

8. 0.0100 mol of a transition metal chloride, MCl_3 , is first dissolved in water. Excess silver nitrate is added in order to precipitate out chloride ions as insoluble silver chloride ($M_r = 143.4$). The final mass of silver chloride is found to be 2.868 grams.

The most likely species that reacted with Ag^+ is ...

- A $[M(H_2O)_6]Cl_3$
- B $[M(H_2O)_5Cl]Cl_2$
- C $[M(H_2O)_4Cl_2]Cl$
- D $[M(H_2O)_2Cl_2]Cl$

9. The ion $[Ni(NH_3)_6]^{2+}$ is blue. Given that ammonia is higher than water in the spectroscopic series, a likely color of $[Ni(H_2O)_6]^{2+}$ would be ...

- A green
- B red
- C orange
- D yellow

10. Copper malachite is a natural mineral that contains copper(II) ions, carbonate ions and hydroxide ions; which is a reasonable formula for malachite?

- A $Cu(CO_3)(OH)$
- B $Cu_2(CO_3)(OH)_2$
- C $Cu_3(CO_3)(OH)_2$
- D $Cu_3(CO_3)_2(OH)_4$

11. Within sodium carbonate, ethanoic acid and sodium ethanoate, which species features the longest and shortest CO bonds, respectively?

- | | Longest | Shortest |
|---|------------------|------------------|
| A | Ethanoic acid | Sodium carbonate |
| B | Sodium carbonate | Sodium ethanoate |
| C | Sodium ethanoate | Sodium carbonate |
| D | Ethanoic acid | Ethanoic acid |

12. Propanone is miscible with water while hexan-1-ol is not. The best explanation is ...

- A Propanone can form dipole-dipole interaction with water but hexan-1-ol cannot
- B Propanone can form hydrogen-bonding interaction with water but hexan-1-ol cannot
- C Propanone can avoid forming hydrogen bonds with water while hexan-1-ol cannot
- D Propanone disrupts hydrogen bonding of water less severely than hexan-1-ol does

13. According to ideas of formal charges, the major resonance contributor of nitrous oxide, N_2O (N - - N - - O) contains ...

- A an $N \equiv N$ triple bond and an $N-O$ single bond.
- B an $N=N$ double bond and an $N=O$ double bond.
- C an $N=N$ double bond and an $N-O$ single bond.
- D an $N-N$ single bond and an $N=O$ triple bond.

14. The hybrid orbitals around the nitrogen atom in the molecule $\text{HN}=\text{CH}_2$ are used in all of the following ways **except** ...

- A forming a σ bond with carbon
- B forming a π bond with carbon
- C forming a σ bond with hydrogen
- D accommodating a lone pair

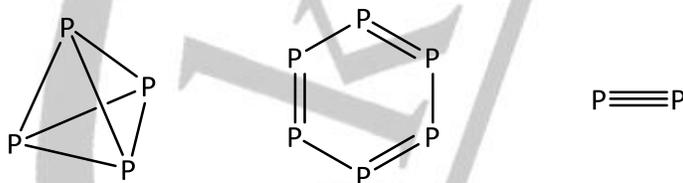
15. The best way to describe the **average** bond enthalpy of a P–F bond is to use the $\Delta H_{\text{reaction}}$ for:

- A $\text{PF}_5(\text{g}) \rightarrow \text{P}(\text{g}) + 2.5 \text{F}_2(\text{g})$
- B $0.2 \text{PF}_5(\text{g}) \rightarrow 0.2\text{P}(\text{g}) + \text{F}(\text{g})$
- C $\text{PF}_5(\text{g}) \rightarrow \text{PF}_4(\text{g}) + \text{F}(\text{g})$
- D $\text{PF}_5(\text{g}) \rightarrow \text{P}(\text{g}) + 5\text{F}(\text{g})$

16. When 50 cm^3 of $1.0 \text{ mol dm}^{-3} \text{ NaCl}(\text{aq})$ is mixed with 50 cm^3 of $1.0 \text{ mol dm}^{-3} \text{ AgNO}_3(\text{aq})$, a silver chloride precipitate is formed along with an increase in temperature of $4.8 \text{ }^\circ\text{C}$. The experiment is repeated with the same concentration and volume of $\text{AgNO}_3(\text{aq})$ as before, but this time, 100 cm^3 of $0.5 \text{ mol dm}^{-3} \text{ NaCl}(\text{aq})$ is used. The expected temperature change should be ...

- A $2.4 \text{ }^\circ\text{C}$
- B $3.2 \text{ }^\circ\text{C}$
- C $3.6 \text{ }^\circ\text{C}$
- D $4.8 \text{ }^\circ\text{C}$

17. Consider the following three allotropes of phosphorus – P_4 , P_6 and P_2 . The bond enthalpies of P–P, P=P and P≡P are 200 , 350 and 500 kJ mol^{-1} , respectively. According to bond enthalpy data alone, the enthalpic stability of these three allotropes should be in the order of ... (most stable first)



- A $\text{P}_2 > \text{P}_4 > \text{P}_6$
- B $\text{P}_6 > \text{P}_4 > \text{P}_2$
- C $\text{P}_4 > \text{P}_6 > \text{P}_2$
- D $\text{P}_2 > \text{P}_6 > \text{P}_4$

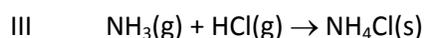
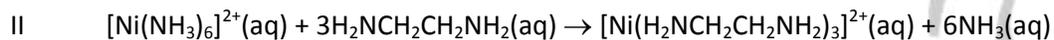
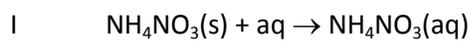
18. Given the following information:

Enthalpy of hydration of $\text{Cr}^{3+}(\text{g})$ and $\text{SO}_4^{2-}(\text{g})$ are $p \text{ kJ mol}^{-1}$ and $q \text{ kJ mol}^{-1}$, respectively
Lattice enthalpy of chromium(III) sulphate(s) (endothermic process) = $r \text{ kJ mol}^{-1}$

The enthalpy of solution of chromium(III) sulphate is ...

- A $2p + 3q - r$
- B $3p + 2q - r$
- C $r + 2p + 3q$
- D $r + 3p + 2q$

19. The following reactions all essentially go to completion at room temperature. Which of the following spontaneous reactions are entropy-driven?



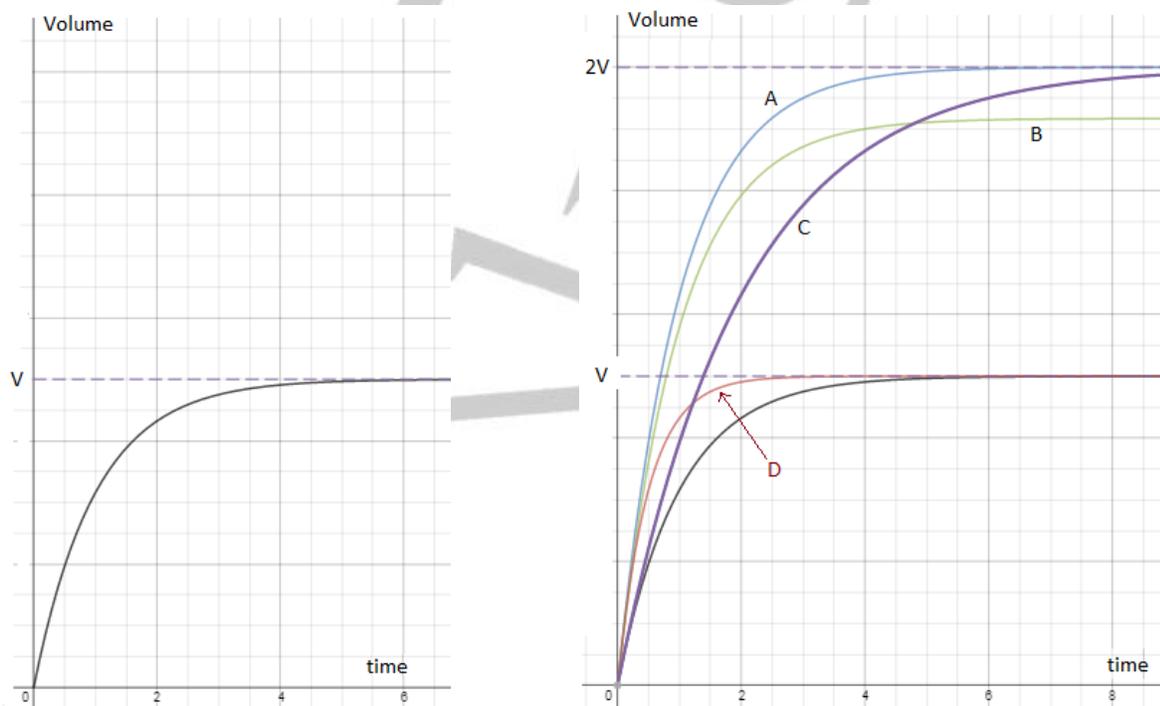
- A I and II B I and III C II and III D I, II and III

20. The activation energy and enthalpy for the single-step reaction $\text{A} \rightarrow \text{B}$ is $+m$ and $+n$ kJ per mole, respectively. What is the activation energy for the backward reaction?

- A m
 B $-m + n$
 C $m - n$
 D $m + n$

21. 0.60 grams of Zn ($A_r = 65.4$) are added to 100 cm^3 of a 0.10 mol dm^{-3} HCl solution, and the volume of H_2 gas collected was monitored (graph to the left).

The experiment was repeated with 100 cm^3 of a 0.20 mol dm^{-3} HCl solution, with all other factors kept constant. How should the new volume(H_2) vs time graph (diagram to the right) look like?



22. Consider the following data obtained for the reaction $A + B \rightarrow C$:

Run	[A] (mol dm ⁻³)	[B] (mol dm ⁻³)	Time to increase [C] from 0 to 0.001 mol dm ⁻³ (s)
1	0.050	0.150	132
2	0.150	0.150	44
3	0.200	0.090	55

The overall order of the reaction is

- A 1 B 2 C 3 D 4

23. The time required for a sulphur precipitate to turn the reaction mixture cloudy during the reaction



is measured at various temperatures. How can a plot of $\ln(\text{time required})$ vs $\frac{1}{T}$ provide you information about parameters in the Arrhenius equation?

- | | | |
|---|----------------------------------|---|
| | E_a can be calculated from ... | A (Arrhenius constant) is deduced using ... |
| A | gradient \times R | insufficient information |
| B | -gradient \times R | insufficient information |
| C | -gradient \times R | $e^{(\text{y-intercept})}$ |
| D | insufficient information | insufficient information |

24. An equilibrium is established between $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$, where $[\text{H}_2] = x \text{ mol dm}^{-3}$, $[\text{I}_2] = y \text{ mol dm}^{-3}$ and $[\text{HI}] = z \text{ mol dm}^{-3}$. The equilibrium is now disturbed by removing a small amount of I_2 . When a new equilibrium is established, the new equilibrium concentrations of each species will be ...

- | | $[\text{H}_2]$ | $[\text{I}_2]$ | $[\text{HI}]$ |
|---|----------------|----------------|---------------|
| A | $< x$ | $< y$ | $> z$ |
| B | $< x$ | $> y$ | $< z$ |
| C | $> x$ | $< y$ | $< z$ |
| D | $> x$ | $> y$ | $< z$ |

25. The gaseous equilibrium $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$ is established within a syringe when the gas is suddenly compressed. The values of Q and K_c , respectively, have

- | | Q | K_c |
|---|-----------|-------------|
| A | increased | increased |
| B | decreased | not changed |
| C | increased | not changed |
| D | decreased | decreased |

26. The following equilibrium has been established in a 1.0 dm^3 solution:
 $\text{P(aq)} \rightleftharpoons \text{Q(aq)}$
with $[\text{P}] = 1.2 \text{ mol dm}^{-3}$ and $[\text{Q}] = 1.8 \text{ mol dm}^{-3}$. The equilibrium is now disturbed by the addition of 1.0 mol of P. When equilibrium is re-established, the equilibrium concentration of P is
- A 1.2 mol dm^{-3} B 1.6 mol dm^{-3}
C 2.0 mol dm^{-3} D 2.4 mol dm^{-3}
27. The pH of water at 60°C is 6.4; the pOH of water at the same temperature is ...
- A 6.4
B 7.0
C 7.6
D 13.4
28. $1.28 \times 10^6 \text{ g}$ of hydrogen iodide, a strong acid (molar mass = 128 g mol^{-1}), is dissolved in 10 dm^3 of water. The resulting pH of the solution is closest to
- A 1
B 5
C 7
D 9
29. The pK_a of a weak acid HA is 4.40. The pH of a 0.10 mol dm^{-3} solution of HA has an approximate pH of ...
- A 2.20
B 2.70
C 3.40
D 4.40
30. The value of K_a for HPO_4^{2-} is 10^{-11} . Based on this information, the value of K_b of which of the following species is 10^{-3} ?
- A H_3PO_4
B H_2PO_4^-
C HPO_4^{2-}
D PO_4^{3-}

31. Which of the following reaction involves the oxidation of chromium?

- A $\text{CrO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CrO}_4$
- B $\text{Cr}(\text{OH})_3 + 6 \text{F}^- \rightarrow \text{CrF}_6^{3-} + 3 \text{OH}^-$
- C $\text{Cr}_2\text{O}_7^{2-} + 2 \text{OH}^- \rightarrow 2 \text{CrO}_4^{2-} + \text{H}_2\text{O}$
- D $\text{CrCl}_2 + 2 \text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{CrO}_4 + 2 \text{HCl}$

32. When reacted with concentrated nitric acid, silver dissolves and forms silver nitrate, nitrogen dioxide and water. Choose the correct entry that describes the reaction:

- | | Role of silver | Role of nitric acid |
|---|-----------------|---------------------|
| A | Base | Proton donor |
| B | Oxidizing agent | Proton donor |
| C | Reducing agent | Hydrogen is reduced |
| D | Reducing agent | Nitrogen is reduced |

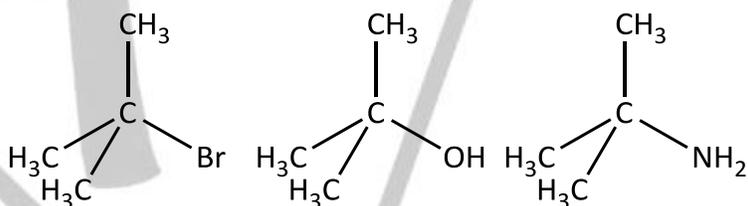
33. 39.00 cm^3 of 0.10 mol dm^{-3} solution of molybdenum(III) chloride, MoCl_3 , exactly reacted with 13.00 cm^3 of acidified 0.20 mol dm^{-3} KMnO_4 to form a dark brown MnO_2 precipitate. The final oxidation state of molybdenum is most likely ...

- A +2 B +4 C +5 D +6

34. The following solutions are electrolyzed for the same amount of time using the same current; which solution will yield the largest mass of metal? (A: Au = 197, Zn = 65.5, Cu = 63.5, Cd = 112)

- A gold(III) nitrate
- B zinc nitrate
- C copper(I) nitrate
- D cadmium(II) nitrate

35. Classify the following compounds:



- A tertiary bromoalkane, tertiary alcohol, tertiary amine
- B tertiary bromoalkane, tertiary alcohol, primary amine
- C tertiary bromoalkane, primary alcohol, primary amine
- D primary bromoalkane, primary alcohol, primary amine

36. Compounds P and Q belong to the same homologous series and differ by 3 carbons in length. The difference in molecular mass of P and Q is.....
- A 36
B 39
C 42
D 44
37. In the presence of UV light, propene and ethene can react with a maximum of X molecules and Y molecules of bromine, respectively. What is the ratio X : Y?
- A 1 : 1
B 4 : 3
C 3 : 2
D 7 : 5
38. 3-methylcyclohexene will exhibit which kind(s) of stereoisomerism?
- | | Cis-trans isomerism | Optical isomerism |
|---|---------------------|-------------------|
| A | Yes | Yes |
| B | Yes | No |
| C | No | Yes |
| D | No | No |
39. The high-resolution ^1H NMR spectrum of 1,2-dichloroethane should exhibit.....
- A 1 singlet
B 2 singlets
C 1 set of triplet
D 2 sets of triplets
40. Which substance will not possess a peak in the 1650 cm^{-1} (alkene) region of its IR spectrum?
- A Ethene
B Propene
C 2-methylpropene
D But-1-ene