

科目 普通化學 類組別 A6

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*請在試卷、答案卡內作答

1. How many protons, neutrons, and electrons does ^{56}Fe have? (2.5%)
 (皆為單選題)
- a) 26 protons, 26 neutrons, 30 electrons
 b) 26 protons, 26 neutrons, 56 electrons
 c) 30 protons, 30 neutrons, 26 electrons
 d) 26 protons, 30 neutrons, 26 electrons
 e) 56 protons, 26 neutrons, 56 electrons
2. Which formula is not correct? (2.5%)
 a) Na_2O b) K_2PO_4 c) HCN d) SrCl_2 e) Al_2O_3
3. What is the molar mass of ethanol ($\text{C}_2\text{H}_5\text{OH}$)? (2.5%)
 a) 45.07 b) 38.90 c) 46.07 d) 34.17 e) 62.07
4. To calculate the concentration in molarity of a salt solution, you need to know (2.5%)
 a) The mass of the salt added to the solution and the volume of water added to the solution.
 b) The mass of the salt added to the solution and the total volume of the solution.
 c) The mass of the salt added the molar mass of the salt, and the total volume of the solution.
 d) The molar mass of the salt and the total volume of the solution.
 e) The mass of the salt added, the molar mass of the salt, the volume of water added, and the total volume of the solution.
5. An aqueous solution of silver nitrate is added to an aqueous solution of potassium chromate and this reaction produces a solid. What is the formula for the solid? (2.5%)
 a) AgK b) AgCrO_4 c) KNO_3 d) K_2NO_3 e) Ag_2CrO_4
6. Aqueous solutions of sodium sulfide and copper (II) chloride are mixed together. Which statement is correct? (2.5%)
 a) Both NaCl and CuS precipitate from solution.
 b) No precipitate forms.
 c) CuS will precipitate from solution.
 d) NaCl will precipitate from solution.
 e) No reaction will occur.

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Consider three 1-L flasks at STP. Flask A contains NH_3 gas, flask B contains NO_2 gas, and flask C contains N_2 gas.

7. Which contains the largest number of molecules? (2.5%)
 a) flask A b) flask B c) flask C d) all are the same e) none
8. In which flask are the molecules least polar and therefore most ideal in behavior? (2.5%)
 a) flask A b) flask B c) flask C d) all are the same e) none
9. In which flask do the molecules have the highest average velocity? (2.5%)
 a) flask A b) flask B c) flask C d) all are the same e) none

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10. Consider a sample of neon gas in a container fitted with a moveable piston (assume the piston is massless and frictionless). The temperature of the gas is increased from 20.0 °C to 40.0 °C. The density of neon (2.5%)
- a) Increases less than 10%. b) Decreases less than 10%.
 c) Increases more than 10%. d) Decreases more than 10%.
 e) Does not change.
11. For the hypothetical reactions 1 and 2, $K_1 = 10^2$ and $K_2 = 10^{-4}$. (2.5%)
1. $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$
 2. $2A_2(g) + C_2(g) \rightleftharpoons 2A_2C(g)$
 3. $A_2C(g) + B_2(g) \rightleftharpoons 2AB(g) + (1/2)C_2(g)$
- What is the value for K for reaction 3? a) 10^{-2} b) 10^4 c) 10^6 d) 10^2 e) 10^{-4}
12. The value of the equilibrium constant K depends on (2.5%)
- I) The initial concentrations of the reactants.
 II) The initial concentrations of the products.
 III) The final concentrations of the reactants.
 IV) The final concentrations of the products.
- a) I, II b) II, III c) III, IV d) It is dependent on three of the above. e) None of these
13. Which of the following does not represent a conjugate acid-base pair? (2.5%)
- a) HF and F⁻
 b) C₅H₅NH⁺ and C₅H₅N
 c) H₃O⁺ and H₂O
 d) HCN and NH₃
 e) none of these
14. As water is heated, its pH decreases. This means that (2.5%)
- a) the water is no longer neutral
 b) $[H^+] > [OH^-]$
 c) $[OH^-] > [H^+]$
 d) a and b are correct
 e) none of these
15. Buffers in the human body (2.5%)
- a) Help to maintain a constant blood pH.
 b) Help to keep the body temperature constant.
 c) Help change the blood plasma pH when foods are eaten.
 d) Precipitate proteins so enzymes are inactive.
 e) none of these

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16. The pH at the equivalence point of a titration of a weak acid with a strong base is (2.5%)
- Less than 7.00.
 - Equal to 7.00.
 - Greater than 7.00.
 - More data is needed to answer this question.
 - none of the above
17. An indicator HIn has a $K_a = 1 \times 10^{-8}$. At pH = 6.0, what is the ratio HIn/In⁻? (2.5%)
- 1/1
 - 100/1
 - 1/100
 - 1/1
 - none of these
18. Suppose you add 45 J of heat to a system, let it do 10. J of expansion work, then returns the system to its initial state by cooling and compression. Which statement is true for this process? (2.5%)
- $\Delta H < \Delta E$
 - The work done in compressing the system must exactly equal the work done by the system in the expansion step.
 - $\Delta H = 70. \text{ J}$
 - The change in the internal energy for this process is zero.
 - none of the above
19. Which one of the following statements is FALSE? (2.5%)
- The change in internal energy, E, for a process is equal to the amount of heat absorbed at constant volume, q_v .
 - The change in enthalpy, H, for a process is equal to the amount of heat absorbed at constant pressure, q_p .
 - A bomb calorimeter measures H directly.
 - If q_i for a process is negative, the process is exothermic.
 - The freezing of water is an example of an exothermic reaction.
20. One mole of an ideal gas at 25°C is expanded isothermally and reversibly from 125.0 L to 250.0 L. Which statement is correct? (2.5%)
- $\Delta S_{\text{gas}} = 0$
 - $\Delta S_{\text{gas}} = R \ln 2$
 - $\Delta S_{\text{univ}} = 0$
 - $\Delta S_{\text{surr}} = 0$
 - $\Delta S_{\text{gas}} = \Delta S_{\text{surr}}$
21. Which of the following is true? (2.5%)
- As long as the disorder of the surroundings is increasing, a process will be spontaneous.
 - For any process, ΔS_{surr} and ΔS_{sys} have opposite signs.
 - If $\Delta S_{\text{surr}} = -\Delta S_{\text{sys}}$, the process is at equilibrium.
 - ΔH° is zero for a chemical reaction at constant temperature.
 - None of these

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22. For a spontaneous endothermic process, which conditions must hold? (2.5%)

- 1) $w_{\max} = \Delta G$
- 2) $\Delta S_{\text{surr}} > 0$
- 3) ΔS cannot be negative.
- 4) ΔS is positive.

a) All are true. b) None are true. c) 1 and 3 d) 1, 2, and 4 e) 3 and 4

23. How many electrons are transferred in the following reaction? (2.5%)



a) 6 b) 2 c) 10 d) 4 e) 3

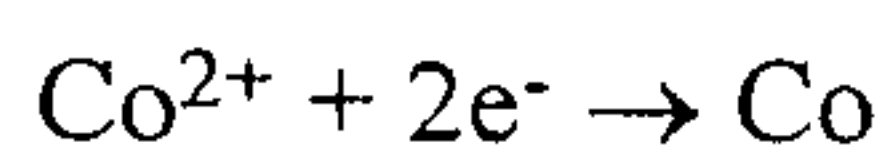
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24. The standard potential for the following reaction: $\text{Zn} + 2\text{Ag}^+ \rightarrow \text{Zn}^{2+} + 2\text{Ag}$ is 1.56 V. Calculate the cell potential for the following reaction: $2\text{Zn}^{2+} + 4\text{Ag} \rightarrow 2\text{Zn} + 4\text{Ag}^+$ (2.5%)

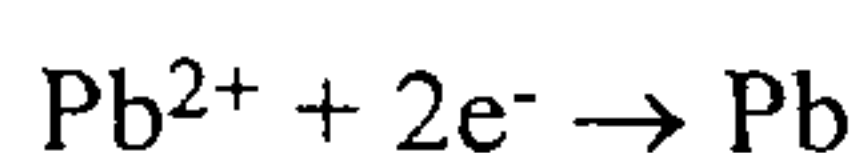
- a) 1.56 V
- b) -1.56 V
- c) 3.12 V
- d) -3.12 V
- e) none of these

25. What is the oxidation state of Cr in $\text{Cr}_2\text{O}_7^{2-}$? (2.5%)

a) +7 b) +6 c) +12 d) -1 e) -2

26. Consider an electrochemical cell with a cobalt electrode immersed in 1.0 M Co^{2+} and a lead electrode immersed in 1.0 M Pb^{2+} . (2.5%)

$$E^\circ = -0.28 \text{ V}$$



$$E^\circ = -0.13 \text{ V}$$

Calculate E° for this cell

a) -0.15 V b) 0.15 V c) -0.41 V d) 0.41 V e) none of these

27. Which of the following statements about quantum theory is incorrect? (2.5%)

- a) The energy and position of an electron cannot be determined simultaneously.
- b) Lower energy orbitals are filled with electrons before higher energy orbitals.
- c) When filling orbitals of equal energy, two electrons will occupy the same orbital before filling a new orbital.
- d) No two electrons can have the same four quantum numbers.
- e) All of these are correct.

28. What is the correct order of the following bonds in terms of decreasing polarity? (2.5%)

a) N-Cl, P-Cl, As-Cl b) P-Cl, N-Cl, As-Cl c) As-Cl, N-Cl, P-Cl
 d) P-Cl, As-Cl, N-Cl e) As-Cl, P-Cl, N-Cl

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29. Which statement is correct? (2.5%)
- H₂O is linear.
 - The molecule ClO₂ cannot be accurately described by a Lewis structure consistent with the octet rule.
 - The diatomic molecule Cl₂ is an example of a polar molecule.
 - The bonds in LiF have more covalent character than those in F₂.
 - none of these
30. Which of the following statements is correct? (2.5%)
- A triple bond is composed of two σ bonds and one π bond.
 - σ bonds result from the head-to-head overlap of atomic orbitals.
 - Free rotation may occur about a double bond.
 - π bonds have electron density on the internuclear axis.
 - More than one of these statements is correct.
31. Which of the following statements is true? (2.5%)
- Electrons are never found in an antibonding MO.
 - All antibonding MOs are higher in energy than the atomic orbitals of which they are composed.
 - Antibonding MOs have electron density mainly outside the space between the two nuclei.
 - None of the above is true.
 - Two of the above statements are true.
32. Which of the following statements is FALSE? (2.5%)
- Atoms or molecules with an even number of electrons are diamagnetic.
 - Atoms or molecules with an odd number of electrons are paramagnetic.
 - Paramagnetism cannot be deduced from the Lewis structure of a molecule alone.
 - Paramagnetic molecules are attracted toward a magnetic field.
 - N₂ molecules are diamagnetic.
33. For which order reaction is the half life of the reaction proportional to 1/k (k is the rate constant)? (2.5%)
- Zero order
 - First order
 - Second order
 - All of the above
 - None of the above
34. The reaction $A \rightarrow B + C$ is known to be zero order in A with a rate constant of $5.0 \times 10^{-2} \text{ mol/L} \cdot \text{s}$ at 25°C. An experiment was run at 25°C where $[A]_0 = 1.0 \times 10^{-3} \text{ M}$. The integrated rate law is (2.5%)
- $[A] = kt$
 - $[A] - [A]_0 = kt$
 - $\frac{[A]}{[A]_0} = kt$
 - $\ln \frac{[A]}{[A]_0} = kt$
 - $[A]_0 - [A] = kt$

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35. Which statement regarding water is true? (2.5%)
- Energy must be given off in order to break down the crystal lattice of ice to a liquid.
 - Hydrogen bonds are stronger than covalent bonds.
 - Liquid water is less dense than solid water.
 - Only covalent bonds are broken when ice melts.
 - All of the statements (a–d) are false.
36. Which of the following statements is/are true? (2.5%)
- Rate of dissolution of a solid in a liquid always increases with increasing temperature.
 - Solubility of a solid in a liquid always increases with increasing temperature.
 - According to Henry's law, the amount of gas dissolved in a solution is directly proportional to the pressure of the gas above the liquid.
 - Two of the above statements are true.
 - All three statements (a-c) are true.
37. A solution of two liquids, A and B, shows negative deviation from Raoul's law. This means that (2.5%)
- Molecules of A interact strongly with other A-type molecules.
 - The two liquids have a positive heat of solution.
 - Molecules of A interact weakly, if at all, with B molecules.
 - The molecules of A hinder the strong interaction between B molecules.
 - Molecules of A interact more strongly with B than with A or B with B.
38. The molar mass of a solid as determined by freezing point depression is 10% higher than the true molar mass. Which of the following experimental errors could not account for this discrepancy? (2.5%)
- Not all the solid was dissolved.
 - More than the recorded amount of solvent was pipetted into the solution.
 - The solid dissociated slightly into two particles when it dissolved.
 - Some solid was left on the weighing paper.
 - Before the solution was prepared, the container was rinsed with solvent and not dried.
39. Within the halogen family, as atomic number increases, (2.5%)
- Ionic radius decreases.
 - Covalent atomic radius increases.
 - Melting point decreases.
 - Electronegativity increases.
 - None of the above
40. What is the sum of the geometric and optical isomers that the complex ion $[\text{Co}(\text{en})_2\text{Cl}]^{2+}$ exhibits? (2.5%)
- a) 0 b) 1 c) 2 d) 3 e) 4

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