一、單選題（每題4分，答錯不倒扣）

元素原子量：H=1, D=2, C=12, N=14, O=16, F=19, Na=23, S=32, Cl=35.5, P=31, K=39, Ca=40, Mn=55, Fe=55.85, Br=80, Rb=85.5, I=127 ; Faraday constant=96500 $Cmol^{-1}$, Gas constant R=8.314 J K^{-1} mol^{-1}; 5.189×10^{19} eV K^{-1} mol^{-1} or 0.082 L atm K^{-1} mol^{-1}, Plank Constant h=6.626×10^{-34} J • s

[1]. Which of the following pairs is incorrect?

A) NH_4Br, ammonium bromide
B) K_2CO_3, potassium carbonate
C) $BaPO_4$, barium phosphate
D) CuCl, copper(I) chloride
E) MnO_2, manganese (IV) oxide

[2]. Rutherford's experiment was important because it showed that:

A) radioactive elements give off alpha particles.
B) gold foil can be made to be only a few atoms thick.
C) a zinc sulfide screen scintillates when struck by a charged particle.
D) the mass of the atom is uniformly distributed throughout the atom.
E) an atom is mostly empty space.

[3]. The atomic mass of rhenium is 186.2. Given that 37.1% of natural rhenium is rhenium-185, what is the other stable isotope?

A) $^{183}_{75}Re$, B) $^{187}_{75}Re$, C) $^{189}_{75}Re$, D) $^{181}_{75}Re$, E) $^{190}_{75}Re$

[4]. The following reactions

$2K(s) + Br_2(l) \rightarrow 2KBr(s)$
$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$
$HCl(aq) + KOH(aq) \rightarrow H_2O(l) + KCl(aq)$

are examples of

A) precipitation reactions.
B) redox, precipitation, and acid-base, respectively.
C) precipitation (two) and acid-base reactions, respectively.
D) redox reactions.
E) none of these

注意:背面有試題

[5]. 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.

A) 247 g/mol
B) 171 g/mol
C) 165 g/mol
D) 151 g/mol
E) 82.7 g/mol

[6]. Consider two organic molecules, ethanol and benzene. One dissolves in water and the other does not. Why?

A) They have different molar masses.
B) One is ionic, the other is not.
C) One is an electrolyte, the other is not.
D) Ethanol contains a polar O—H bond, and benzene does not.
E) Two of these.

[7]. Calculate the density of nitrogen at STP.

A) 0.312 g/L
B) 0.625 g/L
C) 0.800 g/L
D) 1.25 g/L
E) 1.60 g/L

[8]. The van der Waals equation, $nRT = [P + (n^2a/V^2)]\ (V - nb)$, incorporates corrections to the ideal gas law in order to account for the properties of real gases. One of the corrections accounts for

A) the possibility of chemical reaction between molecules.
B) the finite volume of molecules.
C) the quantum behavior of molecules.
D) the fact that average kinetic energy is inversely proportional to temperature.
E) the possibility of phase changes when the temperature is decreased or the pressure is increased.

[9]. A 25.0 g piece of aluminum (which has a molar heat capacity of 24.03J/°Cmol) is heated to 82.4°C and dropped into a calorimeter containing water (specific heat capacity of water is 4.18J/g°C) initially at 22.3°C. The final temperature of the water is 24.9°C. Calculate the mass of water in the calorimeter.

A) 118 g
B) 6.57 g
C) 3180 g
D) 2120 g
E) none of these

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[10]. Calculate the lattice energy for MgO(*s*) using a Born-Haber cycle and the following information:

$MgO(s) \rightarrow Mg^{2+}(g) + O^{2-}(g)$	?
$Mg(s) \rightarrow Mg(g)$	+147.1 kJ/mol
$Mg(g) \rightarrow Mg^{+}(g) + e^{-}$	+737.8 kJ/mol
$Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$	+1451 kJ/mol
$1/2\ O_2(g) \rightarrow O(g)$	+249.0 kJ/mol
$O(g) + e^{-} \rightarrow O^{-}(g)$	-141.1 kJ/mol
$O^{-}(g) + e^{-} \rightarrow O^{2-}(g)$	+798.0 kJ/mol
$Mg(s) + 1/2\ O_2(g) \rightarrow MgO(s)$	-601.8 kJ/mol

A) +1842 kJ/mol
B) +2444 kJ/mol
C) +3844 kJ/mol
D) +4108 kJ/mol

[11]. While mercury is very useful in barometers, mercury vapor is toxic. Given that mercury has a ΔH_{vap} of 59.11 kJ/mol and its normal boiling point is 356.7°C, calculate the vapor pressure in mm Hg at room temperature, 25°C.

A) 2.68×10^{-3} mm Hg
B) 2.99 mm Hg
C) 372 mm Hg
D) 753 mm Hg

[12]. At a given temperature the vapor pressures of benzene and toluene are 183 mm Hg and 59.2 mm Hg, respectively. Calculate the total vapor pressure over a solution of benzene and toluene with $X_{benzene} = 0.400$.

A) 110 mm Hg
B) 133 mm Hg
C) 109 mm Hg
D) 242 mm Hg

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[13]. A concentration-time study of the gas phase reaction $2\ A_3 \rightarrow 3\ A_2$ produced the data in the table below.

Time (s)	$[A_3]$ (M)	$[A_2]$ (M)
0	4.00×10^{-4}	0
10	2.00×10^{-4}	3.00×10^{-4}
20	1.00×10^{-4}	4.50×10^{-4}
30	5.00×10^{-5}	?

What is the average rate of formation of A_2 in the time interval 20-30 seconds?

A) 6.00×10^{-4} M/s
B) 5.25×10^{-5} M/s
C) 7.50×10^{-6} M/s
D) 6.00×10^{-6} M/s

[14]. The following set of data was obtained by the method of initial rates for the reaction:

$$BrO_3^-(aq) + 5\ Br^-(aq) + 6\ H^+(aq) \rightarrow 3\ Br_2(aq) + 3\ H_2O(l).$$

Calculate the initial rate when BrO_3^- is 0.30 M, Br^- is 0.050 M, and H^+ is 0.15 M.

Expt	$[BrO_3^-]$ (M)	$[Br^-]$ (M)	$[H^+]$ (M)	Rate (M/s)
1	0.10	0.10	0.10	8.0×10^{-4}
2	0.20	0.10	0.10	1.6×10^{-3}
3	0.20	0.15	0.10	2.4×10^{-3}
4	0.10	0.10	0.25	5.0×10^{-3}

A) 6.1×10^{-5} M/s
B) 2.7×10^{-3} M/s
C) 5.3×10^{-2} M/s
D) 8.4×10^{-2} M/s

[15]. The first-order isomerization reaction: cyclopropane → propene, has a rate constant of $1.10 \times 10^{-4}\ s^{-1}$ at 470°C and an activation energy of 264 kJ/mol. What is the temperature of the reaction when the rate constant is equal to $4.36 \times 10^{-3}\ s^{-1}$?

A) 126°C
B) 411°C
C) 510°C
D) 540°C

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[16]. Nitric oxide reacts with oxygen to form nitrogen dioxide:

$$2\ NO(g) + O_2(g) \rightleftharpoons 2\ NO_2(g)$$

What is K_C' for the reverse reaction if the equilibrium concentration of NO is 0.300 M, O_2 is 0.200 M, and NO_2 is 0.530 M at 25°C?

A) 0.0340
B) 0.0641
C) 0.624
D) 15.6

[17]. The decomposition of ammonia is: $2\ NH_3(g) \rightarrow N_2(g) + 3\ H_2(g)$. If K_p is 1.5×10^3 at 400°C, what is the partial pressure of ammonia at equilibrium when N_2 is 0.10 atm and H_2 is 0.15 atm?

A) 2.2×10^{-7} atm
B) 4.7×10^{-4} atm
C) 2.1×10^{3} atm
D) 4.4×10^{6} atm

[18]. For acid solutions of the same molarity acid strength is proportional to the equilibrium concentration of H_3O^+. For equimolar solutions of acids, which equilibrium expression below corresponds to the strongest acid?

A) $K_C = \dfrac{[H_3O^+]\,[F^-]}{[HF]} = 3.5 \times 10^{-4}$

B) $K_C = \dfrac{[H_3O^+]\,[OCl^-]}{[HOCl]} = 3.5 \times 10^{-8}$

C) $K_C = \dfrac{[H_3O^+]\,[NO_2^-]}{[HNO_2]} = 4.5 \times 10^{-4}$

D) $K_C = \dfrac{[H_3O^+]\,[CN^-]}{[HCN]} = 4.9 \times 10^{-10}$

[19]. What is the strongest BrØnsted-Lowry acid in the chemical reaction shown below?

$$2\ HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2\ H_2O(l)$$

A) HNO_3
B) $Ba(OH)_2$
C) $Ba(NO_3)_2$
D) H_2O

注意:背面有試題

[20]. If the ionization constant of water, K_W, at 40°C is 2.92×10^{-14}, then what is the hydronium ion concentration for a neutral solution?

A) $[H_3O^+] < 1.00 \times 10^{-7}$ M
B) $[H_3O^+] > 1.71 \times 10^{-7}$ M
C) $[H_3O^+] = 1.71 \times 10^{-7}$ M
D) $[H_3O^+] < 1.71 \times 10^{-7}$ M

[21]. What is the balanced equation for the galvanic cell reaction expressed using shorthand notation below?

$$Mg(s) \mid Mg^{2+}(aq) \mid\mid Cl_2(g) \mid Cl^-(aq) \mid C(s)$$

A) $Mg(s) + 2\ Cl^-(aq) \rightarrow Mg^{2+}(aq) + Cl_2(g)$
B) $Mg(s) + Cl_2(g) \rightarrow Mg^{2+}(aq) + 2\ Cl^-(aq)$
C) $Mg^{2+}(aq) + 2\ Cl^-(aq) \rightarrow Mg(s) + Cl_2(g)$
D) $Mg^{2+}(aq) + 2\ Cl^-(aq) \rightarrow MgCl_2(s)$

[22]. The nickel-cadmium battery cell has a standard potential of +1.20 V. The cell reaction is

$$2\ NiO(OH)(s) + Cd(s) + 2\ H_2O(l) \rightarrow 2\ Ni(OH)_2(s) + Cd(OH)_2(s).$$

What is the standard free energy change for this reaction?

A) -38.7 kJ
B) -116 kJ
C) -232 kJ
D) -463 kJ

[23]. Consider the following table of standard reduction potentials:

Reduction Half-Reaction	E^o (V)
$A^+ + e^- \rightarrow A$	0.70
$B^{2+} + 2\ e^- \rightarrow B$	0.43
$C_3 + 3\ e^- \rightarrow 3\ C^-$	0.27

Which substance is the strongest reducing agent?

A) A
B) B
C) C_3
D) C^-

注意:背面有試題

[24]. Beta decay of ^{24}Na produces a beta particle and

A) ^{20}F.

B) ^{23}Na.

C) ^{24}Ne.

D) ^{24}Mg.

[25]. Iodine-123, used in thyroid therapy, has a half-life of 13.27 hours. How many half-lives are required for a 160 mg sample of iodine-123 to decay to 5.0 mg?

A) 0.031

B) 1.0

C) 5.0

D) 32