

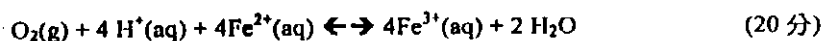
國立臺灣科技大學
八十七學年度碩士班招生考試試題

所 別：工程技術研究所
學程別：材料科技學程

組別：乙組

科目：普通化學

1. Calculate the equilibrium constant at 25 °C for the reaction



[hint: $\Delta G = -nE^\circ \mathcal{F} = -RT \ln(K)$, $\mathcal{F} = 96500 \text{ J/V-mole e}^{-1}$]

2. A 3 g sample of ammonium nitrite (NH_4NO_2) is heated in a sealed chamber having a volume of 0.5 liter and an initial pressure of 10^{-1} Pa. The ammonium nitrite is expected to decompose according to the equation



If it does decompose completely in this way, what will be the pressure when the chamber is cooled down to 26 °C? (20 分)

3. A particular arrangement of electrons in the orbitals of an atom is referred to as an electron configuration. Please write down the electron configurations of the following elements: (10 分)

(A) As, (B) Cl, (C) W, (D) Be, and (E) Fr

Please also arrange these five elements in the order of increasing electronegativity. (10 分)

4. In an experiment, ammonia (NH_3) was synthesized using a mixture of hydrogen and nitrogen. The system was allowed to attain chemical equilibrium at 472 °C, with a total pressure of 10 atm. The equilibrium mixture of gases under these conditions consisted of 73.76 percent H_2 , 24.58 percent N_2 , and 1.66 percent NH_3 . From these data, (A) calculate the equilibrium constant of this reaction at 472 °C (10 分), and (B) propose two approaches to enhance the yield of ammonia produced via this reaction. (10 分)
5. What are the types of bonding (primary bonding and secondary bonding) in the following materials at room temperature?

(A) HF, (B) SiC, (C) Au-10%Cu, (D) graphite, and (E) polyethylene. (10 分)

6. Translate and briefly describe the following terms:

(A) Cathode, (B) Cation, (C) Proton, (D) Nucleus, and (E) Isotope (10 分)

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Periodic Table of Elements

1 H 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3 Li 6.939	4 Be 9.012																	5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.9994	9 F 19.00	10 Ne 20.183	11 Na 22.99	12 Mg 24.31																	13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948	19 K 39.102	20 Ca 40.08																	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37																	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.909	36 Kr 83.80	37 Rb 85.47	38 Sr 87.62																	39 Y 88.905	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98	44 Ru 101.1	45 Rh 102.90	46 Pd 106.4	47 Ag 107.87	48 Cd 112.4																	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30	55 Cs 132.905	56 Ba 137.34																	57 Fr 223	58 Ra 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standard reduction potentials in water at 25°C

REDUCTION HALF-REACTION	STANDARD POTENTIAL (V)
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	2.87
$Co^{3+}(aq) + e^- \rightarrow Co^{2+}(aq)$	1.82
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O$	1.77
$PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O$	1.70
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O$	1.51
$Au^+(aq) + 3e^- \rightarrow Au(s)$	1.50
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O$	1.33
$MnO_4^-(aq) + 4H^+(aq) + 2e^- \rightarrow Mn^{2+}(aq) + 2H_2O$	1.23
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O$	1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	1.09
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O$	0.96
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	0.77
$O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O_2(aq)$	0.68
$MnO_4^-(aq) + 2H_2O + 3e^- \rightarrow MnO_2(s) + 4OH^-(aq)$	0.59
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	0.53
$O_2(g) + 2H_2O + 4e^- \rightarrow 4OH^-(aq)$	0.40
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.34
$AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$	0.22
$Cu^+(aq) + e^- \rightarrow Cu(s)$	0.15
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	0.13
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	-0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	-0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	-0.25
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	-0.28
$PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}(aq)$	-0.31
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	-0.40
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	-0.44
$Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$2H_2O + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	-1.18
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66
$H_2(g) + 2e^- \rightarrow 2H^-(aq)$	-2.25
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	-2.37
$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	-2.87
$Ba^{2+}(aq) + 2e^- \rightarrow Ba(s)$	-2.90
$K^+(aq) + e^- \rightarrow K(s)$	-2.93
$Li^+(aq) + e^- \rightarrow Li(s)$	-3.05

prefixes

$G = 10^9$, $M = 10^6$, $k = 10^3$, $c = 10^{-2}$
 $m = 10^{-3}$, $\mu = 10^{-6}$, $n = 10^{-9}$

length (meter = m)

1 m = 39.37 inches
 1 in = 25.4 mm
 1 angstrom = 10^{-10} m
 1 ft = 0.305 m

mass (kilogram = kg)

1 kg = 2.205 pounds
 1 lb = 0.454 kg

volume (liter = l)

1 l = 10^{-3} m³ = 0.264 gallons
 1 gal = 3.79 l

force (newton = N)

1 N = 1 kg m/s² = 10^5 dyne

pressure/stress (pascal = Pa)

1 Pa = 1 N/m² = 0.000145 pound/in²
 1 psi = 6895 Pa
 1 MPa = 0.145 kpsi = 10 atmospheres
 1 kpsi = 6.895 MPa

energy (joule = J)

1 J = 1 N m = 0.00095 Btu = 10^7 erg
 1 Btu = 1053 J
 1 J = 0.239 calorie = 1 watt s
 1 kcal = 4.18 kJ

temperature

(Celsius, Kelvin = °C/K)
 0°C = 32°F = 273 K
 100°C = 212°F = 373 K

Constants

acceleration of gravity = 9.80 m/s²
 atomic mass unit = 1.66×10^{-24} g
 Avogadro number = 6.02×10^{23} atoms/mol
 Boltzmann constant = 1.38×10^{-23} J/K
 electron charge = 1.60×10^{-19} coulomb
 electron volt = 1.60×10^{-19} J
 gas constant = 8.31 J/mol K
 gas volume = 22.4 l/mol
 Planck constant = 6.62×10^{-34} J s
 Stefan-Boltzmann constant = 5.67×10^{-8} J/(s m² K⁴)

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SUBSTANCE	ΔH_f° (kJ/mole)	ΔG_f° (kJ/mole)	S° (J/mole-K)
$C_2H_4(g)$	52.30	60.11	219.4
$C_2H_6(g)$	-84.68	-32.89	229.5
$C_2H_6(l)$	-103.85	-23.47	269.9
$CH_3OH(g)$	-201.2	-161.9	237.6
$CH_3OH(l)$	-238.6	-166.23	126.8
$C_2H_5OH(l)$	-277.7	-174.76	160.7
$CH_3COOH(l)$	-487.0	-392.4	159.8
$C_6H_6(l)$	49.0	124.5	172.8
$C_6H_6(g)$	82.9	129.7	269.2
$CaCO_3$ (calcite)	-1207.1	-1128.76	92.88
$CaO(s)$	-635.5	-604.17	39.75
$Cl_2(g)$	0.00	0.00	222.96
$Cu(s)$	0.00	0.00	33.30
$Fe(s)$	0.00	0.00	27.15
$Fe^{2+}(aq)$	-87.86	-84.93	113.4
$Fe^{3+}(aq)$	-47.69	-10.54	293.3
$Fe_2O_3(s)$	-822.16	-740.98	89.96
$H(g)$	217.94	203.26	114.60
$HBr(g)$	-36.23	-33.22	198.49
$HCl(g)$	-92.30	-95.27	186.69
$HF(g)$	-268.61	-270.70	173.51
$HI(g)$	25.94	1.30	206.3
$H_2(g)$	0.00	0.00	130.58
$H_2O(g)$	-241.8	-228.61	188.7
$H_2O(l)$	-285.85	-236.81	69.96
$H_2S(g)$	-20.17	-33.01	205.6
$Hg(g)$	60.83	31.76	174.89
$Hg(l)$	0.00	0.00	77.40
$I(g)$	106.60	70.16	180.66
$I_2(g)$	62.25	19.37	260.57
$I_2(s)$	0.00	0.00	116.73
$K(g)$	89.99	61.17	160.2
$KNO_3(s)$	-492.70	-393.13	288.1
$Mg(s)$	0.00	0.00	32.51
$MnO_2(s)$	-519.6	-464.8	53.14
$NH_3(g)$	-46.19	-16.66	192.5
$NO(g)$	90.37	86.71	210.62
$NO_2(g)$	33.84	51.84	240.45
$N_2(g)$	0.00	0.00	191.50
$N_2O(g)$	81.55	103.59	220.0
$N_2O_4(g)$	9.66	98.28	304.3
$NaCl(s)$	-410.9	-384.0	72.33
$NaHCO_3(s)$	-947.7	-851.8	102.1
$Na_2CO_3(s)$	-1130.9	-1047.7	136.0
$O(g)$	247.5	230.1	161.0
$O_2(g)$	0.00	0.00	205.0
$O_3(g)$	142.3	163.4	237.6
$S(s, \text{rhombic})$	0.00	0.00	31.88
$SO_2(g)$	-296.9	-300.4	248.5
$SO_3(g)$	-395.2	-370.4	256.2
$Zn(s)$	0.00	0.00	41.6
$ZnO(s)$	-348.0	-318.2	43.9