

台灣聯合大學系統 97 學年度學士班轉學生考試命題紙

科目： 普通化學 類組別 A5

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*請在試卷答案卡內作答

單選題，每題 2.5 分，共 40 題，滿分 100 分

- Co-60 is a beta emitter with a half-life of 5.3 years. Approximately what fraction of Co-60 atoms will remain in a particular sample after 26.5 years?
(A) 1/5 (B) 1/16 (C) 1/26 (D) 1/32 (E) 1/64
- The overall reaction $2\text{Co}^{3+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow 2\text{Co}^{2+}(\text{aq}) + \text{Cl}_2(\text{g})$ has the standard cell voltage $E^{\circ}_{\text{cell}} = 0.46 \text{ V}$
Given: $\text{Cl}_2(\text{g}) + 2\text{e}^{-} \rightarrow 2\text{Cl}^{-}(\text{aq}) \quad E^{\circ} = 1.36 \text{ V}$
Calculate the standard reduction potential for the following half reaction at 25°C :
 $\text{Co}^{3+} + \text{e}^{-} \rightarrow \text{Co}^{2+} \quad E^{\circ}_{\text{Co}^{3+}/\text{Co}^{2+}} = ?$
(A) 1.82 V (B) -0.90 V (C) 0.90 V (D) -1.82V (E) -1.36 V
- Given the following notation for an electrochemical cell
 $\text{Pt}(\text{s}) \left| \text{H}_2(1\text{atm}) \right| \text{H}^{+}(1\text{M}) \parallel \text{Cu}^{2+}(1\text{M}) \left| \text{Cu}(\text{s}) \right.$
Which one of the following changes will cause an increase in the cell voltage?
(A) Lower the $\text{H}_2(\text{g})$ pressure
(B) Increase the size/mass of the copper electrode
(C) Lower the $\text{H}^{+}(\text{aq})$ concentration
(D) Decrease the concentration of Cu^{2+} ion
(E) None of the above
- The equilibrium constant for the reaction:
 $\text{AgBr}(\text{s}) \rightleftharpoons \text{Ag}^{+}(\text{aq}) + \text{Br}^{-}(\text{aq})$
is the solubility product constant, $K_{\text{sp}} = 7.7 \times 10^{-13}$ at 25°C . Calculate ΔG for the reaction when $[\text{Ag}^{+}] = 1.0 \times 10^{-2} \text{ M}$ and $[\text{Br}^{-}] = 1.0 \times 10^{-3} \text{ M}$. Is the reaction spontaneous or nonspontaneous at these concentrations?
(A) $\Delta G = 69.1 \text{ kJ}$, nonspontaneous
(B) $\Delta G = -69.1 \text{ kJ}$, spontaneous
(C) $\Delta G = 97.5 \text{ kJ}$, spontaneous
(D) $\Delta G = 40.6 \text{ kJ}$, nonspontaneous
(E) $\Delta G = -97.5 \text{ kJ}$, nonspontaneous
- The equilibrium constant at 427°C for the reaction
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ is $K_{\text{p}} = 9.4 \times 10^{-5}$.
Calculate the value of ΔG° for the reaction at 427°C . Given: $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.
(A) -33 kJ (B) -54 kJ (C) 54 kJ (D) 33 kJ (E) 1.3 kJ
- The lanthanide contraction was introduced to rationalize the relative sizes of the fifth and sixth period atoms. Which of the following elements should have the greatest ionization energy?
(A) Zr (B) Rh (C) Hf (D) Ir (E) Cs

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7. Which of the following statements is correct?
- (A) An element with all electrons paired exhibits paramagnetism.
 - (B) The magnetic moments of atoms or ions are randomly oriented in regions called ferromagnetic domains.
 - (C) A ferromagnetic solid once magnetized becomes a permanent magnet.
 - (D) A ferromagnetic solid is comprised of diamagnetic atoms or ions.
 - (E) A paramagnetic solid can be converted into a ferromagnetic solid by randomizing the location of the individual atoms.
8. Mercury is toxic to the human body, in part, because Hg^{2+} interferes with
- (A) oxygen uptake.
 - (B) sulfur containing enzymes.
 - (C) digestion.
 - (D) transport of electrons across the blood-brain barrier.
 - (E) antioxidant activity
9. Which statement is not true regarding optical isomerism?
- (A) Two optical isomers of $[\text{Co}(\text{en})_3]^{3+}$ exist.
 - (B) Optical isomers are mirror images of each other.
 - (C) Optical isomers rotate plane polarized light in opposite directions.
 - (D) Optical isomers are not superimposable.
 - (E) Two optical isomers of square planar $[\text{Pt}(\text{en})\text{BrCl}]$ exist.
10. The complex ion $[\text{NiBr}_4]^{2-}$ is found to have two unpaired electrons. Use crystal field theory to deduce what geometry is consistent with the observation. (Br^- is a weak field ligand.)
- (A) tetrahedral (B) square planar (C) seesaw (D) octahedral (E) trigonal bipyramidal
11. A negative sign for ΔG indicates that at constant T and P
- (A) the reaction is exothermic.
 - (B) the reaction is endothermic.
 - (C) the reaction is fast.
 - (D) the reaction is spontaneous.
 - (E) ΔS must be > 0 .
12. Arrange the following reactions according to increasing ΔS values.
- (1) $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$
 (2) $2\text{NO}(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{O}_2(\text{g})$
 (3) $\text{MgCO}_3(\text{s}) \rightarrow \text{MgO}(\text{s}) + \text{CO}_2(\text{g})$
- lowest \rightarrow highest
- (A) $\Delta S^\circ(1) < \Delta S^\circ(2) < \Delta S^\circ(3)$
 - (B) $\Delta S^\circ(2) < \Delta S^\circ(3) < \Delta S^\circ(1)$
 - (C) $\Delta S^\circ(3) < \Delta S^\circ(2) < \Delta S^\circ(1)$
 - (D) $\Delta S^\circ(2) < \Delta S^\circ(1) < \Delta S^\circ(3)$
 - (E) $\Delta S^\circ(1) < \Delta S^\circ(3) < \Delta S^\circ(2)$
13. Which of the following species has the highest entropy (S°) at 25°C ?
- (A) $\text{CO}(\text{g})$ (B) $\text{CH}_4(\text{g})$ (C) $\text{NaCl}(\text{s})$ (D) $\text{H}_2\text{O}(\text{l})$ (E) $\text{Fe}(\text{s})$

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14. In order for a gas to be a "greenhouse gas" it must (complete):
 (A) transmit visible light and absorb infrared radiation.
 (B) be radioactive.
 (C) transmit infrared and absorb visible light.
 (D) be combustible.
 (E) absorb both visible light and infrared.
15. In the reaction $\text{CaO(s)} + \text{SO}_2\text{(g)} \rightleftharpoons \text{CaSO}_3\text{(s)}$
 (A) O^{2-} acts as a Lewis base, and SO_2 acts as a Lewis acid.
 (B) Ca^{2+} acts as a Lewis base, and SO_4^{2-} acts as a Lewis acid.
 (C) SO_4^{2-} acts as a Lewis base, and SO_2 acts as a Lewis acid.
 (D) SO_2 acts as a Lewis base, and O^{2-} acts as a Lewis acid.
 (E) SO_2 acts as a Lewis base, and Ca^{2+} acts as a Lewis acid.
16. Which correlation of ligand and solution color is most reasonable?
 (A) weak field – yellow
 (B) strong field – yellow
 (C) weak field – red
 (D) strong field – violet
 (E) strong field – blue
17. For which element is the inert pair effect expected to be the most important?
 (A) N (B) P (C) As (D) Sb (E) Bi
18. The best explanation for the fact that oxygen forms only OF_2 with fluorine while sulfur forms SF_2 , SF_4 , and SF_6 is that
 (A) oxygen is more electronegative than sulfur.
 (B) oxygen is smaller than sulfur.
 (C) sulfur has *d* orbitals available for bonding.
 (D) sulfur is more fluorophilic than oxygen.
 (E) only oxygen forms hydrogen bonds.
19. Which of the following nuclides would be the most likely to be radioactive?
 (A) ^{13}C (B) ^{18}O (C) ^{23}Na (D) ^{27}Al (E) ^{28}P
20. Arrange the following compounds in the expected order of increasing solubility in water (lowest solubility first, highest solubility last).
 LiOH Sr(OH)₂ Ba(OH)₂ Ca(OH)₂
 A B C D
 (A) D, B, C, A
 (B) A, D, B, C
 (C) A, B, C, D
 (D) D, A, B, C
 (E) C, D, B, A

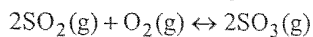
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21. Consider the following reaction at equilibrium



If the volume of the system is compressed at constant temperature, what change will this cause in the system?

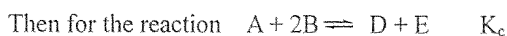
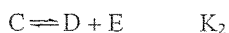
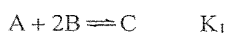
- (A) a shift to produce more SO_2
- (B) a shift to produce more O_2
- (C) no change
- (D) a shift to produce more SO_3

22. For the equilibrium reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ $\Delta H^\circ_{\text{rxn}} = -198 \text{ kJ}$

which one of the following factors would cause the equilibrium constant value to increase?

- (A) decrease the temperature.
- (B) add SO_2 gas.
- (C) remove O_2 gas.
- (D) add a catalyst
- (E) none of the above.

23. For the following reactions the equilibrium constants are defined:



the equilibrium constant must be equal to :

- (A) $K_1 + K_2$
- (B) $K_c = K_1 / K_2$
- (C) $K_c = K_1 - K_2$
- (D) $K_c = K_1 * K_2$
- (E) $K_c = K_2 / K_1$

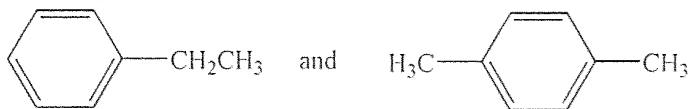
24. When the concentration of reactant molecules are increased, the rate of reaction increases. The best explanation is: As the reactant concentration increases;

- (A) average kinetic energy of molecules increases.
- (B) the frequency of molecular collisions increases.
- (C) the rate constant increases.
- (D) the activation energy increases.
- (E) the order of reaction increases.

25. For the chemical reaction $\text{A} \rightarrow \text{B} + \text{C}$, a plot of $[\text{A}]$ versus time is found to give a straight line with a negative slope. What is the order of reaction with respect to A?

- (A) zero (B) first (C) second (D) third (E) none of the above

26. Which type of spectroscopy would be most useful in distinguishing the following pair of compounds



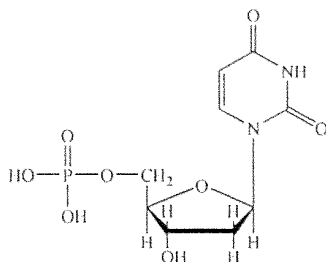
- (A) IR (B) UV-Vis (C) NMR (D) MS (E) EPR

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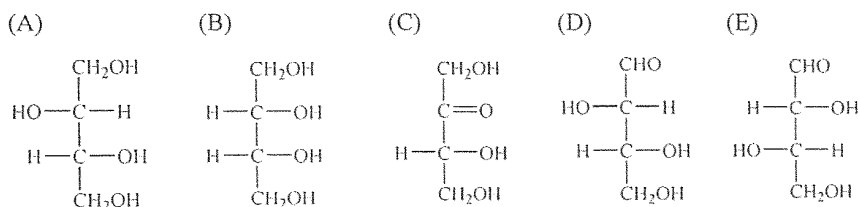
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27. If a reaction goes via the S_N2 reaction mechanism, it should result in
- replacement of a group on a molecule with a nucleophile.
 - formation of an alkene functional group.
 - retention of stereochemical configuration of product molecule.
 - rearrangement of the molecule to a more stable alkane.
 - regeneration of the aromatic ring.
28. How do drugs exhibit biological activity?
- They stimulate the cells to perform acid-base reactions.
 - They interact with specific enzymes and block or change the shape of the active site of the receptor.
 - They mimic the action of a specific enzyme, increasing the availability of the receptors.
 - They hydrolyze the fats and oils in abnormal cells to make metal salts of fatty acids.
 - They react with abnormal cells in the body and form Lewis acids by electrophilic aromatic substitution.
29. Match the following classifications with the compound shown.



- | Base | Sugar |
|----------------|----------|
| (A) purine | pyranose |
| (B) purine | furanose |
| (C) pyrimidine | pyranose |
| (D) pyrimidine | furanose |
| (E) pyrimidine | tetrose |

30. Which of the following carbohydrates can be classified as an aldose?

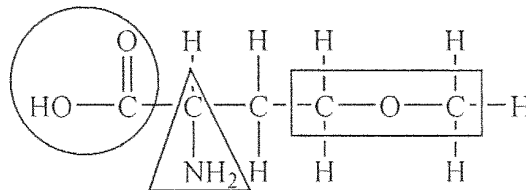


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31. According to Raoult's law, which statement is false?
 (A) The vapor pressure of a solvent over a solution decreases as its mole fraction increases.
 (B) The solubility of a gas increases as the temperature decreases.
 (C) The vapor pressure of a solvent over a solution is less than that of pure solvent.
 (D) The greater the pressure of a gas over a solution the greater its solubility.
 (E) Ionic solutes dissociate in solution causing an enhancement of all colligative properties.
32. What is the osmotic pressure of a solution prepared from 13.7 g of the electrolyte HCl and enough water to make 0.50 L of solution at 18°C?
 (A) 0.55 atm (B) 1.10 atm (C) 8.95 atm (D) 17.9 atm (E) 35.9 atm
33. The number of atoms in a body-centered cubic unit cell is
 (A) 1 (B) 2 (C) 3 (D) 4 (E) 8
34. Estimate the enthalpy change (ΔH) for the reaction
 $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
 BE(C - H) = 1074 kJ
 BE(C - Cl) = 499 kJ
 BE(H - Cl) = 802 kJ
 BE(Cl - Cl) = 1074 kJ
 (A) -103 kJ (B) -109 kJ (C) +275 kJ (D) +109 kJ (E) +103 kJ
35. The heat of solution of LiCl is -37.1 kJ/mol, and the lattice energy of LiCl(s) is 828 kJ/mol. Calculate the total heat of hydration of gas phase Li^+ ions and Cl^- ions.
 (A) 791 kJ (B) 865 kJ (C) -865 kJ (D) -791 kJ (E) none of the above
36. A carbon that has four different groups attached to it is a _____ carbon?
 (A) chimerical
 (B) dextrorotatory
 (C) typical
 (D) chiral
 (E) phospholipids
37. Name the functional groups in the following molecule (in the order, circle, triangle, and rectangle).



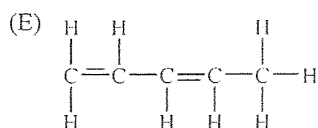
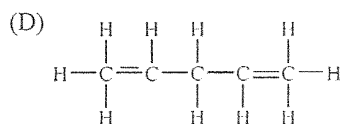
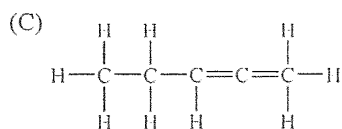
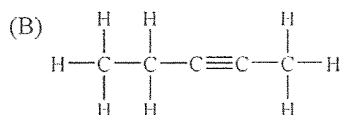
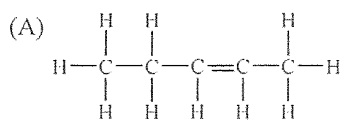
- (A) alcohol, amine, ketone
 (B) carboxylic acid, nitro, ester
 (C) ester, amine, alcohol
 (D) carboxylate, imine, ether
 (E) carboxylic acid, amine, ether

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38. Which of the following is an example of a conjugated molecule?



39. Which of the following reaction types involves formation of a carbocation in the mechanism?

- (A) free radical substitution.
- (B) electrophilic aromatic substitution.
- (C) dehydrogenation.
- (D) nucleophilic substitution (S_N2).
- (E) hydration.

40. Which of the following is a D-sugar?

