A-Level Chemistry

Transition Metals (Multiple Choice)

Question Paper

Time available: 32 minutes
Marks available: 30 marks

1. Which equation does **not** show the reduction of a transition metal?

A $TiCl_4 + 2\ Mg \rightarrow Ti + 2\ MgCl_2$ ⬭

B $2\ FeCl_3 + 2\ KI \rightarrow 2\ FeCl_2 + 2\ KCl + I_2$ ⬭

C $MnO_2 + 4\ HCl \rightarrow MnCl_2 + Cl_2 + 2\ H_2O$ ⬭

D $CoO + 4\ HCl \rightarrow [CoCl_4]^{2-} + H_2O + 2\ H^+$ ⬭

(Total 1 mark)

2. Which shows the electron configuration of an atom of a transition metal?

A $[Ar]\ 4s^2 3d^0$ ⬭

B $[Ar]\ 4s^2 3d^8$ ⬭

C $[Ar]\ 4s^2 3d^{10}$ ⬭

D $[Ar]\ 4s^2 3d^{10} 4p^1$ ⬭

(Total 1 mark)

3. Which will **not** act as a ligand in the formation of a complex ion?

A CH_4 ⬭

B CO ⬭

C H_2O ⬭

D NH_3 ⬭

(Total 1 mark)

4. Which shows the correct oxidation state and co-ordination number of cobalt in $[Co(NH_3)_5Cl]Cl_2$?

	oxidation state	co-ordination number	
A	+2	5	⬭
B	+2	6	⬭
C	+3	5	⬭
D	+3	6	⬭

(Total 1 mark)

5. Which statement is **not** correct?

A $CuCl_4^{2-}$ is square planar. ⬭

B NH_4^+ is tetrahedral. ⬭

C $[Co(H_2NCH_2CH_2NH_2)_3]^{2+}$ is octahedral. ⬭

D $[Fe(H_2O)_6]^{2+}$ is octahedral. ⬭

(Total 1 mark)

6. Cobalt(II) chloride solution changes colour when an excess of concentrated hydrochloric acid is added.

What type of reaction takes place?

A hydrolysis ⬭

B ligand substitution ⬭

C precipitation ⬭

D redox ⬭

(Total 1 mark)

7. The oxidation of ethanedioate (*oxalate*) ions by manganate(VII) ions can be represented by the half equations:

$$C_2O_4^{2-}(aq) \rightarrow 2CO_2(g) + 2e^-$$

$$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$$

What volume (in cm^3) of 0.02 M $KMnO_4$ is required to oxidise completely a solution containing 0.02 mol of ethanedioate ions?

A 25

B 40

C 250

D 400

(Total 1 mark)

8. Which one of the following electronic configurations is that of a transition element?

A [Ar] $4s^2 3d^{10}$

B [Ar] $4s^2 3d^9$

C [A] $4s^2 3d^0$

D [Ar] $4s^2 3d^{10} 4p^1$

(Total 1 mark)

9. When vanadium reacts with chlorine at 400°C, a brown compound is obtained. When an aqueous solution containing 0.193 g of this compound was treated with aqueous silver nitrate all the chlorine in the compound was precipitated as silver chloride. The mass of silver chloride (AgCl) produced was 0.574 g. Which one of the following could be the formula of the brown compound?

A VCl

B VCl_2

C VCl_3

D VCl_4

(Total 1 mark)

10. In which one of the following reactions does the metal species undergo reduction?

A $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

B $[Cu(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CuCl_4]^{2-} + 6H_2O$

C $CrO_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$

D $TiO_2 + 2C + 2Cl_2 \rightarrow TiCl_4 + 2CO$

(Total 1 mark)

11. Which one of the following statements is true?

A A blue solution containing the ion $[CoCl_4]^{2-}$ turns pink when added to an excess of water.

B A purple solution is formed when chlorine is bubbled into aqueous sodium bromide.

C A yellow precipitate is formed when aqueous silver nitrate is added to aqueous sodium chloride.

D A green solution containing the ion $[CuCl_4]^{2-}$ turns blue when added to an excess of concentrated hydrochloric acid.

(Total 1 mark)

12. Which of the species given below can behave as ligands?

NH_2^- NH_3 NH_4^+

A all three

B only NH_3

C NH_3 and NH_4^+

D NH_2^- and NH_3

(Total 1 mark)

13. The percentage of iron in a sample of impure iron(II) sulphate crystals can be determined by titrating solutions, made from separate weighed samples acidified with dilute sulphuric acid, against a standard solution of potassium manganate(VII).

Which one of the following would lead to the greatest error in the calculation of the percentage of iron(II) in the sample?

A an error of 0.005 g made when weighing out a sample of mass 0.987 g

B an end-point error of 0.1 cm^3 in 25.0 cm^3

C an error of 5 cm^3 when measuring out 25.0 cm^3 of dilute sulphuric acid

D using the average of the titration values 25.4, 25.7 and 25.9 when the correct value is 25.5 cm^3

(Total 1 mark)

14. The percentage of iron in a sample of impure iron(II) sulphate crystals can be determined by titrating solutions, made from separate weighed samples acidified with dilute sulphuric acid, against a standard solution of potassium manganate(VII).

Which one of the following would lead to an inaccurate result?

A transferring the weighed sample of iron(II) sulphate into a wet conical flask

B failing to measure accurately the volume of water used to dissolve each weighed sample of iron(II) sulphate

C transferring the standard solution of potassium manganate(VII) from its original container to the burette using a wet beaker

D failing to measure accurately the volume of dilute sulphuric acid added to the mixture before titration

(Total 1 mark)

15. The percentage of iron in a sample of impure iron(II) sulphate crystals can be determined by titrating solutions, made from separate weighed samples acidified with dilute sulphuric acid, against a standard solution of potassium manganate(VII).

Which one of the following statements explains why dilute hydrochloric acid is unsuitable for use in this titration?

A HCl will oxidise Fe^{2+} to Fe^{3+}

B Cl^- will reduce Fe^{3+} to Fe^{2+}

C Cl^- will reduce MnO_4^-

D HCl is a strong acid

(Total 1 mark)

16. Aqueous $C_2O_4^{2-}$ ions react with MnO_4^- ions in acidic solution according to the equation

$$5\ C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Under the same conditions Fe^{2+} ions also react with MnO_4^- ions. How many moles of MnO_4^- ions are required to react exactly with one mole of $Fe(C_2O_4).2H_2O$?

A 0.4

B 0.6

C 2.5

D 7.5

(Total 1 mark)

17. Which one of the following can act as an oxidising agent but not as a reducing agent?

A CH_3CHO

B Fe^{2+}

C I^-

D MnO_4^-

(Total 1 mark)

18. Which one of the following statements about the reaction below is **false**?

$$[Cu(H_2O)_6]^{2+} + EDTA^{4-} \rightleftharpoons [Cu(EDTA)]^{2-} + 6H_2O$$

A $[Cu(EDTA)]^{2-}$ is a more stable complex than $[Cu(H_2O)_6]^{2+}$

B Both $[Cu(H_2O)_6]^{2+}$ and $[Cu(EDTA)]^{2-}$ are octahedral complexes.

C There is an increase in entropy when the reaction occurs.

D There is a redox reaction.

(Total 1 mark)

19. Which one of the following would **not** react with aqueous silver nitrate to produce a precipitate that is soluble in concentrated aqueous ammonia?

A $CaBr_2$

B $[COCl_4]^{2-}$

C $(CH_3)_4N^+I^-$

D CH_3COCl

(Total 1 mark)

20. Which one of the following would **not** reduce an acidified aqueous solution of potassium dichromate(VI)?

A CH_3COOH

B Zn

C CH_3CHO

D $Fe^{2+}(aq)$

(Total 1 mark)

21. In the table below, which one of the following complex ions has a correct shape, co-ordination number and oxidation state?

	Complex	Shape	Co-ordination number	Oxidation state of central cation
A	$[Ag(CN)_2]^-$	Linear	2	–1
B	$[CuCl_4]^{2-}$	Tetrahedral	4	–2
C	$[Cr(C_2O_4)_3]^{3-}$	Octahedral	3	+3
D	$[Cu(NH_3)_4(H_2O)_2]^{2+}$	Octahedral	6	+2

(Total 1 mark)

22. Which one of the following could **not** act as a ligand?

A F^-

B CH_3CH_3

C NH_2NH_2

D CH_3OCH_3

(Total 1 mark)

23. What is the electron configuration of Cu^{2+}?

A $[Ar]3d^94s^2$ ⬭

B $[Ar]3d^{10}4s^1$ ⬭

C $[Ar]3d^9$ ⬭

D $[Ar]3d^{10}$ ⬭

(Total 1 mark)

24. Electrons in copper(II) ions can be excited by the absorption of light with a wavelength of 600 nm.

What is the increase in energy, in J, for each electron excited?

Speed of light, $c = 3.00 \times 10^{8}$ m s^{-1}
Planck's constant, $h = 6.63 \times 10^{-34}$ J s

A 3.98×10^{-40} ○

B 1.33×10^{-39} ○

C 3.32×10^{-28} ○

D 3.32×10^{-19} ○

(Total 1 mark)

25. A solution absorbs light with wavelengths corresponding to red, yellow and green light.

Which ion is most likely to be in the solution?

A $Cr_2O_7^{2-}(aq)$ ○

B $Fe^{2+}(aq)$ ○

C $Fe^{3+}(aq)$ ○

D $Cu^{2+}(aq)$ ○

(Total 1 mark)

26. Which is **not** a correct statement?

A Transition metals form coloured ions and complexes ○

B Transition metals display variable oxidation states ○

C A ligand accepts a pair of electrons from a transition metal ○

D A complex is a central metal atom or ion surrounded by ligands ○

(Total 1 mark)

27. Which complex exists as optical isomers?

A $[Ag(NH_3)_2]^+$ ⬭

B $[Co(C_2O_4)_3]^{4-}$ ⬭

C $[Cu(EDTA)]^{2-}$ ⬭

D $[Cu(NH_3)_4(H_2O)_2]^{2+}$ ⬭

(Total 1 mark)

28. Which statement is correct about this reaction?

$$[Co(NH_3)6]^{2+} + 3H_2NCH_2CH_2NH_2 \rightarrow [Co(H_2NCH_2CH_2NH_2)_3]^{2+} + 6NH_3$$

A The co-ordination number of cobalt decreases. ⬭

B The enthalpy change is large and positive. ⬭

C The entropy change is large and positive. ⬭

D The shape of the complex changes from octahedral. ⬭

(Total 1 mark)

29. What is observed when concentrated hydrochloric acid is added to an aqueous solution of $CuSO_4$until no further change occurs?

A A colourless gas is evolved and a precipitate forms. ⬭

B A colourless gas is evolved and no precipitate forms. ⬭

C A precipitate forms that dissolves in an excess of concentrated hydrochloric acid. ⬭

D The solution changes colour and no precipitate forms. ⬭

(Total 1 mark)

30. Which compound decolourises acidified potassium manganate(VII) solution?

A $Al_2(SO_4)_3$ ⬭

B $CuSO_4$ ⬭

C $FeSO_4$ ⬭

D $Fe_2(SO_4)_3$ ⬭

(Total 1 mark)