

Name: Key

M	T	W	Tr	F
8	9	10	11	12
1	2	3	4	5

Clearly write your letter answer on the line.A 1. (Remember) What reaction occurs at the anode?

- A. Oxidation
B. Combustion
C. Reduction
D. Neutralization

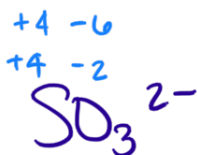
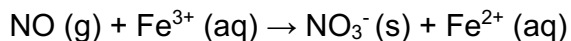
Red - cat
Reduction at Cathode \therefore Oxidation at anode

D 2. (Remember) If a redox reaction is spontaneous what must be true?

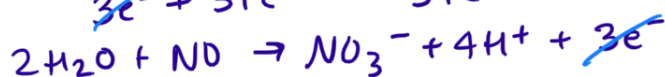
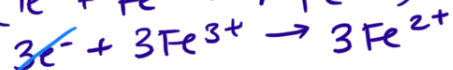
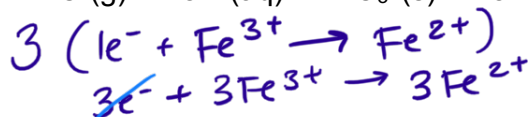
- ~~A.~~ $E^\circ_{\text{cell}} +$ and $\Delta G^\circ +$
~~B.~~ $E^\circ_{\text{cell}} -$ and $\Delta G^\circ +$
C. $E^\circ_{\text{cell}} -$ and $\Delta G^\circ -$
D. $E^\circ_{\text{cell}} +$ and $\Delta G^\circ -$

 $\Delta G^\circ = \text{spontaneous}$ $\Delta G = -nFE^\circ_{\text{cell}} \therefore E^\circ_{\text{cell}} = (+) \text{ spontaneous}$ C 3. (Understand) What is the oxidation state of sulfur in sulfite, SO_3^{2-} ?

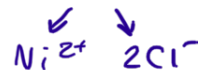
- A. -2
B. +1
C. +4
D. +6

B 4. (Understand) Balance the redox reaction below in acidic conditions. What is the coefficient for Fe^{3+} ?

- A. 1
B. 3
C. 4
D. 5

C 5. (Apply) If 3.4 A of a necessary voltage are applied to an aqueous solution of NiCl_2 for 54 min, how much Ni (s) would be expected to plate out?

- A. 0.0039 g
B. 1.67 g
C. 3.35 g
D. 6.70 g



$$54 \text{ min} \left| \frac{60 \text{ s}}{1 \text{ min}} \right| \frac{3.4 \text{ C}}{1 \text{ s}} \left| \frac{1 \text{ mole } e^-}{96485 \text{ C}} \right| \frac{1 \text{ mol Ni(s)}}{2 \text{ mole } e^-} \left| \frac{58.693 \text{ g}}{1 \text{ mol Ni(s)}} \right| = 3.35 \text{ g}$$

A 6. (Apply) A galvanic cell which transfers 6 electrons per mole has an E°_{cell} of 0.043 V. What is the value of K?

- A. 2.28×10^4
B. 1.001
C. 28.36
D. 7.8×10^2

$$E^\circ_{\text{cell}} = \frac{0.0592 \text{ V}}{n} \log K$$

$$0.043 \text{ V} = \frac{0.0592 \text{ V}}{6} \log K$$

D 7. (Analyze) Which of the diatomic halogens is the strongest reducing agent?

- A. F_2 $+2.866V$ ← really wants to be reduced
 B. Cl_2 $+1.358V$
 C. Br_2 $+1.087V$
 D. I_2 $+0.5355V$ ← closest to 0 ∴ So best reducing agent

→ wants to be oxidized
 ↳ Things which are easily oxidized have (-) reduction potentials.

A 8. (Analyze) Which reaction will be the most spontaneous at standard conditions?

$$\Delta G = -nFE_{cell}^{\circ}$$

Reaction	E°_{cell} (V)	Mole e^- transferred
→ A	0.431	2
B	0.024	3
C	0.177	4
D	0.249	2

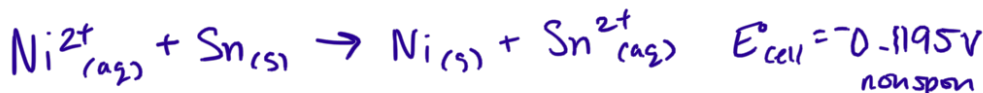
ΔG°
 -83.2 kJ
 -6.9 kJ
 -68.3 kJ
 -48.0 kJ

B 9. (Evaluate) Which reaction below will yield an electrochemical cell which requires an external voltage of at least 0.90 V for the reaction to occur in the forward direction? Calculate E_{cell}°

- ox = anode red = cathode $E_{cell}^{\circ} = E_{cath}^{\circ} - E_{anode}^{\circ}$
 A. $Na(s) + Fe^{3+}(aq) \rightarrow Na^+(s) + Fe^{2+}(aq)$ $E_{cell}^{\circ} = -0.497V - (-2.71V) = 2.26V$
 B. $Cu^{2+}(aq) + Pt(s) \rightarrow Cu(s) + Pt^{2+}(aq)$ $E_{cell}^{\circ} = 0.34V - 1.20V = -0.86V$
 C. $Co^{2+}(aq) + Cd(s) \rightarrow Co(s) + Cd^{2+}(aq)$ $E_{cell}^{\circ} = -0.28V - (-0.403V) = 0.123V$
 D. $Ni^{2+}(aq) + Cu(s) \rightarrow Ni(s) + Cu^{2+}(aq)$ $E_{cell}^{\circ} = -0.257V - 0.34V = -0.597V$

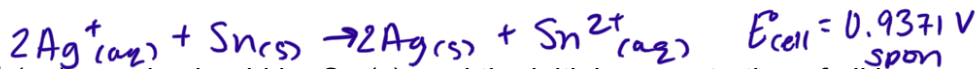
Needs external so nonspontaneous, $E_{cell}^{\circ} \ominus$. B & C are both \ominus but B needs 0.90V... C turns on at 0.6V

C 10. (Create) You want to create a galvanic cell which will produce $Sn^{2+}(aq)$ in solution spontaneously. Select a cathode, anode, and the concentration of reactants which will yield the desired product.



A. The cathode should be $Ni^{2+}(aq)$, anode should be $Sn(s)$, and the initial concentration of all ions should be 0.34 M.

X B. The cathode should be $Sn^{2+}(aq)$, anode should be $Ni^{2+}(s)$, and the initial concentration of all ions should be 0.12 M. ← reactant... we want to make this



C. The cathode should be $Ag^+(aq)$, anode should be $Sn(s)$, and the initial concentration of all ions should be 0.50 M.



D. The cathode should be $Sn^{4+}(aq)$, anode should be $Ag(s)$, and the initial concentration of all ions should be 0.01 M.

$E_{cells}^{\circ} \dots$
 A. $= -0.257V - (-0.1375V)$
 $= -0.1195V$

C. $= 0.7996V - 0.1375V$
 $= +0.9371V$

D. $= 0.151V - 0.7996V$
 $= -0.6486V$

$E_{cell} = -0.1195V - \frac{0.0592V}{2} \log \left(\frac{0.34}{(0.34)} \right)$
 $E_{cell}^{\circ} = -0.1195V$

$E_{cell} = 0.9371 - \frac{0.0592}{2} \log \left(\frac{0.50}{(0.50)^2} \right)$
 $E_{cell} = 0.928V \text{ most } (+)$

$E_{cell} = 0.6486 - \frac{0.0592}{2} \log \left(\frac{(0.01 \cdot (0.01)^2)}{0.01} \right)$
 $E_{cell} = -0.5676V$

Half-Reaction	E° (V)
$\text{F}_2(g) + 2\text{e}^- \rightarrow 2\text{F}^-(aq)$	+2.866
$\text{Au}^{3+}(aq) + 3\text{e}^- \rightarrow \text{Au}(s)$	+1.498
$\text{Cl}_2(g) + 2\text{e}^- \rightarrow 2\text{Cl}^-(aq)$	+1.35827
$\text{O}_2(g) + 4\text{H}^+(aq) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(l)$	+1.229
$\text{Pt}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Pt}(s)$	+1.20
$\text{Br}_2(aq) + 2\text{e}^- \rightarrow 2\text{Br}^-(aq)$	+1.0873
$\text{Ag}^+(aq) + \text{e}^- \rightarrow \text{Ag}(s)$	+0.7996
$\text{Hg}_2^{2+}(aq) + 2\text{e}^- \rightarrow 2\text{Hg}(l)$	+0.7973
$\text{Fe}^{3+}(aq) + \text{e}^- \rightarrow \text{Fe}^{2+}(aq)$	+0.771
$\text{I}_2(s) + 2\text{e}^- \rightarrow 2\text{I}^-(aq)$	+0.5355
$\text{Cu}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Cu}(s)$	+0.34
$\text{Sn}^{4+}(aq) + 2\text{e}^- \rightarrow \text{Sn}^{2+}(aq)$	+0.151
$2\text{H}^+(aq) + 2\text{e}^- \rightarrow \text{H}_2(g)$	0.00
$\text{Pb}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Pb}(s)$	-0.1262
$\text{Sn}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Sn}(s)$	-0.1375
$\text{Ni}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Ni}(s)$	-0.257
$\text{Co}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Co}(s)$	-0.28
$\text{Cd}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Cd}(s)$	-0.4030
$\text{Fe}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Fe}(s)$	-0.447
$\text{Cr}^{3+}(aq) + 3\text{e}^- \rightarrow \text{Cr}(s)$	-0.744
$\text{Mn}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Mn}(s)$	-1.185
$\text{Zn}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Zn}(s)$	-0.7618
$\text{Al}^{3+}(aq) + 3\text{e}^- \rightarrow \text{Al}(s)$	-1.662
$\text{Mg}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Mg}(s)$	-2.372
$\text{Na}^+(aq) + \text{e}^- \rightarrow \text{Na}(s)$	-2.71
$\text{Ca}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Ca}(s)$	-2.868
$\text{Ba}^{2+}(aq) + 2\text{e}^- \rightarrow \text{Ba}(s)$	-2.912
$\text{K}^+(aq) + \text{e}^- \rightarrow \text{K}(s)$	-2.931
$\text{Li}^+(aq) + \text{e}^- \rightarrow \text{Li}(s)$	-3.04

$$1 \text{ atm} = 760 \text{ mmHg} \quad 1 \text{ mmHg} = 1 \text{ torr} \quad 0 \text{ }^{\circ}\text{C} = 273 \text{ K}$$

$$R = 8.314 \text{ J}/(\text{mol K}) = 0.08206 \text{ (L atm)}/(\text{mol K})$$

$$\Delta G^{\circ} = -nFE_{\text{cell}}^{\circ} \quad F = 96,485 \text{ C/mol e}^{-}$$

$$E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ}$$

$$E_{\text{cell}}^{\circ} = \frac{0.0592 \text{ V}}{n} \log K \quad (\text{at } T = 25 \text{ }^{\circ}\text{C})$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0592 \text{ V}}{N} \log Q \quad (\text{at } T = 25 \text{ }^{\circ}\text{C})$$

Periodic Table of the Elements																					
<div><div><div><div><div>1</div><div>H</div><div>Hydrogen</div><div>1.008</div></div><div><div><div>2</div><div>He</div><div>Helium</div><div>4.003</div></div><div><div><div>3</div><div>Li</div><div>Lithium</div><div>6.941</div></div><div><div><div>4</div><div>Be</div><div>Beryllium</div><div>9.012</div></div><div><div><div>5</div><div>B</div><div>Boron</div><div>10.811</div></div><div><div><div>6</div><div>C</div><div>Carbon</div><div>12.011</div></div><div><div><div>7</div><div>N</div><div>Nitrogen</div><div>14.007</div></div><div><div><div>8</div><div>O</div><div>Oxygen</div><div>15.999</div></div><div><div><div>9</div><div>F</div><div>Fluorine</div><div>18.998</div></div><div><div><div>10</div><div>Ne</div><div>Neon</div><div>20.180</div></div></div></div><div><div><div>11</div><div>Na</div><div>Sodium</div><div>22.990</div></div><div><div><div>12</div><div>Mg</div><div>Magnesium</div><div>24.305</div></div><div><div><div>13</div><div>Al</div><div>Aluminum</div><div>26.982</div></div><div><div><div>14</div><div>Si</div><div>Silicon</div><div>28.086</div></div><div><div><div>15</div><div>P</div><div>Phosphorus</div><div>30.974</div></div><div><div><div>16</div><div>S</div><div>Sulfur</div><div>32.066</div></div><div><div><div>17</div><div>Cl</div><div>Chlorine</div><div>35.453</div></div><div><div><div>18</div><div>Ar</div><div>Argon</div><div>39.948</div></div></div></div><div><div><div>19</div><div>K</div><div>Potassium</div><div>39.098</div></div><div><div><div>20</div><div>Ca</div><div>Calcium</div><div>40.078</div></div><div><div><div>21</div><div>Sc</div><div>Scandium</div><div>44.956</div></div><div><div><div>22</div><div>Ti</div><div>Titanium</div><div>47.867</div></div><div><div><div>23</div><div>V</div><div>Vanadium</div><div>50.942</div></div><div><div><div>24</div><div>Cr</div><div>Chromium</div><div>51.996</div></div><div><div><div>25</div><div>Mn</div><div>Manganese</div><div>54.938</div></div><div><div><div>26</div><div>Fe</div><div>Iron</div><div>55.845</div></div><div><div><div>27</div><div>Co</div><div>Cobalt</div><div>58.933</div></div><div><div><div>28</div><div>Ni</div><div>Nickel</div><div>58.693</div></div><div><div><div>29</div><div>Cu</div><div>Copper</div><div>63.546</div></div><div><div><div>30</div><div>Zn</div><div>Zinc</div><div>65.38</div></div><div><div><div>31</div><div>Ga</div><div>Gallium</div><div>69.723</div></div><div><div><div>32</div><div>Ge</div><div>Germanium</div><div>72.631</div></div><div><div><div>33</div><div>As</div><div>Arsenic</div><div>74.922</div></div><div><div><div>34</div><div>Se</div><div>Selenium</div><div>78.971</div></div><div><div><div>35</div><div>Br</div><div>Bromine</div><div>79.904</div></div><div><div><div>36</div><div>Kr</div><div>Krypton</div><div>83.798</div></div></div></div><div><div><div>37</div><div>Rb</div><div>Rubidium</div><div>85.468</div></div><div><div><div>38</div><div>Sr</div><div>Strontium</div><div>87.62</div></div><div><div><div>39</div><div>Y</div><div>Yttrium</div><div>88.906</div></div><div><div><div>40</div><div>Zr</div><div>Zirconium</div><div>91.224</div></div><div><div><div>41</div><div>Nb</div><div>Niobium</div><div>92.906</div></div><div><div><div>42</div><div>Mo</div><div>Molybdenum</div><div>95.95</div></div><div><div><div>43</div><div>Tc</div><div>Technetium</div><div>98.907</div></div><div><div><div>44</div><div>Ru</div><div>Ruthenium</div><div>101.07</div></div><div><div><div>45</div><div>Rh</div><div>Rhodium</div><div>102.906</div></div><div><div><div>46</div><div>Pd</div><div>Palladium</div><div>106.42</div></div><div><div><div>47</div><div>Ag</div><div>Silver</div><div>107.868</div></div><div><div><div>48</div><div>Cd</div><div>Cadmium</div><div>112.414</div></div><div><div><div>49</div><div>In</div><div>Indium</div><div>114.818</div></div><div><div><div>50</div><div>Sn</div><div>Tin</div><div>118.711</div></div><div><div><div>51</div><div>Sb</div><div>Antimony</div><div>121.760</div></div><div><div><div>52</div><div>Te</div><div>Tellurium</div><div>127.6</div></div><div><div><div>53</div><div>I</div><div>Iodine</div><div>126.904</div></div><div><div><div>54</div><div>Xe</div><div>Xenon</div><div>131.294</div></div></div></div><div><div><div>55</div><div>Cs</div><div>Cesium</div><div>132.905</div></div><div><div><div>56</div><div>Ba</div><div>Barium</div><div>137.328</div></div><div><div><div>57-71</div></div></div><div><div><div>72</div><div>Hf</div><div>Hafnium</div><div>178.49</div></div><div><div><div>73</div><div>Ta</div><div>Tantalum</div><div>180.948</div></div><div><div><div>74</div><div>W</div><div>Tungsten</div><div>183.84</div></div><div><div><div>75</div><div>Re</div><div>Rhenium</div><div>186.207</div></div><div><div><div>76</div><div>Os</div><div>Osmium</div><div>190.23</div></div><div><div><div>77</div><div>Ir</div><div>Iridium</div><div>192.217</div></div><div><div><div>78</div><div>Pt</div><div>Platinum</div><div>195.085</div></div><div><div><div>79</div><div>Au</div><div>Gold</div><div>196.967</div></div><div><div><div>80</div><div>Hg</div><div>Mercury</div><div>200.592</div></div><div><div><div>81</div><div>Tl</div><div>Thallium</div><div>204.383</div></div><div><div><div>82</div><div>Pb</div><div>Lead</div><div>207.2</div></div><div><div><div>83</div><div>Bi</div><div>Bismuth</div><div>208.980</div></div><div><div><div>84</div><div>Po</div><div>Polonium</div><div>[209]</div></div><div><div><div>85</div><div>At</div><div>Astatine</div><div>[209]</div></div><div><div><div>86</div><div>Rn</div><div>Radon</div><div>[222]</div></div></div></div><div><div><div>87</div><div>Fr</div><div>Francium</div><div>[223]</div></div><div><div><div>88</div><div>Ra</div><div>Radium</div><div>[226]</div></div><div><div><div>89-103</div></div></div><div><div><div>104</div><div>Rf</div><div>Rutherfordium</div><div>[261]</div></div><div><div><div>105</div><div>Db</div><div>Dubnium</div><div>[262]</div></div><div><div><div>106</div><div>Sg</div><div>Seaborgium</div><div>[266]</div></div><div><div><div>107</div><div>Bh</div><div>Bohrium</div><div>[264]</div></div><div><div><div>108</div><div>Hs</div><div>Hassium</div><div>[269]</div></div><div><div><div>109</div><div>Mt</div><div>Meitnerium</div><div>[278]</div></div><div><div><div>110</div><div>Ds</div><div>Darmstadtium</div><div>[281]</div></div><div><div><div>111</div><div>Rg</div><div>Roentgenium</div><div>[280]</div></div><div><div><div>112</div><div>Cn</div><div>Copernicium</div><div>[285]</div></div><div><div><div>113</div><div>Nh</div><div>Nihonium</div><div>[286]</div></div><div><div><div>114</div><div>Fl</div><div>Flerovium</div><div>[289]</div></div><div><div><div>115</div><div>Mc</div><div>Moscovium</div><div>[289]</div></div><div><div><div>116</div><div>Lv</div><div>Livermorium</div><div>[293]</div></div><div><div><div>117</div><div>Ts</div><div>Tennessine</div><div>[294]</div></div><div><div><div>118</div><div>Og</div><div>Oganesson</div><div>[294]</div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div></div>																		<div><div><div>1</div><div>IA</div></div><div><div><div>2</div><div>IIA</div></div><div><div><div>3</div><div>IIIB</div></div><div><div><div>4</div><div>IVB</div></div><div><div><div>5</div><div>VB</div></div><div><div><div>6</div><div>VIB</div></div><div><div><div>7</div><div>VIIIB</div></div><div><div><div>8</div><div>VIII</div></div><div><div><div>9</div><div>IX</div></div><div><div><div>10</div><div>X</div></div><div><div><div>11</div><div>IB</div></div><div><div><div>12</div><div>IIB</div></div></div></div></div></div></div></div></div></div></div></div></div></div>		<div><div><div>13</div><div>IIIA</div></div><div><div><div>14</div><div>IVA</div></div><div><div><div>15</div><div>VA</div></div><div><div><div>16</div><div>VIA</div></div><div><div><div>17</div><div>VIIA</div></div><div><div><div>18</div><div>VIIIA</div></</div></div></div></div></div></div></div>	