

Numerical constants may be listed below. Other needed information is given in the problem or written on the board or found in the periodic tables you will use during exam. For numerical problems, be sure to **show your work**, include units and circle your final answer. If several choices are given, **circle the one correct answer**. Your written answers should be brief and to the point. You can use only your own calculator on the exam, but no notes, books, external information, or other electronic devices are to be used. No cell phone is to be used in Exam room.

$$1 \text{ cal} = 4.184 \text{ J} \quad c = 3.00 \times 10^8 \text{ m/s} \quad 1 \text{ atm} = 760 \text{ torr} = 1.01 \times 10^5 \text{ N/m}^2 \quad h = 6.63 \times 10^{-34} \text{ Js}$$

$$R = 0.08206 \text{ (L atm/ mol K)} \quad R = 8.31 \text{ J/mol K} \quad (\text{K}) = (^\circ\text{C}) + 273 \quad (^\circ\text{C}) = (^\circ\text{F} - 32) / 1.8$$

$$1 \text{ g} = 6.02 \times 10^{23} \text{ amu} \quad 1 \text{ F} = 96485 \text{ C/mol} \quad \Delta G^\circ = -n F E^\circ \quad \Delta G^\circ = -R T \ln K$$

$$E = E^\circ - (0.0592/n) \log(Q) \quad \ln(N/N_0) = -kt \quad \text{or} \quad \ln N = \ln N_0 - kt \quad 0.693 = k t_{1/2} \quad J = C V \quad A = C/s$$

- 1) The oxidation number of phosphorus in PO_4^{3-} is $\overset{(5)}{5}$ and ox nu of P in P_4 is $\overset{(0)}{0}$

$$(P) + 4(O) = -3$$

$$(P) + 4(-2) = -3 \quad (-3)$$

- 2) The oxidation number of ~~nitrogen~~ nitrogen in NH_3 is $\overset{(-3)}{-3}$ and ox nu of U in UF_6 is $\overset{(6)}{6}$

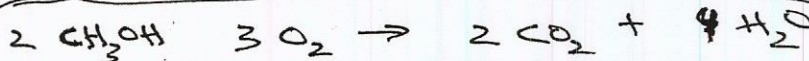
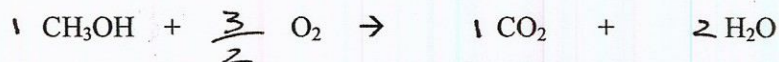
$$(N) + 3(H) = 0$$

$$(N) + 3(1) = 0$$

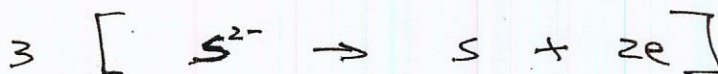
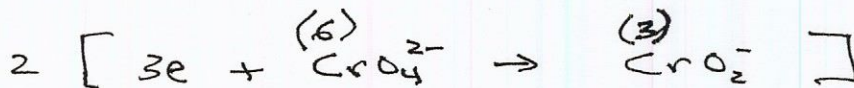
$$U + 6(F) = 0$$

$$(U) + 6(-1) = 0$$

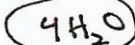
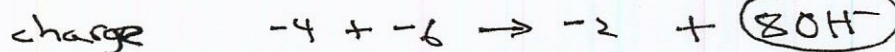
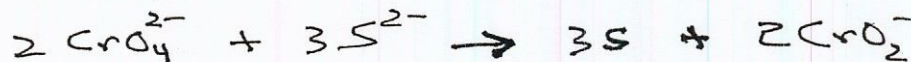
- 3) By simple inspection balance the combustion reaction of methanol below and write final equation with no fractions



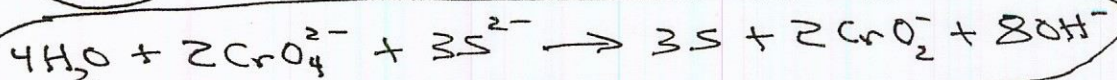
- 4) Using the reaction $\text{CrO}_4^{2-} + \text{S}^{2-} \rightleftharpoons \text{S} + \text{CrO}_2^-$ write two half reactions with electrons



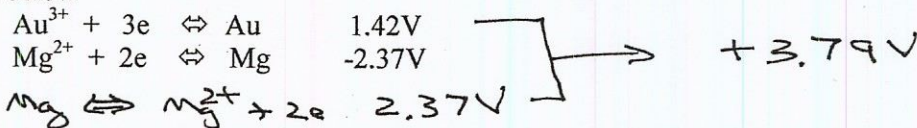
- 5) Now balance by first combining the two half reactions above appropriately and then adding OH^- and H_2O as needed assuming that this reaction takes place in a basic aqueous solution



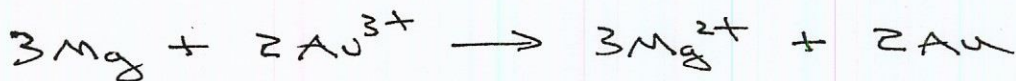
Final



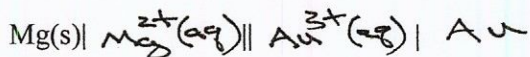
6) You are hired by a company to help with their design of a new gold and magnesium battery (galvanic cell) and the first question they ask is what is the voltage at standard state E° would be using the half reactions below



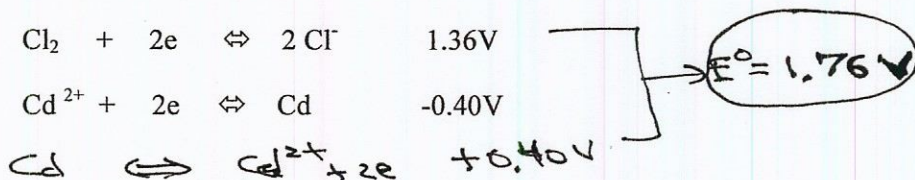
7) Next they ask what is the overall balanced chemical reaction obtained by combining these half reactions?



8) and then they ask you to complete the abbreviated cell representation below based on the reaction above



9) Using the half reactions below find the value of the standard state potential E° for the reaction $\text{Cl}_2(\text{g}) + \text{Cd}(\text{s}) \rightleftharpoons \text{Cd}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq})$



10) And what is the voltage potential of E for the same reaction $\text{Cl}_2(\text{g}) + \text{Cd}(\text{s}) \rightleftharpoons \text{Cd}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq})$ where conditions are not at standard but rather $[\text{Cl}^-]=0.022\text{M}$ and $[\text{Cd}^{2+}]=0.022\text{M}$ and $P_{\text{Cl}_2}=2.22\text{atm}$

$$E = E^\circ - \frac{0.0592}{n} \log Q$$

$$E = 1.76\text{V} - \frac{0.0592}{2} \log \frac{[\text{Cd}^{2+}][\text{Cl}^-]^2}{P_{\text{Cl}_2}}$$

$$= 1.76\text{V} - \frac{0.0592}{2} \log (4.80 \times 10^{-6})$$

$$= 1.76\text{V} - (-0.16\text{V}) = 1.92\text{V}$$

less products so stronger driving force to products

11) What is the value of ΔG° for a reaction if the value of the emf potential voltage is $E^\circ = +1.55\text{V}$ and $n = 2\text{mol}$

$$\Delta G^\circ = -nFE^\circ$$

$$\Delta G^\circ = -(2\text{mol}) \left(\frac{96485\text{C}}{\text{mol}} \right) (+1.55\text{V}) = -299,104\text{J}$$

$$\Delta G^\circ = -299\text{kJ}$$

12) The electrolysis (where electricity is passed) through acidic water produces what two gases

- a Cl_2 H_2 b O_2 H_2 c CO H_2 d CO_2 O_2 e NO O_2

13) This element is found in different allotropes including a red, black, and white form
 a N **b P** c As d Sb e Bi

14) _____ is a halogen that exists as a purple diatomic solid.
 a mercury b fluorine c chlorine **d iodine**

15) Which of the following is the most reactive (explosive) when added to water
 a Au **b Cs** c Hg d Mg e Na

16) Balance the following nuclear reaction



17) Which of these noble gases has the highest boiling point
 a He b Ne c Ar d Kr **e Xe**

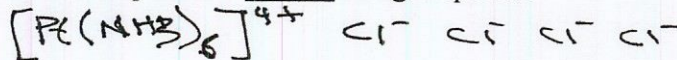
18) This element is found in borax and combines with halogens to form a trigonal planar compound.
 a Ar **b B** c C d Si e O

19) Group in the periodic table that includes nonmetals, metalloids and metals.
 a 1 b 2 **c 14** d 17 e 18

20) _____ is the most abundant element (by mass) in the human body
 a H **b O** c C d P e N

21) If MgCl_2 is placed in water it can break apart into 3 charged species: Mg^{2+} , Cl^- , and Cl^- . Platinum (IV), Pt^{4+} , forms a coordination complex with ammonia and combines with chlorine to form the salt $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$. If $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$ is placed in water it can break apart into _____ charged species.

a 2 b 3 **c 5** d 11 e 29



22) How many neutrons in the isotope of mercury, ${}^{202}\text{Hg}$?
 a 282 b 202 **c 122** d 80

$$\begin{array}{r} 202 \\ - 80 \\ \hline 122 \end{array}$$

23) For the reaction $2\text{H}^+(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g})$ with an potential of +0.76V, you can expect that the equilibrium constant, K is a small b about 1 **c large**

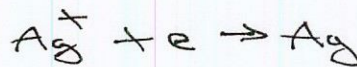


24) A 9.6 A current is passed for 1000 seconds through a solution containing Ag^+ ions. How many moles of silver would plate out during this time?

a 100 b 10 c 1 **d 0.1** e 0.001

$$\left(9.6 \frac{\text{C}}{\text{s}}\right) (1000 \text{ s}) = 9600 \text{ C}$$

$$F = \frac{96485 \text{ C}}{\text{mol}}$$



$$? \text{ mol Ag} = \frac{9600 \text{ C}}{96485} \left(\frac{1 \text{ mole}}{1 \text{ mole}} \right) = 0.0995 \text{ mol Ag}$$

or
0.1 mol Ag

25) Complete the following equation associated with beta emission.

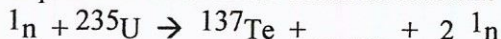


26) The isotope ${}^{14}\text{C}$ contains how many neutrons

- a 2 b 4 c 6 d 7 **e 8**

$$\begin{array}{r} 14 \\ - 6 \\ \hline 8 \end{array}$$

27) One possible reaction for uranium fission is given below. Complete the reaction



- a ${}^{93}_{40}\text{Zr}$ b ${}^{95}_{40}\text{Zr}$ **c ${}^{97}_{42}\text{Zr}$** d ${}^{99}_{40}\text{Zr}$

$$236 = 137 + (\quad) + 2$$

} **97**

28) A radioactive nuclide has a half-life of 12.0 hours.

A thyroid patient is given 20.0 microcurie of this radioactive substance. How many microcuries of activity remain in the patient 24 hours later.

- a 2.0 b 1.0 **c 0.5** d 2.5 e 1

$$\begin{array}{l} 0 \rightarrow 12 \rightarrow 24 \text{ hr} \\ 20 \rightarrow 10 \rightarrow 5 \\ 2 t_{1/2} \end{array}$$

29) Is a pale blue gas at room temperature

- a Br_2 b I_2 **c O_3** d O_2 e N_2

30) The source of the sun's energy is :

- nuclear fusion** nuclear fission n-reaction C++reaction

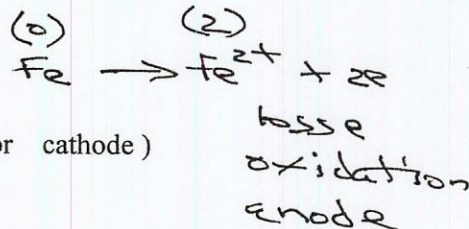
31) Most abundant metal in the earth's crust but more expensive than gold in 1855.

- a Au b Pb **c Al** d Cu e Ni

32) For the reaction $\text{Fe} + \text{Ni}^{2+} \rightarrow \text{Fe}^{2+} + \text{Ni}$

At the Fe electrode there is a (gain or **loss**) of electrons

and so the iron electrode is the (**anode**) or cathode)



33) In the reaction $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ the

H is reduced or **oxidized**

34) If 8.000 grams of ${}^{234}\text{U}$ are sealed in a container and then opened many years later — how time has passed if the amount of uranium isotope left in the container is 2.833g given that the half life of this isotope of uranium is $t_{1/2} = 200,000$ year

$$\ln 2 = k t_{1/2} \Rightarrow k = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{200,000 \text{ yr}}$$

$$k = 3.47 \times 10^{-6} \text{ yr}^{-1}$$

$$\ln N = \ln N_0 - k t$$

$$\ln(2.833) = \ln(8.000) - (3.47 \times 10^{-6} \text{ yr}^{-1}) t$$

$$(1.0413 - 2.0794) / (-3.47 \times 10^{-6} \text{ yr}^{-1}) = 299,166 \text{ yr} = t$$

or **$2.99 \times 10^5 \text{ yr}$**