

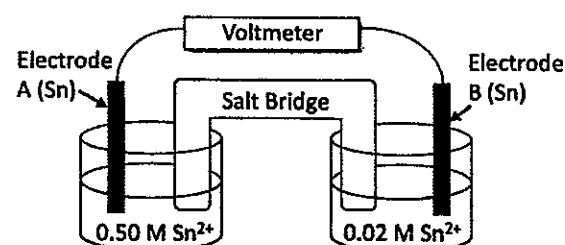
H 1.007																	He 4.002
Li 6.941	Be 9.012											B 10.81	C 12.01	N 14.00	O 15.99	F 18.99	Ne 20.18
Na 22.99	Mg 24.30											Al 26.98	Si 28.08	P 30.97	S 32.06	Cl 35.45	Ar 39.94
K 39.09	Ca 40.07	Sc 44.95	Ti 47.86	V 50.94	Cr 51.99	Mn 54.93	Fe 55.84	Co 58.93	Ni 58.69	Cu 63.54	Zn 65.38	Ga 69.72	Ge 72.64	As 74.92	Se 78.96	Br 79.90	Kr 83.79
Rb 85.46	Sr 87.62	Y 88.90	Zr 91.22	Nb 92.90	Mo 95.96	Tc -	Ru 101.0	Rh 102.9	Pd 106.4	Ag 107.8	Cd 112.4	In 114.8	Sn 118.7	Sb 121.7	Te 127.6	I 126.9	Xe 131.2
Cs 132.9	Ba 137.3	57-71	Hf 178.4	Ta 180.9	W 183.8	Re 186.2	Os 190.2	Ir 192.2	Pt 195.0	Au 196.9	Hg 200.5	Tl 204.3	Pb 207.2	Bi 208.9	Po -	At -	Rn -
Fr -	Ra -	89-103	Rf -	Db -	Sg -	Bh -	Hs -	Mt -	Ds -	Rg -	Cn -		Fl -		Lv -		

La 138.9	Ce 140.1	Pr 140.9	Nd 144.2	Pm -	Sm 150.3	Eu 151.9	Gd 157.2	Tb 158.9	Dy 162.5	Ho 164.9	Er 167.2	Tm 168.9	Yb 173.0	Lu 174.9
Ac -	Th 232.0	Pa 231.0	U 238.0	Np -	Pu -	Am -	Cm -	Bk -	Cf -	Es -	Fm -	Md -	No -	Lr -

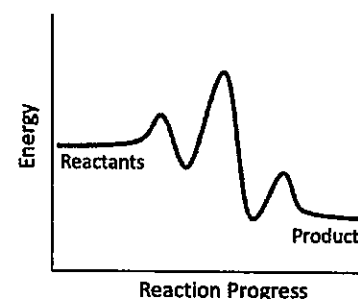
$c = 2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$ $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ $J = \text{kg}\cdot\text{m}^2\cdot\text{s}^{-2}$
 $N_A = 6.022 \times 10^{23}$ $m_e = 9.109 \times 10^{-31} \text{ kg}$ $R = 8.31446 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$

Multiple Choice – Choose one answer (10 questions) 本大題請於試卷內之「選擇題作答區」依序作答。

- Which of the following has five significant figures? (5 pts)
 a) 0.0045 b) 1.0400 c) 24300 d) (b) and (c) e) (a) (b) and (c)
- How many nodes are present in a 3s orbital? (5 pts)
 a) 0 b) 1 c) 2 d) 3 e) 4
- Which of the following statements is **true**? (5 pts)
 a) Z_{eff} is greater for valence electrons of S than for those of Si.
 b) B is smaller in size than F.
 c) S is less electronegative than Si.
 d) Cl has a lesser first ionization energy than Si.
 e) Bromide anion is smaller than fluoride anion.
- Consider this electrochemical cell and choose the **true** statement. (5 pts)
 a) Electrode A will act as the anode.
 b) No electrons will flow through this circuit as drawn.
 c) Electrons will flow through the circuit from A → B (left side to right side).
 d) E_{cell} is zero.
 e) Electrode A will gain mass over time.



- Consider a reaction with the following energy diagram. Which of the following statements is **true**? (5 pts)
 a) The overall reaction is endergonic.
 b) There are two intermediates in this reaction.
 c) The first step of this reaction is rate-limiting.
 d) Isolating transition states of this reaction could be used to identify possible reaction mechanisms.
 e) The reverse reaction has the same activation energy for its rate-limiting step as the forward reaction.



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6) Consider a vessel containing the following reaction at equilibrium: $\text{CCl}_4(\text{g}) \rightleftharpoons \text{C}(\text{s}) + 2 \text{Cl}_2(\text{g})$

Which changes would **increase** the amount of C (s) present? (5 pts)

- a) Adding $\text{Cl}_2(\text{g})$.
- b) Adding a catalyst.
- c) Doubling the volume of the reaction vessel.
- d) Increasing pressure of the vessel by adding an unreactive noble gas.
- e) None of the above.

7) Choose the **true** statement about acids and bases. (5 pts)

- a) Dilute acids are weak acids.
- b) The conjugate acid of a strong base is a strong acid.
- c) AlCl_3 is a Lewis base.
- d) Cl_3CCOOH is a stronger acid than H_3CCOOH .
- e) Metal cations cannot affect the pH of an aqueous solution.

8) The equilibrium $\text{H}_2 + \text{I}_2 \rightleftharpoons 2 \text{HI}$ has a $K_p = 617$ at a temperature of 25°C . (5 pts)

At the same temperature, what is K_p for the equilibrium $4\text{HI} \rightleftharpoons 2 \text{H}_2 + 2 \text{I}_2$?

- a) 2.63×10^{-6}
- b) 1.23×10^3
- c) 617
- d) -1.23×10^3
- e) 3.24×10^{-3}

9) Compound A undergoes isomerization to Compound B described by the equilibrium reaction:



What is the approximate ratio of the concentrations $[\text{A}] : [\text{B}]$ in solution at 25°C ? (5 pts)

- a) 1 : 3.6
- b) 1 : 38
- c) 1 : 2600
- d) 1 : 0.28
- e) 1 : 0.026

10) Which of the following salt solutions will form a precipitate if its pH is raised to 8.0? (5 pts)

- a) 0.50 M $\text{MgSO}_4(\text{aq})$ ($\text{Mg}(\text{OH})_2 : K_{sp} = 1.5 \times 10^{-11}$)
- b) 0.50 M $\text{CaCl}_2(\text{aq})$ ($\text{Ca}(\text{OH})_2 : K_{sp} = 7.9 \times 10^{-6}$)
- c) 0.50 M $\text{CrCl}_2(\text{aq})$ ($\text{Cr}(\text{OH})_2 : K_{sp} = 2.0 \times 10^{-16}$)
- d) 1.0×10^{-24} M $\text{FeCl}_3(\text{aq})$ ($\text{Fe}(\text{OH})_3 : K_{sp} = 6.3 \times 10^{-38}$)
- e) None of these solutions will form a precipitate at $\text{pH} = 8.0$

Short Answer (13 questions) 本大題請於試卷內之「非選擇題作答區」標明題號依序作答。

11) Linear n-pentane (bp = 309.4 K) has a higher boiling point than its highly branched isomer neopentane (bp = 282.7 K). Explain. (5 pts)

12) What is the empirical formula of a compound with the following composition by mass? (5 pts)

C: 54.94% H: 9.99% N: 10.68% O: 24.39%

Consider the reaction: $\text{NH}_3(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{H}_2\text{O}(\text{g})$

13) Balance the stoichiometry of the equation. (3 pts)

14) Label the oxidation states of N and O on each side of the reaction. (3 pts)

15) What is oxidized and what is reduced in this reaction? (3 pts)

Using the above reaction, if 4.00 g of NH_3 reacts with 4.50 g of O_2 :

16) What is the limiting reactant? (3 pts)

17) How many grams of NO will form? (5 pts)

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18) Draw the most reasonable Lewis structure of N_3^- . (5 pts)

19) What is the geometry of N_3^- ? (2 pts)

20) Draw a molecular orbital diagram for B_2 . (5 pts)

21) What is the bond order of B_2 ? (3 pts)

22) Would you expect B_2 to interact strongly with a magnetic field? Why or why not? (3 pts)

23) Electromagnetic radiation with a wavelength of 120 nm hits a copper metal surface (work function = 7.0×10^{-19} J). What is the maximum velocity of electrons ejected from the surface? (5 pts)

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