

臺灣綜合大學系統 115 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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選擇題：（單選，不倒扣，共 40 題；每題 2.5 分，共 100 分）

- An element's most stable ion forms an ionic compound with chlorine having the formula XCl_2 . If the mass number of the ion is 24 and it has 10 electrons, what is the element and how many neutrons does it have?
(A) Ne, 14 neutrons ; (B) Ca, 16 neutrons ; (C) O, 8 neutrons ; (D) Mg, 12 neutrons ;
(E) Ti, 24 neutrons.
- How many atoms of hydrogen are present in 4.25 g of ammonia? (H: 1 ; N: 14)
(A) 4.5×10^{23} ; (B) 6.0×10^{23} ; (C) 1.5×10^{-24} ; (D) 5.8×10^{23} ; (E) 0.75.
- The mass percent of iron in an iron oxide is 77.7%. Find the empirical formula. (Fe: 55.5 ; O: 16)
(A) Fe_3O_2 ; (B) Fe_3O_4 ; (C) FeO ; (D) Fe_2O_3 ; (E) Fe_3O_5 .
- In the reaction: $2\text{A} + \text{B} \rightarrow 3\text{C} + \text{D}$;
3.0 mol A and 2.0 mol B react to form 4.0 mol C. What is the percent yield of this reaction?
(A) 100% ; (B) 89% ; (C) 75% ; (D) 67% ; (E) 50%.
- Select the unbalanced net ionic equation for the reaction between aqueous lead nitrate and aqueous potassium iodide.
(A) $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{KI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + \text{KNO}_3(\text{aq})$
(B) $\text{Pb}^{2+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) + \text{K}^{+}(\text{aq}) + \text{I}^{-}(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + \text{I}^{-}(\text{aq}) + \text{K}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq})$;
(C) $\text{Pb}^{2+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) + \text{K}^{+}(\text{aq}) + \text{I}^{-}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + \text{K}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq})$;
(D) $\text{Na}^{+}(\text{aq}) + \text{NO}_3^{-}(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$;
(E) $\text{Pb}^{2+}(\text{aq}) + \text{I}^{-}(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$.
- The following reaction occurs in aqueous acid solution: $\text{NO}_3^{-} + \text{I}^{-} \rightarrow \text{IO}_3^{-} + \text{NO}_2$
In the balanced equation, what is the coefficient of water?
(A) 1 ; (B) 2 ; (C) 3 ; (D) 4 ; (E) 5.
- Equimolar amounts of the gases N_2 and H_2 are mixed in a closed container fitted with a piston (allowing the volume of the container to change, thus keeping the pressure constant). Calculate the ratio of the final volume of the container to the initial volume of the container when the reaction:
 $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ goes to completion.
(A) 2/3 ; (B) 1/3 ; (C) 3/4 ; (D) 1/2 ; (E) 3/2.

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8. Calculate the temperature at which the average kinetic energy of O₂ gas is twice that of He gas at 10.0°C. (He: 4 ; O: 16)
(A) 2.50°C ; (B) 80°C ; (C) 20.0°C ; (D) 1160°C ; (E) 293°C.

9. Based on the van der Waals equation of state, which of the following molecules - hydrogen chloride, nitrogen dioxide, or sulfur dioxide - should behave most like an ideal gas.

van der Waals constants		
	a (atm L ² · mol ⁻²)	b (L · mol ⁻¹)
HCl	3.667	0.04081
NO ₂	5.284	0.04424
SO ₂	6.714	0.05636
H ₂ S	7.210	0.06254

(A) SO₂ ; (B) HCl ; (C) NO₂ ; (D) H₂S ; (E) Must know P and V to answer this question.

10. Consider the reaction: 2SO₂(g) + O₂(g) ⇌ 2SO₃(g) at constant temperature.
Initially a container is filled with pure SO₃(g) at a pressure of 2 atm, after which equilibrium is allowed to be reached. If y is the partial pressure of O₂ at equilibrium, what is the value of K_p?
(A) (2-2y)²/[(y²) (2y)] ; (B) (2-y)²/[(y²) (y/2)] ; (C) (2-y)²/[(y) (2y)²] ; (D) (2-2y)²/[(y) (2y)²] ;
(E) [(y²) (y/2)] /(2-y)²

11. Nitrogen gas (N₂) reacts with hydrogen gas (H₂) to form ammonia (NH₃). At 200°C in a closed container, 1.0 atm of nitrogen gas is mixed with 2.1 atm of hydrogen gas. At equilibrium, the total pressure is 2.1 atm. Calculate the partial pressure of hydrogen gas at equilibrium.
(A) 2.1 atm ; (B) 0.60 atm ; (C) 1.60 atm ; (D) 0.0 atm ; (E) 1.8 atm.

12. Which is the closest pH value of a 1.0 × 10⁻⁸ M solution of CH₃COOH? (K_a = 1.8 × 10⁻⁵)
(A) 8.0 ; (B) 7.10 ; (C) 6.98 ; (D) 6.0 ; (E) 3.0.

13. Calculate the pH of a solution at 25°C made by mixing equal volumes of a solution of NaOH with a pH of 11.30 and a solution of KOH with a pH of 10.30. (Assume the volumes are additive.)
(A) 2.9 ; (B) 9.89 ; (C) 10.10 ; (D) 10.80 ; (E) 11.08 .

14. The K_{sp} of Al(OH)₃ is 2.0 × 10⁻³². At what pH will a 0.2 M Al³⁺ solution begin to show precipitation of Al(OH)₃? [(100)^{1/3} ≈ 5]
(A) 3.7 ; (B) 1.0 ; (C) 5.6 ; (D) 10.3 ; (E) 8.4.

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15. A 100.0-mL sample of 0.2 M (CH₃)₃N ($K_b = 5.0 \times 10^{-5}$) is titrated with 0.2 M HCl at 25°C. What is the pH at the equivalence point? ($\sqrt{20} \approx 4.5$)
(A) 9.9 ; (B) 3.1 ; (C) 10.3 ; (D) 5.4 ; (E) 7.0.

16. Given the equation $S(s) + O_2(g) \rightarrow SO_2(g)$, $\Delta H = -296 \text{ kJ}$, which of the following statements is(are) true? (S: 32) I. The reaction is endothermic.
II. When 0.500 mol of sulfur is reacted, 148 kJ of energy is released.
III. When 32.0 g of sulfur is burned, $2.96 \times 10^5 \text{ J}$ of energy is absorbed from surroundings.
(A) All are true. ; (B) None is true. ; (C) I and II are true. ; (D) I and III are true.; (E) Only II is true.

17. Given the following two reactions at 298 K and 1 atm, which of the statements is true?
1. $N_2(g) + O_2(g) \rightarrow 2NO(g) \quad \Delta H_1$
2. $NO(g) + (1/2)O_2(g) \rightarrow NO_2(g) \quad \Delta H_2$
(A) ΔH_f for $NO_2(g) = \Delta H_2$; (B) ΔH_f for $NO(g) = \Delta H_1$; (C) $\Delta H_1 = \Delta H_2$;
(D) ΔH_f for $NO_2(g) = \Delta H_2 + (1/2)\Delta H_1$; (E) ΔH_f for $O_2(g) = 1/2 (\Delta H_2 - H_1)$.

18. Using the information below, calculate ΔH°_f for $PbO(s)$.
 $PbO(s) + CO(g) \rightarrow Pb(s) + CO_2(g), \quad \Delta H^\circ = -130 \text{ kJ}$
 ΔH°_f for $CO_2(g) = -394 \text{ kJ/mol}$; ΔH°_f for $CO(g) = -110 \text{ kJ/mol}$
(A) -154 kJ/mol ; (B) -283 kJ/mol ; (C) +283 kJ/mol; (D) +253 kJ/mol; (E) ΔH°_f for $Pb(s)$ is needed.

19. Which of the following result(s) in an increase in the entropy of the system?
I. An ideal gas is expanded isothermally from V to 2V. ; II. $Br_2(g) \rightarrow Br_2(l)$
III. $NaBr(s) \rightarrow Na^+(aq) + Br^-(aq)$; IV. $O_2(298 \text{ K}) \rightarrow O_2(373 \text{ K})$
V. $NH_3(1 \text{ atm}, 298 \text{ K}) \rightarrow NH_3(3 \text{ atm}, 298 \text{ K})$
(A) I ; (B) II, V ; (C) I, III, IV ; (D) I, II, III, IV ; (E) I, II, III, V.

20. Calculate ΔS for an isothermal (95°C) expansion of 2 mol of a monatomic ideal gas from 100.0 atm to 1.00 atm. (R: $8.3 \text{ J K}^{-1} \text{ mol}^{-1}$; $\ln 10 = 2.3$)
(A) 76.6 J/K ; (B) 38.3 J/K ; (C) 19.2 J/K; (D) -38.3 J/K ; (E) -76.6 J/K.

21. Consider the reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ for which $\Delta H^\circ = -200 \text{ kJ}$ and $\Delta S^\circ = -200 \text{ J/K}$ at 25°C. Assuming that ΔH° and ΔS° are independent of temperature, calculate the temperature where $K_p = 1$.
(A) 596°C ; (B) 298°C ; (C) 527°C ; (D) 727°C ; (E) 1000°C.

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22. In a common car battery, six identical cells each carry out the following reaction:
- $$\text{Pb} + \text{PbO}_2 + 2\text{HSO}_4^- + 2\text{H}^+ \rightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$$
- For such a cell, E° is 2.00 V. Calculate ΔG° at 25°C. (1 F = 96500 C)
- (A) -787 kJ ; (B) -98 kJ ; (C) -394 kJ ; (D) -197 kJ ; (E) -0.121 kJ.
23. If an electrolysis plant operates its electrolytic cells at a total current of 1.0×10^6 amp, how long will it take to produce one metric ton (one million grams) of Mg(s) from seawater containing Mg^{2+} ? (1 faraday = 96,500 coulombs)
- (A) 2.2 h ; (B) 2.4 days ; (C) 55 min ; (D) 3.7 h ; (E) 1 year.
24. The wavelength of light associated with the $n = 2$ to $n = 1$ electron transition in the hydrogen spectrum is 1.216×10^{-7} m. By what coefficient should this wavelength be multiplied to obtain the wavelength associated with the same electron transition in the Li^{2+} ion?
- (A) 1/3 ; (B) 1/4 ; (C) 3 ; (D) 6 ; (E) 1/9.
25. The number of electrons described by the quantum number $n = 3$ is X. The number of electrons can be described by the quantum numbers ($n = 4, l = 3, m_l = -1, m_s = -1$) is Y. Please calculate the value of X + Y.
- (A) 32 ; (B) 18 ; (C) 10 ; (D) 19 ; (E) 7.
26. Which of the following molecules has a dipole moment?
- (A) SCl_6 ; (B) SO_3 ; (C) BH_3 ; (D) CS_2 ; (E) OF_2 .
27. Given the following information: N_2 bond energy = 940 kJ/mol ; F_2 bond energy = 154 kJ/mol.
- $$\frac{1}{2}\text{N}_2(\text{g}) + \frac{3}{2}\text{F}_2(\text{g}) \rightarrow \text{NF}_3(\text{g}) \quad \Delta H^\circ = -103 \text{ kJ/mol} ; \text{ calculate the N-F bond energy.}$$
- (A) 113 kJ/mol ; (B) 268 kJ/mol ; (C) 317 kJ/mol ; (D) 66 kJ/mol ; (E) 683 kJ/mol.
28. In which of the compounds below is there more than one kind of hybridization (sp , sp^2 , sp^3) for carbon?
- I. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$; II. $\text{CH}_3\text{CH}=\text{CHCH}_3$; III. $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$; IV. $\text{H}-\text{C}\equiv\text{C}-\text{H}$
- (A) II and III ; (B) I and IV ; (C) III and IV ; (D) II only ; (E) III only.
29. Which of the following species has the largest dissociation energy?
- (A) O_2 ; (B) O_2^- ; (C) O_2^{2-} ; (D) O_2^+ ; (E) O_2^{2+} .

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30. Tabulated below are initial rate data for the reaction:

$$2\text{Fe}(\text{CN})_6^{3-} + 2\text{I}^- \rightarrow 2\text{Fe}(\text{CN})_6^{4-} + \text{I}_2$$

Run	$[\text{Fe}(\text{CN})_6^{3-}]_0$ (M)	$[\text{I}^-]_0$ (M)	$[\text{Fe}(\text{CN})_6^{4-}]_0$ (M)	$[\text{I}_2]_0$ (M)	Initial Rate (M/s)
1	0.01	0.01	0.01	0.01	1×10^{-5}
2	0.01	0.02	0.01	0.01	2×10^{-5}
3	0.02	0.02	0.01	0.01	8×10^{-5}

What is the value of k ?

(A) $10^7 \text{ M}^{-2} \text{ s}^{-1}$; (B) $10^3 \text{ M}^{-3} \text{ s}^{-1}$; (C) $10 \text{ M}^{-2} \text{ s}^{-1}$; (D) $50 \text{ M}^{-2} \text{ s}^{-1}$; (E) $0.1 \text{ M}^{-2} \text{ s}^{-1}$.

31. For a reaction $\text{X} \rightarrow \text{Y} + \text{Z}$, $[\text{X}]_0 = 2.0 \text{ M}$, and the first three successive half-lives are 100, 200, and 400 min. Calculate k (without units).

(A) 5.0×10^{-3} ; (B) 2.5×10^{-3} ; (C) 4.0×10^{-3} ; (D) 2.0×10^{-2} ; (E) 1.4×10^{-2} .

32. A certain substance, X, has a triple-point temperature of 20°C at a pressure of 2.0 atm. Which one of the following statements **cannot** possibly be true?

(A) X can exist as a liquid above 20°C . ;
 (B) X can exist as a solid above 20°C . ;
 (C) Liquid X can exist as a stable phase at 25°C , 1 atm. ;
 (D) Both liquid and solid X have the same vapor pressure at 20°C . ;
 (E) All of these statements could be true.

33. What is the expected osmotic pressure, in torr, of a 0.0100 M solution of NaCl in water at 27°C ?
 (R: $0.082 \text{ atm}\cdot\text{L K}^{-1} \text{ mol}^{-1}$)

(A) 0.245 torr ; (B) 0.492 torr ; (C) 15.6 torr ; (D) 187 torr ; (E) 374 torr.

34. Liquid A has vapor pressure x . Liquid B has vapor pressure y , and $x > y$. What is the mole fraction of A in the liquid mixture if the vapor above the solution is 50% A?

(A) $y/(2x + 2y)$; (B) $x/(2x + 2y)$; (C) $x/(x + y)$; (D) $y/(x + y)$; (E) $(1-x)/(x + y)$.

35. How many unpaired electrons are found in $\text{Fe}(\text{en})_3^{2+}$ (Ethylenediamine (en) is strong field)?
 (Fe: $[\text{Ar}] 3d^6 4s^2$)

(A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) 4.

36. How many of the following compounds exhibit geometric isomers?
 I. $\text{Pd}(\text{NH}_3)_2\text{Br}_2$ (square planar) ; II. $[\text{Co}(\text{NH}_3)_2]\text{Cl}_3$; III. $[\text{Ni}(\text{NH}_3)_4(\text{NO}_2)_2]$; IV. $\text{K}_2[\text{CoBr}_4]$

(A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) 4.

37. Which of the following elements exhibit(s) the oxidation states +1 and +3?

(A) B ; (B) Al ; (C) Ga ; (D) Tl ; (E) all of these.

38. If a tree dies and the trunk remains undisturbed for 13,700 years, estimate what percentage of the original ^{14}C is still present? (The half-life of ^{14}C is 5700 years.)

(A) 5.20% ; (B) 19.0% ; (C) 28.0 % ; (D) 2.20% ; (E) 45.0%

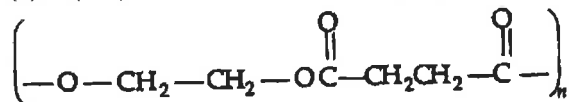
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39. What monomer(s) is(are) needed to make the polymer shown here?



I. $\text{HOCH}_2\text{CH}_2\text{OH}$; II. $\text{HOOCCH}_2\text{CH}_2\text{COOH}$; III. $\text{HOCH}_2\text{CH}_2\text{COOH}$

IV. $\text{HOCH}=\text{CHOH}$; V. $\text{HOOCCH}=\text{CHCOOH}$

(A) II only ; (B) III only ; (C) II and III ; (D) IV and V ; (E) I and II.

40. Which of the following molecules exhibits chirality?

(A) CH_3CClFOH ; (B) $\text{CH}_3\text{CH}_2\text{OCH}_3$; (C) 2-chloropropane ; (D) 3-hexane ; (E) CH_2Cl_2 .