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 exam should have exactly 20 questions. Each question is equally weighted at 5 points each. Bubble in your answer choices on the bubblehseet provided. Your score is based on what you bubble on the bubblesheet and not what is circled on the exam.

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

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

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

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

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

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

---

2. 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. +3, oxidation

b. -3, reduction

c. +4, oxidation

d. +4, reduction

e. +6, reduction

f. +5, oxidation

---

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

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

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

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

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

---

4. 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:

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

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

a. 3

b. 2

c. 8

d. 6

e. 4

---

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

a. 0

b. +1 for monatomics and +2 for diatomics

c. the column in the periodic table

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

---

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

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

a. 1.26 V

b. -1.26 V

c. 3.03 V

d. 1.49 V

e. 0.31 V

---

7. 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. -1.36 V

b. 3.05 V

c. 1.36 V

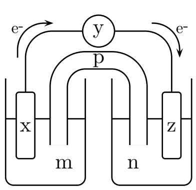
d. 4.41 V

e. 1.40 V

f. 5.40 V

---

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

b. $m =$ salt bridge; cations flow towards x

c. $p =$ salt bridge; cations flow towards p

d. $p =$ salt bridge; cations flow towards z

e. $y =$ salt bridge; cations flow towards z

---

9. (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

---

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

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

a. 2.36 V

b. -0.72 V

c. -1.56 V

d. 1.56 V

e. -2.36 V

---

11. 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. stronger than

b. weaker than

c. equal to

---

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

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

a. -202 mV

b. 27.9 mV

c. 13.9 mV

d. -13.9 mV

e. -27.9 mV

f. -216 mV

---

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

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

b. The cell rapidly discharges its full potential.

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.

---

14. 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. $Pb_2O_3(s)$

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

c. $Pb(s)$

d. $PbO_2(s)$

e. $PbSO_4(s)$

---

15. 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. alkaline cell

b. lithium ion

c. fuel cell

d. car battery

e. NiCd

---

16. 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. 40.8 mA

c. 1.36 mA

d. 102 mA

e. 147 mA

---

17. 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. 96485 C

b. 2×96485 C

c. 3×96485 C

d. $N_a \times 96485$ C

---

18. What drives a voltaic cell?

a. the spontaneity of the redox reaction

b. the external power source

c. the push of electrons from cathode to anode

d. the heat supplied by the chemical reaction

---

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

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

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

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

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

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

---

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

a. the surface area of the electrodes

b. the concentration of the electrolyte

c. the salt used in the salt bridge

d. the working voltage of the battery

e. the conductance of the metal electrodes

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.