選擇題,共 40 題,每題 2.5 分,共 100 分,答錯不倒扣。

1. How many significant figures (有效數字) are there in the number 3.1400? (a) 1, (b) 2, (c) 3, (d) 4, (e) 5.

2. The first scientist to show that atoms emit (放射) any negative particles (粒子) was

(a) J. J. Thomson, (b) Lord Kelvin, (c) Ernest Rutherford, (d) William Thomson, (e) John Dalton.

3. Bromine (溴) exists naturally as a mixture (混合物) of bromine-79 and bromine-81 isotopes (同位素). An atom of bromine-79 contains (溴的原子序為35)
(a) 35 protons (質子), 44 neutrons (中子), 35 electrons(電子).
(b) 34 protons and 35 electrons, only.
(c) 44 protons, 44 electrons, and 35 neutrons.
(d) 35 protons, 79 neutrons, and 35 electrons.
(e) 79 protons, 79 electrons, and 35 neutrons.

4. The atomic mass of rhenium is 186.2. Given that 37.1% of natural rhenium is rhenium-185, what is the other stable isotope?

(a) $^{183}_{75}$Re, (b) $^{187}_{75}$Re, (c) $^{189}_{75}$Re, (d) $^{181}_{75}$Re, (e) $^{190}_{75}$Re.

5. Naturally occurring copper exists in two isotopic forms: $^{63}Cu$ and $^{65}Cu$. The atomic mass of copper is 63.55 amu. What is the approximate natural abundance (天然存量) of $^{63}Cu$?

(a) 63, (b) 90, (c) 70, (d) 50, (e) 30%.

6. You heat 3.970 g of a mixture of $Fe_3O_4$ and FeO to form 4.195 g $Fe_2O_3$. The mass percent of FeO originally in the mixture was: (Fe = 55.85)

(a) 12.1, (b) 28.7%, (c) 71.3%, (d) 87.9%, (e) none of these.

7. $wPCl_5 + xH_2O \rightarrow yPOCl_3 + zHCl$

The above equation is properly balanced when

(a) $w = 1, x = 2, y = 2, z = 4$, (b) $w = 2, x = 2, y = 2, z = 2$, (c) $w = 2, x = 2, y = 2, z = 1$, (d) $w = 1, x = 1, y = 1, z = 2$, (e) none of these.

8. What volume (體積) of 18.0 M sulfuric acid must be used to prepare 15.5 L of 0.195 M $H_2SO_4$?

(a) 168, (b) 336, (c) 92.3, (d) 226 mL, (e) none of these.

9. Which of the following in water is *not* a strong acid? (a) HF, (b) HCl, (c) HBr, (d) HI, (e) $HNO_3$.

10. Aqueous solutions (水溶液) of sodium sulfide ($Na_2S$) and copper(II) chloride ($CuCl_2$) are mixed together. Which statement is correct?

(a) Both NaCl and CuS precipitate (沉澱) from solution.
(b) No precipitate forms.
(c) CuS will precipitate from solution.
(d) NaCl will precipitate from solution.
(e) No reaction will occur.

11. In which of the following does nitrogen have an oxidation state of +4?

(a) $HNO_3$, (b) $NO_2$, (c) $N_2O$, (d) $NH_4Cl$, (e) $NaNO_2$.

12-13. You have two samples of the same gas in the same size container (容器), with the same pressure (壓力). The gas in the first container has a kelvin temperature (絕對溫度) four times that of the gas in the other container.

12. The ratio of the number of moles of gas in the first container compared to that in the second is

(a) 1 : 1, (b) 4 : 1, (c) 1 : 4, (d) 2 : 1, (e) 1 : 2.

13. The ratio of number of collisions with the wall in the first container compared to that in the second is

(a) 1 : 1, (b) 4 : 1, (c) 1 : 4, (d) 2 : 1, (e) 1 : 2.

14. A balloon (氣球) has a volume of 1.20 liters at 24.0°C. The balloon is heated to 48.0°C. Calculate the new volume of the balloon.

(a) 1.20, (b) 1.30, (c) 1.70, (d) 2.10, (e) 2.40 L.

15. The valve (閥) between a 5-L tank (儲存槽) containing a gas at 9 atm and a 10-L tank containing a gas at 6 atm is opened. Calculate the final pressure in the tanks.

(a) 3, (b) 4, (c) 7, (d) 15 atm, (e) none of these.

16. Given reaction $2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$, you react 5.0 L of $NH_3$ with 5.0 L of $Cl_2$ measured at the same conditions in a closed container. Calculate the ratio of pressures in the container ($P_{final}/P_{initial}$).

(a) 0.75, (b) 1.00, (c) 1.33, (d) 1.50, (e) none of these.

17. If the equilibrium constant (平衡常數) for A + B $\rightleftharpoons$ C is 0.123, then the equilibrium constant for 2C $\rightleftharpoons$ 2A + 2B is _____.

(a) 0.754, (b) 8.13, (c) 0.123, (d) 66.1, (e) 16.3.

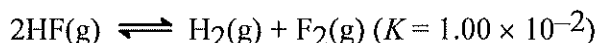18. At a certain temperature $K$ for the reaction

$$2NO_2 \rightleftharpoons N_2O_4$$
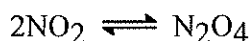
is 7.5 liters/mole. If 2.0 moles of $NO_2$ are placed in a 2.0-liter container and permitted to react at this temperature, calculate the concentration of $N_2O_4$ at equilibrium.

(a) 0.39, (b) 0.65, (c) 0.82, (d) 7.5 mole/liter, (e) none of these.

19. Consider the following reaction:

$$2HF(g) \rightleftharpoons H_2(g) + F_2(g) \; (K = 1.00 \times 10^{-2})$$

Given 1.00 mole of HF(g), 0.500 mole of $H_2$(g), and 0.750 mole of $F_2$(g) are mixed in a 5.00-L flask, determine the reaction quotient (商值), $Q$, and the net direction to achieve equilibrium.

(a) $Q = 0.150$; the equilibrium shifts to the right.
(b) $Q = 0.375$; the equilibrium shifts to the left.
(c) $Q = 0.150$; the equilibrium shifts to the left.
(d) $Q = 0.375$; the equilibrium shifts to the right.
(e) $Q = 0.150$; the system is at equilibrium.

20. Given the equation $A(aq) + 2B(aq) \rightleftharpoons 3C(aq) + 2D(aq)$.  45.0 mL of 0.050 M A is mixed with 25.0 mL 0.100 M B.  At equilibrium the concentration of C is 0.0410 M. Calculate $K$.

(a) 7.3, (b) 0.34, (c) 0.040, (d) 0.14, (e) none of these.

21. For weak acid, HX, $K_a = 1.0 \times 10^{-6}$. Calculate the pH of a 0.10 M solution of HX.

(a) 6.00, (b) 3.50, (c) 3.00, (d) 2.50, (e) none of these.

22-23. The following questions refer to a solution that contains 1.00 M hydrofluoric acid, HF ($K_a = 7.2 \times 10^{-4}$), and 3.00 M hydrocyanic acid, HCN ($K_a = 6.2 \times 10^{-10}$).

22. What is the pH of this mixture (混合物) of weak acids?

(a) 0.00, (b) 1.57, (c) 3.14, (d) 4.37, (e) 9.21.

23. Determine the $[CN^-]$ at equilibrium.
(a) $4.31 \times 10^{-5}$, (b) $4.28 \times 10^{-7}$, (c) $6.9 \times 10^{-8}$, (d) $6.2 \times 10^{-10}$ M, (e) none of these.

24. Which of the following will not produce a buffered solution (緩衝溶液)?

(a) 100 mL of 0.1 M $Na_2CO_3$ and 50 mL of 0.1 M HCl.
(b) 100 mL of 0.1 M $NaHCO_3$ and 25 mL of 0.2 M HCl.
(c) 100 mL of 0.1 M $Na_2CO_3$ and 75 mL of 0.2 M HCl.
(d) 50 mL of 0.2 M $Na_2CO_3$ and 5 mL of 1.0 M HCl.
(e) 100 mL of 0.1 M $Na_2CO_3$ and 50 mL of 0.1 M NaOH.

25. How many moles of solid NaF would have to be added to 1.0 L of 1.90 M HF solution to achieve a buffer of pH 3.35? Assume there is no volume change. ($K_a$ for HF $= 7.2 \times 10^{-4}$)

(a) 3.1, (b) 2.3, (c) 1.6, (d) 1.0, (e) 4.9.

26. A 40.2 g sample of a metal is heated to 99.3°C and then placed in a calorimeter (卡計) containing 120.0 g of water ($c = 4.18J/g°C$) at 21.8°C. The final temperature of the water is 24.5°C.  Which metal was used?

(a) Al ($c = 0.89J/g°C$), (b) Fe ($c = 0.45J/g°C$), (c) Cu ($c = 0.20J/g°C$), (d) Pb ($c = 0.14J/g°C$), (e) none of these.

27. Consider the reaction

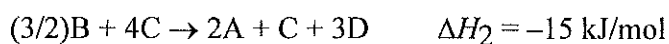$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l), \Delta H = -1.37 \times 10^3 \text{ kJ}$$
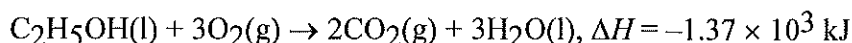
When a 15.1-g sample of ethyl alcohol (乙二醇, 分子量 = 46.1 g/mol) is burned, how much energy is released as heat?

(a) 0.449, (b) $2.25 \times 10^3$, (c) $4.49 \times 10^2$, (d) $1.02 \times 10^3$, (e) 196 kJ.
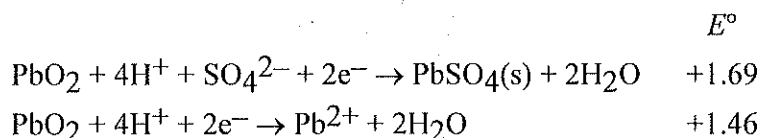
28. Consider the following processes:

$$2A \rightarrow 1/2B + C \qquad \Delta H_1 = 5 \text{ kJ/mol}$$
$$(3/2)B + 4C \rightarrow 2A + C + 3D \qquad \Delta H_2 = -15 \text{ kJ/mol}$$
$$E + 4A \rightarrow C \qquad \Delta H_3 = 10 \text{ kJ/mol}$$

Calculate $\Delta H$ for: $C \rightarrow E + 3D$

(a) 0, (b) 10, (c) –10, (d) –20, (e) 20 kJ/mol.

29. The galvanic cell (伏打電池) described by Zn(s) | $Zn^{2+}$(aq) || $Cu^{2+}$(aq) | Cu(s) has a standard cell potential (標準電池電位) of 1.101 volts. Given that Zn(s) → $Zn^{2+}$(aq) + $2e^-$ has an oxidation potential of 0.762 volts, determine the reduction potential for $Cu^{2+}$.

(a) –1.863, (b) 1.863, (c) –0.339 V, (d) 0.339 V, (e) none of these.

30. Using the following data

$$E°$$

$$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4(s) + 2H_2O \quad +1.69$$
$$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O \quad +1.46$$

calculate the $K_{sp}$ value at 25°C for $PbSO_4$(s).

(a) $1.7 \times 10^{-5}$, (b) $1.7 \times 10^{-6}$, (c) $1.7 \times 10^{-7}$, (d) $1.7 \times 10^{-8}$, (e) $1.7 \times 10^{-9}$.

31. Which of the following atoms has the largest ionization energy (游離能)?

(a) O, (b) Li, (c) N, (d) Be, (e) K.

32. If $n = 2$ (n=主量子數), how many orbitals (軌域) are possible?

(a) 3, (b) 4, (c) 2, (d) 8, (e) 6.

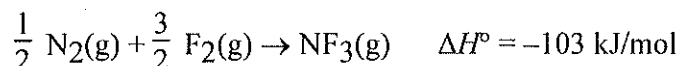33. Which of the following has a zero dipole moment (偶極距)?
(a) $NH_3$, (b) $NO_2$, (c) $PF_5$, (d) $SO_2$, (e) HCN.

34. Given the following information
   $N_2$ bond energy = 941 kJ/mol
   $F_2$ bond energy = 154 kJ/mol

$$\frac{1}{2} N_2(g) + \frac{3}{2} F_2(g) \rightarrow NF_3(g) \quad \Delta H° = -103 \text{ kJ/mol}$$

calculate the N–F bond energy.

(a) 113, (b) 268, (c) 317, (d) 66 kJ/mol, (e) none of these.

35. Which of the following molecules or ions is *not* paramagnetic (順磁) in its ground state (基底狀態)?

(a) $O_2$, (b) $O_2^+$, (c) $B_2$, (d) NO, (e) $F_2$.

36. The following data were obtained at 25°C:

| $[A]_0$ | $[B]_0$ | $[C]_0$ | Rate |
|---|---|---|---|
| 0.1 | 0.2 | 0.3 | 0.063 |
| 0.3 | 0.4 | 0.2 | 0.084 |
| 0.6 | 0.4 | 0.2 | 0.168 |
| 0.3 | 0.4 | 0.1 | 0.021 |
| 0.6 | 0.2 | 0.2 | 0.168 |

What is the correct rate law (速率定律式)?

(a) Rate = $k[A][B][C]$, (b) Rate = $k[A][B][C]^2$, (c) Rate = $k[A][C]$, (d) Rate = $k[A]^3[B]^2[C]$, (e) Rate = $k[A][C]^2$.

37. If equal, rigid spheres are arranged in a simple cubic lattice (立方體晶格) in the usual way, i.e., in such a way that they touch each other, what fraction of the corresponding solid will be empty space? [The volume of a sphere is $(4/3)\pi r^3$, with $\pi = 3.14$.]

(a) 0.52, (b) 0.32, (c) 0.68, (d) 0.48, (e) none of these.

38. In any cubic lattice an atom lying at the corner of a unit cell (晶胞) is shared equally by how many unit cells?

(a) 1, (b) 2, (c) 8, (d) 4, (e) 16.

39. What is the electron configuration (電子組態) of the Mn(II) ion?

(a) [Ar] $4s^2 3d^5$, (b) [Ar] $4s^1 3d^5$, (c) [Ar] $4s^2 3d^3$, (d) [Ar] $3d^5$, (e) none of these.

40. The complex (錯合物) $FeL_6^{2+}$, where L is a neutral ligand (中性配位基), is known to be diamagnetic (逆磁). The number of d electrons in this complex ion is:

(a) 4, (b) 5, (c) 6, (d) 7, (e) 8.