

Time remaining: 59:50

EChemTest - Inorganic Chemistry 3

Welcome ...

1 of 30

Which of the following ions has the smallest radius ?

- ☐ Ca^{2+}
- ☐ Ag^{+}
- ☐ Cr^{3+}
- ☐ Na^{+}
- ☐ O_2^{2-}

2 of 30

Which of the following statements are true for a triple bond ?

- ☐ It is stronger and longer than a double bond.
- ☐ It is weaker and shorter than a double bond.
- ☐ It is weaker and longer than a double bond.
- ☐ It is stronger and shorter than a single bond.
- ☐ It is stronger and shorter than a double bond.

3 of 30

The molecule of BCl_3 , in its equilibrium configuration, is planar, with 120° between the bonds.

The symmetry elements possessed by this molecule are:

Where:

E = identity ; **C_n** = **n**-fold axis ; **s** = plane ;

S_n = improper axis order **n** ; **h**, **v** = horizontal, vertical.

- ☐ $\text{E}, 2\text{C}_2, 3\text{C}_3, s_h, 3s_v, S_3$
- ☐ $\text{E}, 2\text{C}_2, 3\text{C}_3, s_h, 3s_v, 2S_3$

- ☐ E , 2C₃ , 3C₂ , s_h , 3s_v , 2S₃
 - ☐ E , 3C₂ , 3C₃ , s_h , 3s_v , 2S₃
 - ☐ E , 2C₂ , 3C₃ , 3s_h , s_v , 2S₃
-

4 of 30

The compound **K₂[OsCl₅N]** has the systematic name:

- ☐ Potassium azidopentachloroosmate(VI)
 - ☐ Potassium chlorohydrazidoosmate(V)
 - ☐ Potassium pentachloronitridoosmate(VI)
 - ☐ Potassium amidopentachloroosmate(VI)
 - ☐ Potassium pentachloronitridoosmate(VIII)
-

5 of 30

Which of the following stereochemistries are possible for a metal complex of the general formula **MX₂Y₂**?

- ☐ tetrahedral and octahedral
 - ☐ square planar and octahedral
 - ☐ linear and tetrahedral
 - ☐ tetrahedral and square planar
 - ☐ trigonal planar and tetrahedral
-

6 of 30

When hydrides of the alkali metals are treated with water, one of the final products will be:

- ☐ H⁺
 - ☐ H⁻
 - ☐ O₂
 - ☐ H₂
 - ☐ There is no reaction
-

7 of 30

When **PBr₅** is treated with water, the products will be:

- ☐ H₃PO₃ and HBr
 - ☐ H₃PO₂ and HBr
 - ☐ H₃PO₄ and HBr
 - ☐ H₂P₂O₇ and HBr
 - ☐ P₄O₁₀ and Br₂
-

8 of 30

Of the following statements about fluorine, which is not true?

- ☐ It is a small atom.
 - ☐ The F-F bond has a low enthalpy.
 - ☐ It has a high electronegativity.
 - ☐ It forms a series of compounds with the other halogens.
 - ☐ It produces low oxidation states in the elements with which it reacts.
-

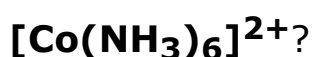
9 of 30

Of the following pairs of transition metals, which has atoms of about the same metallic radius?

- ☐ Ti and Ca
 - ☐ Cr and Mo
 - ☐ Ta and Ir
 - ☐ Ni and Pd
 - ☐ Zr and Hf
-

10 of 30

How many unpaired electrons would you expect to find in the cation



Type your answer in the answer box:

11 of 30

For many ligand substitution reactions of octahedral complexes, it has been found that the rate has little dependence on the nature of the incoming ligand, and varies only slightly with spectator ligands of similar steric demand but differing electronic influence.

This suggests:

- ☐ That all octahedral complexes react at the same rate.
 - ☐ That the rate determining step is associative.
 - ☐ That rates are not related to mechanisms.
 - ☐ That electronic effects are of no importance in the mechanism.
 - ☐ That the rate determining step is dissociative.
-

12 of 30

Which of the following is a correct statement about Lewis acids and bases?

- ☐ A Lewis acid is an electron pair acceptor and a Lewis base is an electron pair donor.
 - ☐ A Lewis acid and a Lewis base both accept electron pairs.
 - ☐ A Lewis acid is a proton donor and a Lewis base is a proton acceptor.
 - ☐ A Lewis acid is both a proton donor and an electron donor.
 - ☐ A Lewis acid and a Lewis base both donate protons.
-

13 of 30

Which of the following groups of organometallic compounds are all electron deficient (or involve multicentre orbitals)?

- ☐ Alkyls of the transition metals.
- ☐ Tetraalkyls of Ti, Zr and Hf.
- ☐ Alkyls of the lithium and beryllium groups.

- ☐ The organic compounds of mercury.
 - ☐ Alkyls of boron and silicon.
-

14 of 30

The common orthorhombic form of elemental sulphur has a structure consisting of:

- ☐ Planar 6-membered rings.
 - ☐ Three-dimensional cages.
 - ☐ Puckered 5-membered rings.
 - ☐ Crown-like 8-membered rings.
 - ☐ Cross-linked polymers.
-

15 of 30

With which group of functions is iron associated in biological systems?

- ☐ Bone formation and repair.
 - ☐ Protein synthesis and hydrolysis.
 - ☐ Molecular rearrangement reactions.
 - ☐ Storage and transport of oxygen, redox reactions.
 - ☐ Synthesis of fatty acids and vitamins.
-

16 of 30

For some dioxygen species the **O-O** bond lengths are:

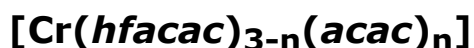
112 pm ; 121 pm ; 126 pm ; 149 pm

In which of the following orders are the distances as given ?

- ☐ O_2^- , O_2^{2-} , O_2^+ , O_2
- ☐ O_2^+ , O_2 , O_2^- , O_2^{2-}
- ☐ O_2^{2-} , O_2^- , O_2 , O_2^+
- ☐ O_2^+ , O_2^{2-} , O_2^- , O_2
- ☐ O_2 , O_2^- , O_2^{2-} , O_2^+

17 of 30

How many isomeric species of all types can be made for an octahedral chromium species of the formula



in which "acac" is the ligand $\text{MeCOCH}_2\text{COMe}$, and "hfacac" is $\text{CF}_3\text{COCH}_2\text{COCF}_3$?

- ☐ 4
☐ 5
☐ 6
☐ 7
☐ 8

18 of 30

The heats of dissociation of amine adducts of trimethyl boron [**BMe₃**] with the following amines are given as:



These values are best rationalised as which of the following?

- ☐ Mainly steric in origin.
☐ Mainly electronic (inductive) in origin.
☐ Due to hybridisation changes on **B**.
☐ A combination of steric and electronic effects.
☐ Due to resonance effects.

19 of 30

In the **¹¹⁹Sn** NMR spectrum, **SnCl₄** has a shift of 150 ppm, and **SnBr₄** has a shift of 638 ppm, relative to tetramethyltin. When the two are mixed the NMR shows peaks at the following positions, with the intensities indicated in brackets:

150 **(1)** ; 265 **(4)** ; 387 **(6)** ; 509 **(4)** ; 635 **(1)**

The explanation is:

- ☐ Reaction with the solvent.
 - ☐ Formation of donor-acceptor complexes between the species.
 - ☐ Partial hydrolysis due to impurities in the mixture.
 - ☐ Formation of complex cluster molecules.
 - ☐ Statistical formation of exchanged species **SnBr_nCl_{4-n}** by redistribution.
-

20 of 30

Which of the following statements about thionyl chloride **SOCl₂** are true?

- ☐ It can be prepared from **SO₂** and **PCl₅**.
 - ☐ It hydrolyses readily to **HCl** and **SO₂**.
 - ☐ The **S-O** bond has double bond character.
 - ☐ It is both a Lewis acid and a Lewis base.
 - ☐ It is a useful reagent for dehydrating metal salts.
-

21 of 30

The structures of the species **[Ni(CN)₄]²⁻**, **[NiCl₄]²⁻**, and **[Ni(CO)₄]** are respectively:

- ☐ Tetrahedral, square planar, tetrahedral.
 - ☐ Square planar, tetrahedral, tetrahedral.
 - ☐ Tetrahedral, octahedral, square planar.
 - ☐ Square planar, octahedral, tetrahedral.
 - ☐ Tetrahedral, tetrahedral, square planar.
-

22 of 30

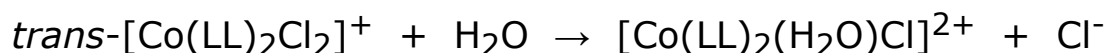
Which of the following statements about the two complexes **[Co(en)(OH₂)₄]²⁺ (A)** , and **[Co(NH₃)₂(OH₂)₄]²⁺ (B)** , is true ?

(*en* = H₂NCH₂CH₂NH₂)

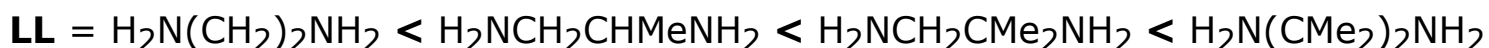
- ☐ **B** is more stable because ammonia binds more strongly than ethylenediamine.
- ☐ We cannot say because it depends on the stereochemistry of the complexes.
- ☐ **A** is more stable because the bond enthalpies are significantly higher.
- ☐ **A** is more stable due to the chelate effect which is entropic in origin.
- ☐ They have very similar stabilities as the nature of the bonds is very similar in both complexes.

23 of 30

For the reaction:



the rate increases in the series:

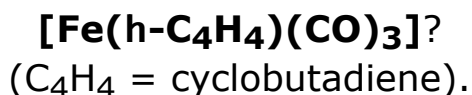


This is because:

- ☐ The chloride destabilises the starting material.
- ☐ The geometry of the complexes changes across the series.
- ☐ The reaction is dissociative and favoured by increasing bulk.
- ☐ The reaction is associative and favoured by methyl groups.
- ☐ The methyl groups destabilise the starting material.

24 of 30

Which of the following statements characterise the complex



- ☐ It can be obtained, but only as a reactive cationic salt.
- ☐ It has been prepared but is a rare example of a 20-electron Fe compound.
- ☐ It cannot be obtained because of the instability of cyclobutadiene.
- ☐ It is a stable, 18-electron species, which liberates cyclobutadiene on oxidation by Ce(IV).

- ☐ The 18-electron configuration renders it unreactive to attack by either nucleophiles, electrophiles or oxidants.

25 of 30

Which of the following statements is true?

- ☐ Different silicates are based on different fundamental **SiO_n** species.
- ☐ Silicates with a planar arrangement, such as the micas, have a trigonal planar **SiO₃³⁻** unit.
- ☐ Silicates are formed from the fundamental **SiO₄⁴⁻** unit, but may involve sharing of 0, 1, 2, 3 or 4 "O" atoms between units.
- ☐ The **SiO₄** unit is tetrahedral in silicates.
- ☐ The only silicates which are stable are aluminosilicates which also contain aluminium.

26 of 30

The term symbol for the electronic ground state of dihydrogen **H₂** is:

- ☐ $1\Sigma_g$
- ☐ $3\Sigma_g$
- ☐ $1\Sigma_u$
- ☐ $3\Pi_u$
- ☐ $1\Delta_g$

27 of 30

For the molecules **[Mo₂(OOCMe)₄]** , **[W₂Cl₄(PEt₃)₄]** and **[Mo₂(OBut)₆(μ-CO)]** the metal-metal bond orders and oxidation states are respectively:

- ☐ 4,4,2 and II, IV, III
- ☐ 4,4,2 and II, II, III
- ☐ 2,2,0 and IV, IV, V
- ☐ 0,0,2 and V, V, III
- ☐

3,3,2 and III, III, II

28 of 30

Which of the following reaction sequences is correct for the synthesis of



- ☐ [Pt(NH₃)₄]²⁺ + HCl → [PtCl(NH₃)₃]⁺ → (+HCl) → [A]
 - ☐ [PtCl₄]²⁻ + NH₃ → [PtCl₃(NH₃)]⁻ → 3) → [A]
 - ☐ PtCl₂ + 2NH₃ → [A]
 - ☐ [Pt(NH₃)₂]²⁺ + 2HCl → [A]
 - ☐ Pt + 2NH₃ + Cl₂ → [A]
-

29 of 30

Which of the following statements about the metalloenzyme, carbonic anhydrase, are true?

- ☐ Its function is to ensure rapid equilibration of **CO₂** with **HCO₃⁻**.
 - ☐ It contains **Zn²⁺** coordinated by three histidine residues.
 - ☐ It catalyses both the hydration of **CO₂** and it's reverse.
 - ☐ It operates only to hydrate **CO₂**.
 - ☐ Its direction of reaction is pH dependent.
-

30 of 30

N₂F₄ is a highly reactive gas, for example, it abstracts **H** from thiols. The gas has an electronic absorption at 260 nm which, at constant temperature, is inversely proportional to the square root of the pressure [$\mu \propto 1/\sqrt{P}$].

This is because:

- ☐ It decomposes to **N₂** and **2F₂**.

- ☐ The compound dissociates into **NF₂** radicals.
- ☐ It dimerises.
- ☐ It polymerises.
- ☐ It reacts with the walls of the vessel.

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