INKCHEMISTRY FLASHCARDS

Transition metals

Unit C14 · 50 cards · fronts and backs

Print double-sided, flipping on the long edge, and each answer lands behind its question. Cut along the card borders.

Definitions to learn and misconceptions to correct. These cards, and a check-yourself question for every lesson, run on the website with spaced-repetition scheduling, at inklearning.co.uk/chemistry/flashcards.

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DEFINITION

Define: Transition metal.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: D-block element.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Ligand.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Coordinate bond.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Complex.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Coordination number.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Monodentate ligand.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Bidentate ligand.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

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DEFINITION

An element whose highest-energy electron is in a d subshell; scandium to zinc in Period 4.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

An element that forms at least one stable ion with an incomplete d subshell.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A covalent bond in which both electrons of the shared pair come from the same atom.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A molecule or ion that forms a coordinate bond with a transition metal ion by donating a pair of electrons.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

The number of coordinate bonds from the ligands to the central metal atom or ion.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A central metal atom or ion surrounded by ligands bonded to it by coordinate bonds.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A ligand that forms two coordinate bonds to the same metal ion, such as ethane-1,2-diamine or the ethanedioate ion.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A ligand that forms one coordinate bond to a metal ion, such as water, ammonia or the chloride ion.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

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DEFINITION

Define: Multidentate ligand.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

SPOT THE ERROR

Say what is wrong with this claim:

Every metal in the middle block of the periodic table is a transition metal, so zinc must be one.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

Define: Octahedral complex.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Tetrahedral complex.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Square planar complex.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Ligand substitution.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Stereoisomers.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Cis–trans isomers.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

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SPOT THE ERROR

A transition metal forms at least one stable ion with a partly filled d subshell. Zinc's only ion, Zn^{2+}, is [Ar] $3d^{10}$, full, so its compounds are white and it has one oxidation state. Scandium's only ion, Sc^{3+}, is $3d^{0}$, empty. Both sit in the d block and neither is a transition metal; titanium to copper are.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A ligand that forms more than two coordinate bonds to the same metal ion, such as $EDTA^{4-}$, which forms six.

TRANSITION METAL CHARACTERISTICS AND COMPLEX FORMATION

DEFINITION

A complex with four coordinate bonds pointing to the corners of a tetrahedron, with bond angles of 109.5°.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

A complex with six coordinate bonds pointing to the corners of an octahedron, with bond angles of 90°.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

A reaction in which one or more ligands in a complex are replaced by different ligands.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

A complex with four coordinate bonds pointing to the corners of a square round the metal, with bond angles of 90°.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Stereoisomers of a complex in which two identical ligands are adjacent, 90° apart, in the cis isomer and opposite, 180° apart, in the trans isomer.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Compounds with the same structural formula but a different arrangement of their atoms in space.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

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DEFINITION

Define: Optical isomers.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Chelate effect.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Stability constant.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

SPOT THE ERROR

Say what is wrong with this claim:

A bidentate ligand pushes water out of a complex because its bonds to the metal are stronger.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Define: Complementary colours.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Transmitted light.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: D-orbital splitting.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Ground state.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

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DEFINITION

The replacement of monodentate ligands by bidentate or multidentate ligands, favoured because the number of particles increases and so the entropy increases.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

Stereoisomers that are non-superimposable mirror images of each other.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

SPOT THE ERROR

The bonds are much the same; the driving force is entropy. $[Cu(H_2O)_6]^{2+}$ and three ethane-1,2-diamine molecules, four particles, give $[Cu(en)_3]^{2+}$ and six waters, seven particles, so ΔS is large and positive, ΔH is close to zero, and ΔG is negative. This is the chelate effect.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

The equilibrium constant for the formation of a complex ion from the aqua ion in aqueous solution; the larger the value, the more stable the complex.

LIGANDS, THE SHAPES OF COMPLEXES, ISOMERISM AND LIGAND SUBSTITUTION

DEFINITION

The light that passes through a sample without being absorbed; its colour is the colour the sample appears.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Two colours of light that together make white light; a substance that absorbs one appears the other.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

The lowest-energy arrangement of the electrons in an atom or ion.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

The separation of the five d orbitals of a metal ion into groups of different energy by the lone pairs of the ligands; the gap between the groups is ΔE.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

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DEFINITION

Define: Excited state.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Colorimeter.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Absorbance.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Calibration curve.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

SPOT THE ERROR

Say what is wrong with this claim:

A blue solution is blue because it absorbs blue light.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

Define: Oxidation state.

VARIABLE OXIDATION STATES

DEFINITION

Define: Oxidising agent.

VARIABLE OXIDATION STATES

DEFINITION

Define: Reducing agent.

VARIABLE OXIDATION STATES

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DEFINITION

An instrument that measures the absorbance of a solution for light of a chosen colour, selected by a filter.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

An arrangement of the electrons at higher energy than the ground state, reached when an electron absorbs energy and moves to a higher orbital.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

A graph of a measured quantity, here absorbance, against the known concentrations of standard solutions, used to find an unknown concentration.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

A measure of how much light of a given wavelength a sample absorbs, proportional to the concentration of the absorbing species.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

The charge an atom would have if all its bonds were ionic, used to follow the electrons in a redox reaction.

VARIABLE OXIDATION STATES

SPOT THE ERROR

A solution has the colour of the light it lets through. $[Cu(H_2O)_6]^{2+}$ absorbs orange and red light, promoting a 3d electron to the higher of the split d orbitals, and transmits blue. Change the ligand and the gap between the orbitals changes, so a different colour is absorbed and a different one is seen.

COLOUR IN TRANSITION METAL COMPLEXES AND COLORIMETRY

DEFINITION

A species that donates electrons to another species and is itself oxidised.

VARIABLE OXIDATION STATES

DEFINITION

A species that accepts electrons from another species and is itself reduced.

VARIABLE OXIDATION STATES

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DEFINITION

Define: E°cell.

VARIABLE OXIDATION STATES

DEFINITION

Define: End point.

VARIABLE OXIDATION STATES

DEFINITION

Define: Self-indicating titration.

VARIABLE OXIDATION STATES

DEFINITION

Define: Concordant titres.

VARIABLE OXIDATION STATES

DEFINITION

Define: Standard electrode potential.

VARIABLE OXIDATION STATES

DEFINITION

Define: Amphoteric.

VARIABLE OXIDATION STATES

SPOT THE ERROR

Say what is wrong with this claim:

The green colour partway through reducing vanadium(V) with zinc is vanadium(III), because vanadium(III) is green.

VARIABLE OXIDATION STATES

DEFINITION

Define: Catalyst.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

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DEFINITION

The point in a titration at which a colour change shows that the reaction is just complete.

VARIABLE OXIDATION STATES

DEFINITION

The EMF of a cell under standard conditions, equal to E° of the couple being reduced minus E° of the couple being oxidised; a positive value means the reaction is feasible.

VARIABLE OXIDATION STATES

DEFINITION

Titres that agree within 0.10 cm^3 of each other; their mean is used in the calculation.

VARIABLE OXIDATION STATES

DEFINITION

A titration in which a reactant changes colour at the end point, so no separate indicator is needed.

VARIABLE OXIDATION STATES

DEFINITION

Able to react both as an acid and as a base, as chromium(III) hydroxide does with acids and with excess sodium hydroxide.

VARIABLE OXIDATION STATES

DEFINITION

The EMF of a half-cell measured against the standard hydrogen electrode under standard conditions of 298 K, 100 kPa and 1.00 mol dm^{-3} solutions.

VARIABLE OXIDATION STATES

DEFINITION

A substance that increases the rate of a reaction by providing an alternative route with a lower activation energy, and is chemically unchanged at the end.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

SPOT THE ERROR

The first green is a mixture: yellow VO_2^+, vanadium(V), still present alongside the blue VO^{2+}, vanadium(IV), that zinc has just made. Yellow and blue together look green. The solution then turns pure blue, and only after that does the green of V^{3+} appear, followed by the violet of V^{2+}.

VARIABLE OXIDATION STATES

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DEFINITION

Define: Heterogeneous catalyst.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Homogeneous catalyst.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Adsorption.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Desorption.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Active site.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Support medium.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Catalyst poisoning.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Define: Intermediate.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

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DEFINITION

A catalyst in the same phase as the reactants.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

A catalyst in a different phase from the reactants.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

The breaking of the bonds between product molecules and a catalyst surface, which releases the products.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

The formation of weak bonds between reactant molecules and atoms on the surface of a solid.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

An unreactive material with a large surface area over which a thin layer of catalyst is spread, to increase the surface area for each gram of catalyst.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

A place on the surface of a heterogeneous catalyst where reactant molecules are adsorbed and react.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

A species formed in one step of a reaction and used up in a later step, so it does not appear in the overall equation.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

The loss of catalytic activity when an impurity is strongly adsorbed onto the active sites, blocking them to the reactants.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

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DEFINITION

Define: Autocatalysis.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

SPOT THE ERROR

Say what is wrong with this claim:

A catalyst takes no part in the reaction; it just sits there and makes it go faster.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

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SPOT THE ERROR

A catalyst reacts and is then regenerated. Fe^{2+} catalysing the peroxodisulfate and iodide reaction is oxidised to Fe^{3+} by $S_2O_8^{2-}$ and reduced back by I^-: two steps between oppositely charged ions in place of one between ions that repel, so the activation energy is lower.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

DEFINITION

Catalysis of a reaction by one of its own products, so that the rate increases as the product forms.

CATALYSIS: HETEROGENEOUS, HOMOGENEOUS AND AUTOCATALYTIC

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