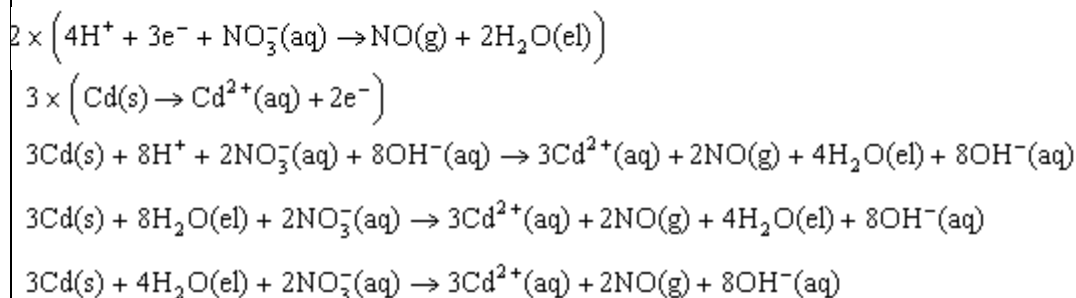
Name: _____

6. Balance the following equation using the half-reactions method in basic solution:



Oxidizing Agent: NO₃⁻ Reducing Agent: Cd

Balanced Equation:



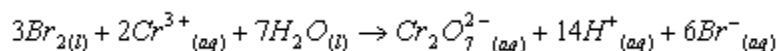
SECTION 3: Short Answer

Use the Standard Reduction Table at the end of the test to determine whether each reaction is spontaneous or not spontaneous.

Calculations: 2 each [T/I]

Correct Spontaneity: 1 each [A]

7. Balance the equation and determine whether each reaction is spontaneous or not spontaneous.



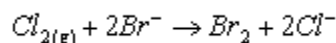
Reduction half-reaction: $3\text{Br}_{2(l)} + 6e^- \rightarrow 6\text{Br}^-_{(aq)}$ $E^\circ = +1.06 \text{ V}$

Oxidation half-reaction: $2\text{Cr}^{3+}_{(aq)} \rightarrow \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} + 6e^-$ $E^\circ = -1.33 \text{ V}$ this should be **-1.23**

Overall reaction: $3 \text{Br}_2 + 2 \text{Cr}^{3+}$ produces $6 \text{Br}^- + \text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+$ $\Delta E^\circ = -0.27 \text{ V}$ This should be **-0.16**

ΔE° for the reaction is negative, thus the reaction is nonspontaneous as written.

8. Balance the equation and determine whether each reaction is spontaneous or not spontaneous.



Reduction half-reaction: $2\text{Br}^- \rightarrow \text{Br}_2 + 2e^-$ $E^\circ = -1.06 \text{ V}$ **This should be -0.17**

Oxidation half-reaction: $\text{Cl}_2 + 2e^- \rightarrow 2\text{Cl}^-$ $E^\circ = +1.36$

Overall reaction: $2 \text{Br}^- + \text{Cl}_2$ produces $\text{Br}_2 + 2 \text{Cl}^-$ **The answer is 0.29 V**

ΔE° for the overall reaction is positive, thus the reaction is spontaneous as written.

SECTION 4: Short Answer

9. A galvanic cell is constructed using the following materials:

- Strip of zinc metal
- Strip of iron metal
- $\text{Fe}(\text{NO}_3)_2$ solution
- $\text{Zn}(\text{NO}_3)_2$ solution
- NaNO_3 (aq)
- 2 beakers
- U-shaped tube
- Connecting wires

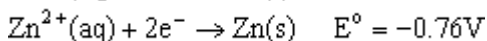
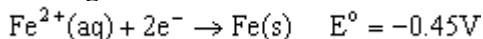
- a) Explain the process of galvanizing. (A, 1)
- b) Identify the anode and the cathode. (A, 1)
- c) What direction will the electrons flow? (A, 0.5)
- d) Identify the oxidizing agent. (A, 0.25)
- e) Identify the reducing agent. (A, 0.25)
- f) Write the equations for the half-reactions in each cell. (A, 0.5)
- g) Write the net ionic equation for the cell reaction. (A, 0.5)

Labeled Diagram (anode, cathode, direction electron flow, etc.):

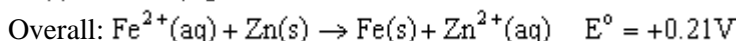
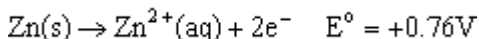
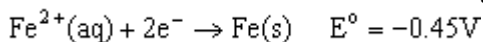
Galvanizing involves coating an iron object with a layer of zinc. Zinc is a more reactive metal that protects the iron in two ways:

1. the coating prevents the iron from contacting the atmosphere
2. Even if contact occurs, the zinc is more reactive, and so the galvanic cell set up will have zinc as the anode and iron as the anode.

As long as the iron is forced to be the cathode, it will not corrode.



These two metals will form the following galvanic cell:



Clearly from this spontaneous reaction, it can be seen that the iron will not spontaneously form ions of iron that would cause the iron to corrode.

Oxidizing Agent: _____ **Reducing Agent:** _____

Oxidation Half-Reaction:

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Reduction Half-Reaction:

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Balanced Net Ionic Equation:

R	A	C	A	C
1	1	1	1	1
/4				

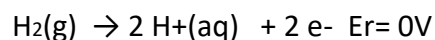
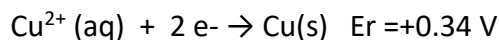
SECTION 5: Long Answer

The following questions will be graded according to the following rubric:

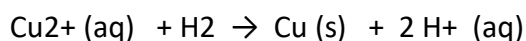
Criteria	Level 4	Level 3	Level 2	Level 1
APPLICATION Making connections between science, technology, society, and environment	makes connections between science, technology, society, and the environment with a high degree of effectiveness (3 marks)	makes connections between science, technology, society, and the environment with considerable effectiveness (2 marks)	makes connections between science, technology, society, and the environment with some effectiveness (1 mark)	makes connections between science, technology, society, and the environment with limited effectiveness (0 - 0.5 mark)
COMMUNICATION Information and ideas are communicated with complete and correct answers	Information and ideas are communicated clearly and precisely (2 mark)	Information and ideas are communicated with considerable clarity and precision (0.1 marks)	Information and ideas are communicated with some clarity and precision (0.5 marks)	Information and ideas are communicated with limited clarity and precision (0 marks)

10. In a copper-hydrogen fuel cell, the chemical energy of this compound is converted into electrical energy that can power a vehicle.

(a) Using only the following half-reactions and reduction potentials, write a net reaction equation and determine the approximate potential for the copper-hydrogen fuel cell.



(b) Discuss one advantages and one disadvantage of this technology for society.





Name: _____

Ecell = + 0.34 volts

No pollutive byproduct, highly combustibile, cost, efficiency

11. How would you explain redox reactions to a chemistry student that has never studied the topic, but was interested in learning about them? Use vocabulary from the unit, but also be sure to give detailed explanations that would allow someone to understand what you are saying.

Answers will vary.



Standard Reduction Potentials:

	E_r° (V)
$F_{2(g)} + 2e^- \rightleftharpoons 2F_{(aq)}^-$	+2.87
$PbO_{2(s)} + SO_{4(aq)}^{2-} + 4H_{(aq)}^+ + 2e^- \rightleftharpoons PbSO_{4(s)} + 2H_2O_{(l)}$	+1.69
$MnO_{4(aq)}^- + 8H_{(aq)}^+ + 5e^- \rightleftharpoons Mn_{(aq)}^{2+} + 4H_2O_{(l)}$	+1.51
$Au_{(aq)}^{3+} + 3e^- \rightleftharpoons Au_{(s)}$	+1.50
$ClO_{4(aq)}^- + 8H_{(aq)}^+ + 8e^- \rightleftharpoons Cl_{(aq)}^- + 4H_2O_{(l)}$	+1.39
$Cl_{2(g)} + 2e^- \rightleftharpoons 2Cl_{(aq)}^-$	+1.36
$2HNO_{2(aq)} + 4H_{(aq)}^+ + 4e^- \rightleftharpoons N_{2(g)}O + 3H_2O_{(l)}$	+1.30
$Cr_2O_{7(aq)}^{2-} + 14H_{(aq)}^+ + 6e^- \rightleftharpoons 2Cr_{(aq)}^{3+} + 7H_2O_{(l)}$	+1.23
$O_{2(g)} + 4H_{(aq)}^+ + 4e^- \rightleftharpoons 2H_2O_{(l)}$	+1.23
$MnO_{2(s)} + 4H_{(aq)}^+ + 2e^- \rightleftharpoons Mn_{(aq)}^{2+} + 2H_2O_{(l)}$	+1.22
$2IO_{3(aq)}^- + 12H_{(aq)}^+ + 10e^- \rightleftharpoons I_{2(s)} + 6H_2O_{(l)}$	+1.20
$Br_{2(l)} + 2e^- \rightleftharpoons 2Br_{(aq)}^-$	+1.07
$Hg_{(aq)}^{2+} + 2e^- \rightleftharpoons Hg_{(l)}$	+0.85
$ClO_{(aq)}^- + H_2O_{(l)} + 2e^- \rightleftharpoons Cl_{(aq)}^- + 2OH_{(aq)}^-$	+0.84
$Ag_{(aq)}^+ + e^- \rightleftharpoons Ag_{(s)}$	+0.80
$NO_{3(aq)}^- + 2H_{(aq)}^+ + e^- \rightleftharpoons NO_{2(g)} + H_2O_{(l)}$	+0.80
$Fe_{(aq)}^{3+} + e^- \rightleftharpoons Fe_{(aq)}^{2+}$	+0.77
$O_{2(g)} + 2H_{(aq)}^+ + 2e^- \rightleftharpoons H_2O_{2(l)}$	+0.70
$MnO_{4(aq)}^- + 2H_2O_{(l)} + 3e^- \rightleftharpoons MnO_{2(s)} + 4OH_{(aq)}^-$	+0.60
$I_{2(s)} + 2e^- \rightleftharpoons 2I_{(aq)}^-$	+0.54
$Cu_{(aq)}^+ + e^- \rightleftharpoons Cu_{(s)}$	+0.52
$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightleftharpoons 4OH_{(aq)}^-$	+0.40
$Cu_{(aq)}^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$	+0.34
$SO_{4(aq)}^{2-} + 4H_{(aq)}^+ + 2e^- \rightleftharpoons H_2SO_{3(aq)} + H_2O_{(l)}$	+0.17
$Sn_{(aq)}^{2+} + 2e^- \rightleftharpoons Sn_{(aq)}^+$	+0.15
$Cu_{(aq)}^+ + e^- \rightleftharpoons Cu_{(s)}$	+0.15
$S_{(s)} + 2H_{(aq)}^+ + 2e^- \rightleftharpoons H_2S_{(aq)}$	+0.14
$AgBr_{(s)} + e^- \rightleftharpoons Ag_{(s)} + Br_{(aq)}^-$	+0.07
$2H_{(aq)}^+ + 2e^- \rightleftharpoons H_{2(g)}$	0.00
$Pb_{(aq)}^{2+} + 2e^- \rightleftharpoons Pb_{(s)}$	-0.13
$Sn_{(aq)}^{2+} + 2e^- \rightleftharpoons Sn_{(s)}$	-0.14
$AgI_{(s)} + e^- \rightleftharpoons Ag_{(s)} + I_{(aq)}^-$	-0.15
$Ni_{(aq)}^{2+} + 2e^- \rightleftharpoons Ni_{(s)}$	-0.26
$Co_{(aq)}^{2+} + 2e^- \rightleftharpoons Co_{(s)}$	-0.28
$H_3PO_{4(aq)} + 2H_{(l)}^+ + 2e^- \rightleftharpoons H_3PO_{3(aq)} + H_2O_{(l)}$	-0.28
$PbSO_{4(s)} + 2e^- \rightleftharpoons Pb_{(s)} + SO_{4(aq)}^{2-}$	-0.36
$Se_{(s)} + 2H_{(aq)}^+ + 2e^- \rightleftharpoons H_2Se_{(aq)}$	-0.40
$Cd_{(aq)}^{2+} + 2e^- \rightleftharpoons Cd_{(s)}$	-0.40
$Cr_{(aq)}^{3+} + e^- \rightleftharpoons Cr_{(aq)}^{2+}$	-0.41
$Fe_{(aq)}^{2+} + 2e^- \rightleftharpoons Fe_{(s)}$	-0.44
$Ag_2S_{(s)} + 2e^- \rightleftharpoons 2Ag_{(s)} + S_{(aq)}^{2-}$	-0.69
$Zn_{(aq)}^{2+} + 2e^- \rightleftharpoons Zn_{(s)}$	-0.76
$Te_{(s)} + 2H_{(aq)}^+ + 2e^- \rightleftharpoons H_2Te_{(aq)}$	-0.79
$2H_2O_{(l)} + 2e^- \rightleftharpoons H_2(g) + 2OH_{(aq)}^-$	-0.83
$Cl_{(aq)}^{2+} + 2e^- \rightleftharpoons Cr_{(s)}$	-0.91
$SO_{4(aq)}^{2-} + H_2O_{(l)} + 2e^- \rightleftharpoons SO_{3(aq)}^{2-} + 2OH_{(aq)}^-$	-0.93
$Al_{(aq)}^{3+} + 3e^- \rightleftharpoons Al_{(s)}$	-1.66
$Mg_{(aq)}^{2+} + 2e^- \rightleftharpoons Mg_{(s)}$	-2.37
$Na_{(aq)}^+ + e^- \rightleftharpoons Na_{(s)}$	-2.71
$Ca_{(aq)}^{2+} + 2e^- \rightleftharpoons Ca_{(s)}$	-2.87
$Ba_{(aq)}^{2+} + 2e^- \rightleftharpoons Ba_{(s)}$	-2.91
$K_{(aq)}^+ + e^- \rightleftharpoons K_{(s)}$	-2.93
$Li_{(aq)}^+ + e^- \rightleftharpoons Li_{(s)}$	-3.04

Periodic Table

Atomic masses are listed underneath each element

1 IA																		18 VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He 4.00	
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95	
19 K 39.1	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80	
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.29	
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra (226)	89 Ac^ (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)								

	58	59	60	61	62	63	64	65	66	67	68	69	70	71
*	Ce 140.1	Pr 140.9	Nd 144.2	Pm (145)	Sm 150.4	Eu 152.0	Gd 157.3	Tb 158.9	Dy 162.5	Ho 164.9	Er 167.3	Tm 168.9	Yb 173.0	Lu 175.0
^	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)