1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											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											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 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 65.38	31 Ga 69.72	32 Ge 72.64	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 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (270)	109 Mt (278)	110 Ds (281)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	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 (266)

constants

$R = 0.08206$ L atm/mol K

$R = 8.314$ J/mol K

$F = 96485$ C/mol e^-

$N_A = 6.022 \times 10^{23}$ /mol

$h = 6.626 \times 10^{-34}$ J·s

$c = 3.00 \times 10^8$ m/s

$g = 9.81$ m/s^2

conversions

1 atm = 760 torr

1 atm = 101325 Pa

1 atm = 1.01325 bar

1 bar = 10^5 Pa

°F = °C(1.8) + 32

K = °C + 273.15

conversions

1 in = 2.54 cm

1 ft = 12 in

1 yd = 3 ft

1 mi = 5280 ft

1 lb = 453.6 g

1 ton = 2000 lbs

1 tonne = 1000 kg

1 gal = 3.785 L

1 gal = 231 in^3

1 gal = 128 fl oz

1 fl oz = 29.57 mL

standard potentials at 25 °C

	$E°$ (V)
$F_2(g) + 2\,e^- \rightleftharpoons 2\,F^-(aq)$	+2.87 V
$Ce^{4+}(aq) + e^- \rightleftharpoons Ce^{3+}(aq)$	+1.61 V
$Cl_2(g) + 2\,e^- \rightleftharpoons 2\,Cl^-(aq)$	+1.36 V
$O_2(g) + 4\,H^+(aq) + 4\,e^- \rightleftharpoons 2\,H_2O(\ell)$	+1.23 V
$Pd^{2+}(aq) + 2\,e^- \rightleftharpoons Pd(s)$	+0.92 V
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+0.80 V
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77 V
$Cu^{2+}(aq) + 2\,e^- \rightleftharpoons Cu(s)$	+0.34 V
$2\,H^+(aq) + 2\,e^- \rightleftharpoons H_2(g)$	**0.00** V
$Fe^{3+}(aq) + 3\,e^- \rightleftharpoons Fe(s)$	−0.04 V
$Pb^{2+}(aq) + 2\,e^- \rightleftharpoons Pb(s)$	−0.13 V
$Ni^{2+}(aq) + 2\,e^- \rightleftharpoons Ni(s)$	−0.23 V
$Fe^{2+}(aq) + 2\,e^- \rightleftharpoons Fe(s)$	−0.44 V
$Zn^{2+}(aq) + 2\,e^- \rightleftharpoons Zn(s)$	−0.76 V
$Al^{3+}(aq) + 3\,e^- \rightleftharpoons Al(s)$	−1.66 V
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	−3.05 V

This extra practice set can be used to test your knowledge for the upcoming exam.

---

1. Conceptually, Faraday's law tells us that the number of moles of metal plated is equal to the charge applied divided by the charge required to plate one mole of metal. How much charge will it take to plate out one mole of cobalt metal from Co^{2+} ions?

a. 2×96485 C

b. 96485 C

c. $N_a \times 96485$ C

d. 3×96485 C

---

2. What drives a voltaic cell?

a. the spontaneity of the redox reaction

b. the push of electrons from cathode to anode

c. the external power source

d. the heat supplied by the chemical reaction

---

3. Suppose you set up what will be a fully functional electrochemical cell using two beakers with aqueous solutions, electrodes, and a salt bridge. Just before connecting the wires, you think about the cell you created for a bit. Which of the following statements is false?

a. The spontanous reaction will occur when you connect the wires.

b. The cell will run as a voltaic cell if you do not provide any voltage.

c. You can turn this into an electrolytic cell if you provide a sufficient amount of voltage.

d. You cannot run the nonspontaneous reaction, even if you supply a power source.

---

4. The standard cell potential and the number of electrons transferred are matched below for four different electrochemical cells. Which cell will provide the greatest amount of electrical work (energy)?

a. $E^\circ = 3.95$ V, $n = 1$

b. $E^\circ = 0.58$ V, $n = 6$

c. $E^\circ = 1.38$ V, $n = 4$

d. $E^\circ = 1.55$ V, $n = 3$

---

5. What is the balanced redox equation represented by the following shorthand notation:

$$\mathrm{Pt} \,|\, \mathrm{H_2} \,|\, \mathrm{H^+} \,||\, \mathrm{Al^{3+}} \,|\, \mathrm{Al}$$

a. $2H^+ + 2Al \rightleftharpoons 3H_2 + 2Al^{3+}$

b. $2H_2 + 3Al^{3+} \rightleftharpoons 2H^+ + 3Al$

c. $H_2 + Al^{3+} \rightleftharpoons H^+ + Al$

d. $3H_2 + 2Al^{3+} \rightleftharpoons 6H^+ + 2Al$

e. $6H^+ + 2Al \rightleftharpoons 3H_2 + 2Al^{3+}$

---

6. What are the oxidation numbers of Na, S, and O in Na_2SO_3?

a. Na = 2, S = 2, O = -2

b. Na = 1, S = 4, O = -2

c. Na = 1, S = 2, O = -2

d. Na = 2, S = 2, O = -6

e. Na = 2, S = 4, O = -6

---

7. What is the cell potential for the following nonstandard cell?

$$\mathrm{Ni} \,|\, \mathrm{Ni^{2+}}\,(0.023\,\mathrm{M}) \,||\, \mathrm{Ni^{2+}}\,(0.068\,\mathrm{M}) \,|\, \mathrm{Ni}$$

a. -202 mV

b. -216 mV

c. 27.9 mV

d. -13.9 mV

e. 13.9 mV

f. -27.9 mV

---

8. Looking at two half-reactions on a reduction potential table, how can you determine the roles of each reaction in an electrolytic cell?

a. The cathode is the stronger reduction reaction and the anode is the weaker reduction reaction.

b. The cathode is the weaker reduction reaction and the anode is the stronger reduction reaction.

c. There is no way to know.

---

9. You wish to electroplate 1.00 g of gold on a piece of jewelry from a concentrated solution of Au^{3+} ions. What current is needed to achieve the reaction in 10 hours?

a. 27.2 mA

b. 147 mA

c. 102 mA

d. 1.36 mA

e. 40.8 mA

---

10. What is the voltage of a standard voltaic cell made from the following two half reactions:

$$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$$
$$Pb^{2+} + 2e^- \rightleftharpoons Pb$$

a. -1.26 V

b. 1.49 V

c. 0.31 V

d. 3.03 V

e. 1.26 V

---

11. Which of the following factors is the *main* one that governs the maximum amount of current that a battery can deliver?

a. the salt used in the salt bridge

b. the working voltage of the battery

c. the conductance of the metal electrodes

d. the concentration of the electrolyte

e. the surface area of the electrodes

---

12. Elements in their standard state have an oxidation number equal to...

a. the column in the periodic table for metals and eight minus the column in the periodic table for nonmetals

b. the column in the periodic table

c. 0

d. +1 for monatomics and +2 for diatomics

---

13. Which type of battery uses the chemistry shown in the following shorthand notation?

$Zn(s) \,|\, ZnOH(s) \,|\, KOH(aq) \,||$

$KOH(aq) \,|\, Mn_2O_3(s) \,|\, MnO_2(s) \,|C(s)$

a. NiCd

b. alkaline cell

c. car battery

d. fuel cell

e. lithium ion

---

14. What is the maximum amount of electrical work (energy) that can be obtained from the following cell?

$$Fe \,|\, Fe^{3+} \,||\, Pd^{2+} \,|\, Pd$$

a. 556 kJ

b. 92.6 kJ

c. 5.76 kJ

d. 278 kJ

e. 185 kJ

---

15. Looking at two half-reactions on a reduction potential table, how can you determine the roles of each reaction in a voltaic cell?

a. The cathode is the weaker reduction reaction and the anode is the stronger reduction reaction.

b. The cathode is the stronger reduction reaction and the anode is the weaker reduction reaction.

c. There is no way to know.

---

16. Which of these is NOT a characteristic you would want for the primary cells powering your television remote?

a. The cell rapidly discharges its full potential.

b. The cell maintains a stable voltage for as long as possible.

c. The cell has a surface area proportional to the amount of current you want to provide to an external circuit.

d. The cell is voltaic.

---

17. The lead acid battery (aka car battery) has lead in various oxidation states and compounds. Which of the following species listed is the *active* material at the cathode of a lead acid battery as it is being discharged?

a. $PbSO_4(s)$

b. $PbO_2(s)$

c. Pb(s)

d. $Pb^{2+}(aq)$

e. $Pb_2O_3(s)$

---

18. What is the standard potential of the strongest voltaic cell you can make using the following half reactions?

$$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$$

$$Cu^{2+} + 2e^- \rightleftharpoons Cu$$

$$Fe^{3+} + 3e^- \rightleftharpoons Fe$$

$$Li^+ + e^- \rightleftharpoons Li$$

Note: use the standard potentials as your reference for "strongest."

a. 3.05 V

b. 1.36 V

c. 5.40 V

d. 4.41 V

e. 1.40 V

f. -1.36 V

---

19. What is the standard potential for the following cell?

$$Ag\,|\,Ag^+\,||\,Zn^{2+}\,|\,Zn$$

a. -1.56 V

b. 1.56 V

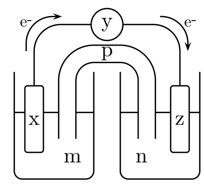
c. 2.36 V

d. -0.72 V

e. -2.36 V

---

20. (part 1 of 2): Consider the electrochemical cell diagram shown below which is running spontaneously with the electron flow direction as shown. Choose the answer the correctly identifies the salt bridge and the flow of cations in cell compartment n.



a. y = salt bridge; cations flow towards z

b. p = salt bridge; cations flow towards z

c. p = salt bridge; cations flow towards p

d. $x + y + z$ = salt bridge; cations do not flow

e. m = salt bridge; cations flow towards x

---

21. (part 2 of 2): For the previously shown cell diagram, what is the assigned charge on the component labeled x

a. negative

b. positive

c. no charge

---

22. Which of the following half reactions would require an inert electrode?

a. $Li^+(aq) + e^- \rightleftharpoons Li(s)$

b. $Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$

c. $F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$

d. $Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$

e. $Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$

---

23. In acidic conditions, iron(II) oxide and dichromate will react to form iron(III) ions and chromium ions as shown in the unbalanced redox equation below:

$$FeO + Cr_2O_7^{2-} \rightleftharpoons Fe^{3+} + Cr^{3+}$$

What is the sum of the two coefficients of the product cations (Fe^{3+} and Cr^{3+}) in the properly balanced equation?

a. 8

b. 6

c. 2

d. 3

e. 4

---

24. Consider the following concentration cells:

$$Pd \,|\, Pd^{2+}\,(0.050\,M) \,||\, Pd^{2+}\,(0.050\,M) \,|\, Pd$$

$$Ni \,|\, Ni^{2+}\,(0.050\,M) \,||\, Ni^{2+}\,(0.050\,M) \,|\, Ni$$

Will the palladium concentration cell have a potential stronger than, weaker than, or equal to the nickel concentration cell?

a. equal to

b. stronger than

c. weaker than

---

25. Identify the change in oxidation number for nitrogen in the conversion of N_2 to NO_2^-. Is this process a reduction or oxidation?

a. +6, reduction

b. +3, oxidation

c. +4, reduction

d. +4, oxidation

e. -3, reduction

f. +5, oxidation

Remember to bubble in ALL your answers BEFORE time is called. Double check your name, uteid, and version number before you turn in your bubblesheet. You must keep your exam for future reference. Please do not lose it. We will not replace it.