



IB Chemistry – HL

Topic 3 Answers

1. B [1]
2. D [1]
3. B [1]
4. B [1]
5. A [1]
6. B [1]
7. A [1]
8. C [1]
9. ligand: a molecule or ion that can bond to a (central) metal ion (to form a complex);
NH₃: Lewis base and Cu²⁺: Lewis acid (*need both for mark*);
each NH₃/ligand donates an electron pair (to Cu²⁺);
forming coordinate covalent/dative covalent bond; 4 [4]
10. (i) NaCl conducts **and** SiCl₄ does not;
NaCl ionic **and** SiCl₄ covalent;
ions can move in liquid (in NaCl)/OWTTE; 3
- (ii) NaCl pH = 7;
salt of strong acid and strong base/Na⁺ and Cl⁻ not hydrolysed;
SiCl₄ pH = 0 to 3;
HCl is formed/strong acid formed; 4 [7]
11. (i) +2 and +3/Fe²⁺ and Fe³⁺;
both s electrons are lost giving Fe²⁺ **and** one more d electron is also lost to form Fe³⁺; 2
- (ii) presence of unpaired electrons;
the d orbitals are split into two energy levels;
electrons move between these energy levels;
electrons can absorb energy from light of visible wavelength



/OWTTE;

Award [1] each for any three.

3

[5]

12. (i) van der Waals' forces (between molecules);
Accept London or dispersion forces or temporary dipole-dipole attractions.

(these forces are) weak/easily overcome;

2

- (ii) $\text{SiCl}_4 + 4\text{H}_2\text{O} \rightarrow \text{Si(OH)}_4 + 4\text{HCl}$;

1

Ignore state symbols, accept $\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ or H_4SiO_4 as product.

[3]

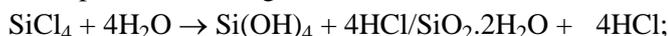
13. (i) MgCl_2 and SiCl_4 ;
 MgCl_2 solid and SiCl_4 liquid;

2

- (ii) MgCl_2 (conducts electricity) when molten/dissolved in water;
 SiCl_4 does not conduct (under any conditions);

2

- (iii) MgCl_2 pH value in range 5.0 to 6.9/just under 7;
 SiCl_4 pH value in range 0 to 3;



3

Do not accept $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$.

[7]

14. (i) $\text{Ni}^{2+} 1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$ / $[\text{Ar}]3d^8$;

1

- (ii) species with lone pair of electrons used to bond with the ion;
co-ordinate bond/dative (covalent) bond;

2

- (iii) +2;
+2;

2

Accept 2+ but not 2 or II.

- (iv) d orbitals/sub-levels (in complexes) split (into two sets at different energy levels);
energy difference corresponds to frequency/wavelength of (part of) visible light;
part of visible spectrum absorbed by electrons;
when they move between energy levels;

3

OWTTE for all of the above.

Award [1] each for any two of the last three.

- (v) iron;



2

No penalty for \rightarrow .

[10]



15. (i) Zn^{2+} has full d sub-shell / Zn^{2+} does not have partially filled d sub-shell/
 Cu^{2+} has partially filled d sub-shell/orbitals;
 d orbitals are split (into two sets of different energy levels);
 colour due to electron transition between (split) d orbitals; 3
- (ii) $[Fe(CN)_6]^{3-}$;
 octahedral/suitable diagram; 2
Accept square bipyramidal
16. (i) an ion or molecule, with a lone pair of electrons that coordinates to a metal
 atom or to a metal ion to form a complex/(OWTTE) **and** cyanide/ CN^- ; 1
- (ii) $Fe^{3+} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5$;
 ;

↑	↑	↑	↑	↑
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 [Ar]
 $3d^5$
 5 unpaired electrons; 3
- (iii) presence of unpaired electrons;
 the d orbitals are split into two energy levels;
 electrons move between these energy levels;
 absorb energy from light of visible wavelength/OWTTE;
 max 3
Award [1] each for any three.
17. (i) NaCl conducts **and** $SiCl_4$ does not;
 NaCl ionic **and** $SiCl_4$ covalent;
ions can move in liquid (in NaCl); 3
- (ii) NaCl pH = 7;
 salt of strong acid and strong base/ Na^+ and Cl^- not hydrolysed;
 $SiCl_4$ pH = 0 to 3;
 HCl is formed/strong acid formed; 4
18. (a) scandium and zinc/Sc and Zn; 1
Both needed for the mark.
Accept copper/Cu if given in addition to Sc and Zn i.e. all three
needed for the mark.
- (b) species/neutral molecules/anions which contain a non-bonding pair
 of electrons; able to form coordinate/dative covalent bonds; 2
- (c)

$[Fe(H_2O)_6]^{3+}$	$2[CuCl_4]^{2-}$	$Cr_2O_7^{2-}$	ion
+3	+2	+6	oxidation state

*Accept 6+, 2+, 3+. If given as 6, 2, 3 or (VI), (II), (III),
 Award [2] only.*

3



- (d) V/V₂O₅ in the contact process;
Fe in the Haber process;
Ni in the conversion of alkenes to alkanes/hydrogenation reactions;
Award [1] each for any two.
Accept any other suitable examples. 2 max
- (e) variable oxidation states; coloured compounds;
Accept any other suitable examples. 2

[10]