第 1 題 4 分其餘每題 6 分總計共 100 分,各題如有計算請詳列計算式

1. A gaseous mixture containing 1.5 mol Ar and 3.5 mol $CO_2$ has a total pressure of 7.5 atm. What is the partial pressure of $CO_2$?

2. A 1.57-g sample of a metal chloride, $MCl_2$, is dissolved in water and treated with excess aqueous silver nitrate. The silver chloride that formed weighed 3.47 g. Calculate the molar mass of M.

3. A 0.307-g sample of an unknown triprotic acid is titrated to the third equivalence point using 35.2 mL of 0.106 $M$ NaOH. Calculate the molar mass of the acid.

4. Given reaction $N_2 + 3H_2 \rightarrow 2NH_3$, you mix 1 mol each of nitrogen and hydrogen gases under the same conditions in a container fitted with a piston. Calculate the ratio of volumes of the container ($V_{final}/V_{initial}$).

5. You have a 400-mL container containing 55.0% He and 45.0% Ar by mass at 25°C and 1.5 atm total pressure. You heat the container to 100°C. Calculate the total pressure and the ratio of $P_{He} : P_{Ar}$.

6. A sample of $N_2$ gas is contaminated with a gas (A) of unknown molar mass. The partial pressure of each gas is known to be 200 torr at 25°C. The gases are allowed to effuse through a pinhole, and it is found that gas A escapes at 5 times the rate of $N_2$. What is the molar mass of gas A ?

7. Predict the signs ( + or - ) of $\Delta S°$, $\Delta H°$, and $\Delta G°$ for the following reaction at 25°C.
   $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O(l)$

8. The reduction potentials for $Au^{3+}$ and $Ni^{2+}$ are as follows:
   $Au^{3+} + 3e^- \rightarrow Au$, $\mathcal{E}° = +1.50$ V　　　　$Ni^{2+} + 2e^- \rightarrow Ni$, $\mathcal{E}° = -0.232$ V
   Calculate $\Delta G°$ (at 25°C) for the reaction:　　$2Au^{3+} + 2Ni \rightarrow 3Ni^{2+} + 2Au$

9. The decomposition of dinitrogen pentaoxide has an activation energy of 102 kJ/mol and $\Delta H°_{rxn} = + 55$ kJ/mol. What is the activation energy for the reverse reaction?

10. Consider the equation $A(aq) + 2B(aq) \rightleftharpoons 3C(aq) + 2D(aq)$. In one experiment, 45.0 mL of 0.050 $M$ A is mixed with 25.0 mL 0.100 $M$ B. At equilibrium the concentration of C is 0.0410 $M$. Calculate $K$.

11. The balanced equation for the reaction of bromate ion with bromide ion in acidic solution is given by:
    $BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$
    At a particular instant in time, the value of $-\Delta[Br^-]/\Delta t$ is 2.9 x $10^{-3}$ mol/L s. What is the value of $\Delta[Br_2]/\Delta t$ in the same units?

12. Consider the reaction:　　$A_2 + B_2 \rightarrow 2AB$　　　　　$\Delta H = -321$ kJ
    The bond energy for $A_2$ is half the amount of AB. The bond energy of $B_2 = 393$ kJ/mol. What is the bond energy of $A_2$?

13. What are the bond orders of the following species:　a) $Ne_2$　　b) $O_2^-$　　c) $B_2$

14. Solutions of benzene and toluene obey Raoult's law. The vapor pressures at 20°C are: benzene, 76 torr; toluene, 21 torr. What is the mole fraction of benzene in a benzene-toluene solution whose vapor pressure is 65 torr at 20°C?

15. A solution contains 0.500 $M$ HA ($K_a = 1.0 \times 10^{-8}$) and 0.320 $M$ NaA. What is the $[H^+]$ after 0.10 mole of HCl is added to 1.00 L of this solution?

16. Consider an electrochemical cell with a zinc electrode immersed in a solution of $Zn^{2+}$ and a silver electrode immersed in a solution of $Ag^+$.　　　$Zn^{2+} + 2e^- \rightarrow Zn$　$\mathcal{E}° = -0.76$ V　　　　$Ag^+ + e^- \rightarrow Ag$　$\mathcal{E}° = 0.80$ V
    If $[Zn^{2+}]_0$ is 0.050 $M$ and $[Ag^+]_0$ is 10.06 $M$, calculate $\mathcal{E}$.

17. The rate constant for a reaction at 40.0°C is exactly 3 times that at 20.0°C. Calculate the Arrhenius energy of activation $E_a$ for the reaction.(ln 3 =1.1)

# PERIODIC TABLE OF THE ELEMENTS

| 1<br>H<br>1.008 | | | | | | | | | | | | | | | | | 2<br>He<br>4.003 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3<br>Li<br>6.941 | 4<br>Be<br>9.012 | | | | | | | | | | | 5<br>B<br>10.81 | 6<br>C<br>12.01 | 7<br>N<br>14.01 | 8<br>O<br>16.00 | 9<br>F<br>19.00 | 10<br>Ne<br>20.18 |
| 11<br>Na<br>22.99 | 12<br>Mg<br>24.31 | | | | | | | | | | | 13<br>Al<br>26.98 | 14<br>Si<br>28.09 | 15<br>P<br>30.97 | 16<br>S<br>32.07 | 17<br>Cl<br>35.45 | 18<br>Ar<br>39.95 |
| 19<br>K<br>39.10 | 20<br>Ca<br>40.08 | 21<br>Sc<br>44.96 | 22<br>Ti<br>47.88 | 23<br>V<br>50.94 | 24<br>Cr<br>52.00 | 25<br>Mn<br>54.94 | 26<br>Fe<br>55.85 | 27<br>Co<br>58.93 | 28<br>Ni<br>58.69 | 29<br>Cu<br>63.55 | 30<br>Zn<br>65.39 | 31<br>Ga<br>69.72 | 32<br>Ge<br>72.61 | 33<br>As<br>74.92 | 34<br>Se<br>78.96 | 35<br>Br<br>79.90 | 36<br>Kr<br>83.80 |
| 37<br>Rb<br>85.47 | 38<br>Sr<br>87.62 | 39<br>Y<br>88.91 | 40<br>Zr<br>91.22 | 41<br>Nb<br>92.91 | 42<br>Mo<br>95.94 | 43<br>Tc<br>(98) | 44<br>Ru<br>101.1 | 45<br>Rh<br>102.9 | 46<br>Pd<br>106.4 | 47<br>Ag<br>107.9 | 48<br>Cd<br>112.4 | 49<br>In<br>114.8 | 50<br>Sn<br>118.7 | 51<br>Sb<br>121.8 | 52<br>Te<br>127.6 | 53<br>I<br>126.9 | 54<br>Xe<br>131.3 |
| 55<br>Cs<br>132.9 | 56<br>Ba<br>137.3 | 57<br>La<br>138.9 | 72<br>Hf<br>178.5 | 73<br>Ta<br>181.0 | 74<br>W<br>183.8 | 75<br>Re<br>186.2 | 76<br>Os<br>190.2 | 77<br>Ir<br>192.2 | 78<br>Pt<br>195.1 | 79<br>Au<br>197.0 | 80<br>Hg<br>200.6 | 81<br>Tl<br>204.4 | 82<br>Pb<br>207.2 | 83<br>Bi<br>209.0 | 84<br>Po<br>(209) | 85<br>At<br>(210) | 86<br>Rn<br>(222) |
| 87<br>Fr<br>(223) | 88<br>Ra<br>226.0 | 89<br>Ac<br>227.0 | 104<br>Rf<br>(261) | 105<br>Db<br>(262) | 106<br>Sg<br>(263) | 107<br>Bh<br>(262) | 108<br>Hs<br>(265) | 109<br>Mt<br>(266) | 110<br>(269) | 111<br>(272) | 112<br>(277) | 114<br>(289) | | 116<br>(289) | | 118<br>(293) | |

| 58<br>Ce<br>140.1 | 59<br>Pr<br>140.9 | 60<br>Nd<br>144.2 | 61<br>Pm<br>(145) | 62<br>Sm<br>150.4 | 63<br>Eu<br>152.0 | 64<br>Gd<br>157.3 | 65<br>Tb<br>158.9 | 66<br>Dy<br>162.5 | 67<br>Ho<br>164.9 | 68<br>Er<br>167.3 | 69<br>Tm<br>168.9 | 70<br>Yb<br>173.0 | 71<br>Lu<br>175.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90<br>Th<br>232.0 | 91<br>Pa<br>231.0 | 92<br>U<br>238.0 | 93<br>Np<br>237.0 | 94<br>Pu<br>(244) | 95<br>Am<br>(243) | 96<br>Cm<br>(247) | 97<br>Bk<br>(247) | 98<br>Cf<br>(251) | 99<br>Es<br>(252) | 100<br>Fm<br>(257) | 101<br>Md<br>(258) | 102<br>No<br>(259) | 103<br>Lr<br>(260) |