臺灣綜合大學系統111學年度學士班轉學生聯合招生考試試題

科目名稱	普通化學B	類組代碼	共同考科
		科目碼	E0018

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一、單選題：（60分，每題3分）

1. The reaction has the rate law of rate = $k[A][B]^2$. Which one of the following will cause the rate to increase the most?
(A) doubling [A] (B) lowering temperature (C) tripling [B]
(D) quadrupling [A] (E) doubling [B]

2. Choose the INCORRECT statement.
(A) When a half reaction is reversed, the sign of the potential is changed.
(B) Reversing a half reaction makes it a reduction potential.
(C) Each electrochemical cell consists of a reduction half-cell and an oxidation half-cell.
(D) A voltaic cell is also called a battery.
(E) The potential difference of a cell is the voltage of the cell.

3. Finish the following reaction: $Li_{(s)} + N_{2(g)} \rightarrow$
(A) $3\ Li_{(s)} + N_{2(g)} \rightarrow Li_3N_{2(s)}$ (B) $4\ Li_{(s)} + N_{2(g)} \rightarrow 2\ Li_2N_{(s)}$
(C) $2\ Li_{(s)} + N_{2(g)} \rightarrow 2\ LiN_{(s)}$ (D) $6\ Li_{(s)} + N_{2(g)} \rightarrow Li_3N_{(s)}$

4. Which element has the largest number of unpaired electrons?
(A) Cu^{2+} (B) Fe^{3+} (C) V^{3+} (D) Ni^{2+} (E) Zn^{2+}

5. Choose the correct shape, weak/strong field, and number of unpaired electrons for $[Co(NH_3)_6]^{3+}$.
(A) square planar, strong, 6 (B) square planar, weak, 0
(C) tetrahedral, strong, 0 (D) octahedral, strong, 0
(E) octahedral, weak, 6

6. Choose the correct statement for half-life:
(I) the time for a sample to decay completely.
(II) constant for a given radioisotope.
(III) the time required for half of a sample to decay.
(IV) inversely proportional to the decay constant.
(A) I and II (B) I, II, and III (C) I and III (D) I, III, and IV (E) II, III, and IV

7. The IUPAC name of the *tert*-butyl group is:
(A) 1,1-dimethylethyl (B) 1,1-dimethylethane (C) 1,2-dimethylethyl
(D) 1-methylpropyl (E) 2-methylpropyl

8. If, at a given temperature, the equilibrium constant for the reaction $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2\ HCl_{(g)}$ is 5.0, then the equilibrium constant for the reaction $HCl_{(g)} \rightleftharpoons {}^1/_2\ H_{2(g)} + {}^1/_2\ Cl_{2(g)}$ can be represented as
(A) 0.040 (B) 25 (C) 0.45 (D) 0.20 (E) 5.0

9. A mixture of H_2SO_4 and NaOH has a pH of 1.9. Which one below is true about the mixture at equilibrium? (K_a of $HSO_4^- = 1.2 \times 10^{-2}$)
(A) $[H_2SO_4] > [HSO_4^-] > [SO_4^{2-}]$ (B) $[HSO_4^-] > [H_2SO_4] > [SO_4^{2-}]$
(C) $[HSO_4^-] > [SO_4^{2-}] > [H_2SO_4]$ (D) $[SO_4^{2-}] > [HSO_4^-] > [H_2SO_4]$
(E) $[SO_4^{2-}] > [H_2SO_4] > [HSO_4^-]$

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10. You are given a solution of the weak base Novocain, Nvc. Its pH is 11.00. You add to the solution a small amount of a salt containing the conjugate acid of Novocain, $NvcH^+$. Which statement is true?
(A) The pH and the pOH remain unchanged. (B) The pH and the pOH both decrease.
(C) The pH and the pOH both increase. (D) The pH increases and pOH decreases.
(E) The pH decreases and the pOH increases.

11. What is the best way to make a buffer?
(A) Dilute sea water
(B) Combine a strong acid and a strong base
(C) Combine a strong acid and a weak base
(D) Combine a strong base and a weak acid
(E) Combine a weak acid and a salt containing its conjugate base

12. What sign of $\Delta G°$ will lead to equilibrium constant that is greater than 1?
(A) $\Delta G° = 0$ (B) Not enough information is given
(C) $\Delta G° > 0$ (D) $\Delta G° < 0$

13. You are trying to dissolve the most amount of Ag_2S possible. Beaker A is filled with 100 mL of pure water and beaker B filled with 100 mL of a 0.10 M Ag_2SO_4 solution. Which beaker will dissolve the most Ag_2S and why?
(A) Beaker B, because sulfate helps dissolve salts
(B) Beaker A, because there isn't a common ion already present
(C) Beaker A, because pure water increases the K_{sp} of Ag_2S
(D) Beaker B, because the silver ions in the solution will increase the solubility
(E) Beaker B, because "like dissolves like"

14. Which acid generates the strongest conjugate base?
(A) Formic acid (B) Hydrochloric acid (C) Sulfuric acid
(D) Nitric acid (E) Perchloric acid

15. Which is the strongest base?
(A) 1 M hydroxylamine; $pK_b = 8.0$ (B) 1 M aniline; $pK_b = 9.4$ (C) 1 M ethylamine; $pK_b = 3.4$
(D) 1 M ammonia; $pK_b = 4.7$ (E) 1 M hydrazine; $pK_b = 6.0$

16. Nodes can be defined as
(A) points of constructive interference between two waves
(B) points of interest
(C) points of destructive interference between two waves
(D) points of high probability of finding an electron

17. The pressure correction term (n^2a/V^2) in the van der Waals equation is present because:
(A) molecules are made from atoms (B) molecules are moving
(C) molecule attract each other (D) molecules occupy volume (E) molecule repel each other

18. Simplify the units of the following: (m/s)(kg)(m)
(A) N (B) J•s (C) m/s (D) Pa (E) N•m

背面有題，請繼續作答。

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19. For a $4d_{xy}$ orbital, what are the values of n and l?
(A) 4, 2　(B) 3, 1　(C) 3, 2　(D) 4, 3　(E) 4, 1

20. What is the ratio of the diffusion rates of Cl_2 and O_2?
(A) 0.45　(B) 0.67　(C) 0.47　(D) 1.5

二、問答題：(40 分)

21. A tank contains 480.0 grams of oxygen and 80.00 grams of helium at a total pressure of 7.00 atm.
(A) What are the total moles of gas in the tank? (4 points)
(B) What is the partial pressure of O_2 (in atm)? (3 points)
(C) What is the partial pressure of He (in atm)? (3 points)

22. What is the energy in kJ/mol of the photon released from a hydrogen atom when dropping from the $n = 5$ to the $n = 2$ energy level? (5 points)

23. Given the following equation:

$$I^-_{(aq)} + ClO^-_{(aq)} \rightarrow I_3^-{}_{(aq)} + Cl^-_{(aq)}$$

(A) What is the oxidizing agent? (2 points)
(B) Which element is reduced? (2 points)
(C) Balance the reduction half reaction in acidic solution. (4 points)
(D) Balance the oxidation half reaction in acidic solution. (4 points)
(E) Give the overall reaction. (3 points)

24. One proposed mechanism for the formation of a double helix ($S_1 + S_2 \rightarrow S_1{:}S_2$) in DNA is given by

$$S_1 + S_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} (S_1{:}S_2)^*$$

$$(S_1{:}S_2)^* \xrightarrow{k_2} S_1{:}S_2$$

where S_1 and S_2 represent strand 1 and 2, and $(S_1{:}S_2)^*$ represents an unstable helix.
(A) Write the rate law of each reaction (that is, r_1, r_{-1}, and r_2, 3 points)
(B) Using steady state approximation, derive a rate law for the rate of formation of $S_1{:}S_2$. (7 points)

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Conversions:

1 atm = 760 Torr = 760 mmHg = 101,325 Pa　　1 cm^3 = 1 mL

101.325 J = 1 L atm　　1 cal = 4.184 J　　10^{10} Å = 1 m = 10^{12} pm = 100 cm

Constants:

R = 8.3145 J / mol K　　R = 0.08206 L atm / mol K

c = 2.9979×10^{8} m / s　　h = 6.626×10^{-34} J s　　$R_H = 2.179 \times 10^{-18}$ J

$K_b(H_2O)$ = 1.86 °C kg/mol　　$K_f(H_2O)$ = 0.51 °C kg/mol

$C_p(H_2O_{(l)})$ = 4.184 J/g °C　　$C_p(H_2O_{(g)})$ = 2.08 J/g °C

Equations:

$$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

$P_A = x_A P°_A$　　$P_{total} = P_A + P_B + P_C + \ldots$　　$\pi = iMRT$　　$\Delta T_b = iK_b m$　　$\Delta T_f = -iK_f m$

$\text{side} = 2R, \text{side} = \frac{4R}{\sqrt{3}}, \text{side} = \sqrt{8}R$　　$\ln\frac{P_2}{P_1} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$\text{rate} = k, [A]_t = -kt + [A]_0, t_{1/2} = \frac{[A]_0}{2k}$

$\text{rate} = k[A], \ln[A]_t = -kt + \ln[A]_0, t_{1/2} = \frac{0.693}{k}$

$\text{rate} = k[A]^2, \frac{1}{[A]_t} = kt + \frac{1}{[A]_0}, t_{1/2} = \frac{1}{k[A]_0}$

Spectrochemical series:

$CN^- > NO_2^- > en > NH_3 > H_2O > OH^- > F^- > Cl^- > Br^- > I^-$

1 H 1.008																	2 He 4.003
3 Li 6.94	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 32.06	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 72.63	33 As 74.92	34 Se 78.97	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 95.95	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57/71	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89/103	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.2	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	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 (262)