

編號: 10 系所: 全校系所

科目: 普通化學

本試題是否可以使用計算機:  可使用,  不可使用 (請命題老師勾選)

注意事項: 1. 請標明題號依序作答。

2. 計算題必須列出計算過程, 否則不予計分。

\* 1. 至 15. 題為單選題, 每題 4 分, 共計 60 分。(答錯不倒扣)

- Four identical 1.0-L flasks contain the gases He, Cl<sub>2</sub>, CH<sub>4</sub>, and NH<sub>3</sub>, each at 0°C and 1 atm pressure. For which gas do the molecules have the smallest average kinetic energy?
  - He
  - Cl<sub>2</sub>
  - CH<sub>4</sub>
  - NH<sub>3</sub>
  - all gases the same
- In the titration of a weak acid HA with 0.100 M NaOH the stoichiometric point is known to occur at a pH value of approximately 10. Which of the following indicator acids would be best to use to mark the endpoint of this titration?
  - indicator A,  $K_a = 10^{-14}$
  - indicator B,  $K_a = 10^{-11}$
  - indicator C,  $K_a = 10^{-8}$
  - indicator D,  $K_a = 10^{-6}$
- The two salts AgX and AgY have very similar solubilities in water. The salt AgX is much more soluble in acid than is AgY. What can be said about the relative strengths of the acids HX and HY?
  - Nothing
  - HY is stronger than HX.
  - HX is stronger than HY.
  - The acids have equal strengths.
- A weak base, B, has basicity constant  $K_b = 2 \times 10^{-3}$ . The pH of any solution in which  $[B] = [BH^+]$  is
  - 4.7
  - 7.0
  - 9.3
  - 9.7
  - 10.3
- Place the elements C, N and O in order of increasing ionization energy.
  - C, N, O
  - O, N, C
  - C, O, N
  - N, O, C
- Which of the following sets has elements with the most nearly identical atomic radii?
  - Cr, Mn, Fe, Co
  - Mg, Ca, Sr, Ba
  - Ne, Ar, Kr, Xe
  - Be, B, C, N
  - C, P, Se, I
- What is the hybridization of Cl in the molecule ClF<sub>3</sub>?
  - sp
  - sp<sup>2</sup>
  - sp<sup>3</sup>
  - dsp<sup>3</sup>
  - d<sup>2</sup>sp<sup>3</sup>
- The fact that O<sub>2</sub> is paramagnetic can be explained by
  - the Lewis structure of O<sub>2</sub>.
  - resonance.
  - a violation of the octet rule.
  - the molecular orbital diagram for O<sub>2</sub>.
  - hybridization of atomic orbitals in O<sub>2</sub>.
- In which case must a reaction be spontaneous at all temperatures?
  - $\Delta H$  is positive,  $\Delta S$  is positive.
  - $\Delta H = 0$ ,  $\Delta S$  is negative.
  - $\Delta S = 0$ ,  $\Delta H$  is positive.
  - $\Delta H$  is negative,  $\Delta S$  is positive.

(背面仍有題目, 請繼續作答)

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10. For a reaction in a voltaic cell both  $\Delta H^\circ$  and  $\Delta S^\circ$  are positive. Which of the following statements is true?
- $E^\circ_{\text{cell}}$  will increase with an increase in temperature.
  - $E^\circ_{\text{cell}}$  will decrease with an increase in temperature.
  - $E^\circ_{\text{cell}}$  will not change when the temperature increases.
  - $\Delta G^\circ > 0$  for all temperatures.
11. For which of the following is the half-life directly dependent on the concentration of the reactant?
- zero-order reaction
  - first-order reaction
  - second-order reaction
  - two of the above
  - all of the above (a-c)
12. A material is made from Al, Ga, and As. The mole fraction of each element is 0.25, 0.26, and 0.49, respectively. This material would be
- a metallic conductor because Al is present.
  - an insulator.
  - a *p*-type semiconductor.
  - an *n*-type semiconductor.
13. Which of the following statements is true about the octahedral complexes of  $\text{Ni}^{2+}$ ?
- Both strong- and weak-field complexes are diamagnetic.
  - The strong-field complex is diamagnetic and the weak-field complex is paramagnetic.
  - The strong-field complex is paramagnetic and the weak-field complex is diamagnetic.
  - Both strong- and weak-field complexes are paramagnetic.
14. The spectrochemical series is
- $$\text{I}^- < \text{Br}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^-$$
- Which of the following complexes will absorb visible radiation of the highest energy (shortest wavelength)?
- $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
  - $[\text{Co}(\text{I})_6]^{3-}$
  - $[\text{Co}(\text{OH})_6]^{3-}$
  - $[\text{Co}(\text{en})_3]^{3+}$
  - $[\text{Co}(\text{NH}_3)_6]^{3+}$
15.  $\text{H}_2\text{CCHCH}_2\text{N}(\text{CH}_3)_2$  is
- an alkyne and a secondary amine.
  - an alkene and a primary amine.
  - an alkene and a tertiary amine.
  - an alkyne and a tertiary amine.
  - none of these

\* 16. 至 19. 題為說明題和計算題, 共計 40 分。

16. (a) What is the Bragg equation? What do the symbols in the equation stand for? (4%)
- (b) Will a crystalline solid or an amorphous solid give a simpler X-ray diffraction pattern? Why? (3%)
- (c) Is it possible to generalize that amorphous solids always have weaker or stronger interparticle forces than crystalline solids? Explain your answer. (3%)

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17. (a) When 2.00 mol of  $\text{SO}_2(\text{g})$  reacts completely with 1.00 mol of  $\text{O}_2(\text{g})$  to form 2.00 mol of  $\text{SO}_3(\text{g})$  at  $25^\circ\text{C}$  and a constant pressure of 1.00 atm, 198 kJ of energy is released as heat. Calculate  $\Delta H$  and  $\Delta E$  for this process. ( $R=8.3145 \text{ J K}^{-1}\text{mol}^{-1}$ ) (6%)

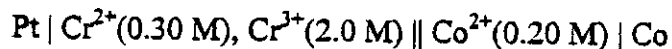
- (b) At what temperatures is the following process spontaneous at 1 atm?



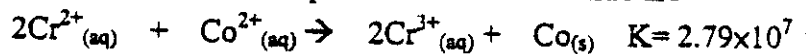
where  $\Delta H^\circ = 31.0 \text{ kJ/mol}$  and  $\Delta S^\circ = 93.0 \text{ J K}^{-1}\text{mol}^{-1}$

What is the normal boiling point of liquid  $\text{Br}_2$ ? (6%)

18. Consider the following galvanic cell at  $25^\circ\text{C}$ :



The overall reaction and equilibrium constant value are



Calculate the cell potential,  $\epsilon$ , for this galvanic cell and  $\Delta G$  for the cell reaction at these conditions. (10%) ( $\log 2.79 = 0.4456$ ;  $\log 2.22 = 0.3463$ )

19. (a) The complex ion  $\text{NiCl}_4^{2-}$  contains two unpaired electrons, but  $\text{Ni}(\text{CN})_4^{2-}$  is diamagnetic. Propose structures for these two complex ions. (4%)

- (b) Which of the complex ions  $\text{CoI}_6^{3-}$ ,  $\text{Co}(\text{H}_2\text{O})_6^{3+}$ , or  $\text{Co}(\text{en})_3^{3+}$ , will absorb light with the longest wavelength? Explain. (4%)