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Co. Reg. No. 200601708E
Blk 102, #02-135
Yishun Avenue 5
Singapore 760102

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2020 Chemistry 6092/02 Answer Key

1) a) i) Treat Acidic Soil: Calcium Hydroxide
ii) Manufacture of Ammonia: Iron and Hydrogen
iii) Manufacture of Steel: Argon
iv) **Removed due to CLT*
v) Used as lubricant: Calcium Hydroxide
vi) **Removed due to CLT*

b) **Removed due to CLT*

2) a) The temperature of the inside of a car engine is high. Nitrogen and oxygen molecules would gain thermal energy and therefore their kinetic energy will increase. This allows the reactant particles to gain the minimum activation energy required in order to break the strong N-N triple bond and thus react.

b) i) Eqn 1: $2NO + O_2 \rightarrow 2NO_2$
Eqn 2: $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$

ii) Sulphur Dioxide

3) a) For Fig 3.1
Small dark circles: Electron
Larger positive circles: Proton

For Fig 3.2
Larger negative circle: Anion
Smaller positive circle: Cation

b) Metals have a sea of delocalised electrons, while ionic compounds, when molten or aqueous, have free moving ions, both of which act as mobile charge carriers for conducting electricity.

c) i) The larger carbon atoms disrupt the orderly arrangement of the iron atoms, resulting in the atoms being unable to easily slide over one another when a force is applied, making it stronger.

ii) The atomic radius of carbon(0.077nm) is smaller than iron (0.126nm), while in the diagram, carbon is larger. There are also no manganese atoms represented in the diagram.

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4) a) The positive end of a cell will be connected to the tin metal, making it an anode, while the negative end will be connected to the iron can cathode. Immerse both in an electrolyte of tin (II) nitrate.

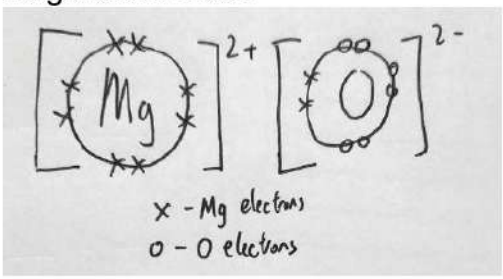
b) $Sn(s) + 2H^+(aq) \rightarrow Sn^{2+}(aq) + H_2(g)$

c) **Removed due to CLT*

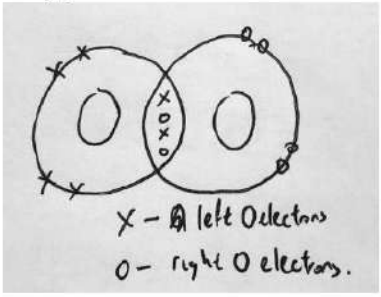
5) a) Carbon dioxide exists in a simple molecular structure, with weak intermolecular forces of attraction that require little energy to break. Thus, the melting point of carbon dioxide is low.
Silicon dioxide exists in a giant molecular structure and are held together by strong covalent bonds that require larger amounts of energy to break. Thus, the melting point of silicon dioxide is higher.

b) Acidic Oxide: CO_2, NO_2, SO_2 or P_2O_5
Basic Oxide: Li_2O, Na_2O or MgO

c) i)
Magnesium Oxide



Oxygen



ii) For magnesium oxide, magnesium loses two electrons, forming Mg^{2+} ion, while oxygen gains those two electrons to form O^{2-} ion.
For oxygen molecule, the two atoms of oxygen share two sets of electrons to form a strong double bond.

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6) a) M(s) + H2(g) -> MH(s)

b) i) Amt of LiH = 8.0g / (7+1) = 1mol
Amt of NaH = 24.0g / (23+1) = 1mol
Amt of KH = 40.0g / (39+1) = 1mol
Down the group, while the mass of metal hydride produced increases, the amount, or number of moles, of each hydride remains the same. Therefore, Beth is correct.

ii) As one mol of hydride is produced,
mass of RbH = 1mol x (85+1)
= 86g
Therefore, Ryan's statement is incorrect.

c) Potassium has a higher reactivity than sodium, and hence will burn brighter and stronger in hydrogen than sodium.

d) Oxygen is reduced as its oxidation state decreases from 0 in O_2 to -2 in H_2O
Sodium is oxidised as its oxidation state increases from 0 in Na to +1 in NaH

7) a) Based on the table, a maximum of 30g of sodium chloride can be dissolved into 100cm^3 of water at room temperature.
Therefore, 30 x 10 = 300g of sodium chloride can be dissolved into 1dm^3 of water at room temperature.
Amt of NaCl = 300 / (23+35.5) = 5.13mol(3sf)

b) Both sodium chloride and calcium chloride initially lowered the freezing point of water in smaller quantities.
While calcium chloride lowered the freezing point proportionally to the mass used from 10 to 30g, sodium chloride lowered the freezing point in irregular amounts using the same range of masses.
Finally, calcium chloride, when using 40g, increased the freezing point of water, while sodium chloride was not able to fully dissolve.

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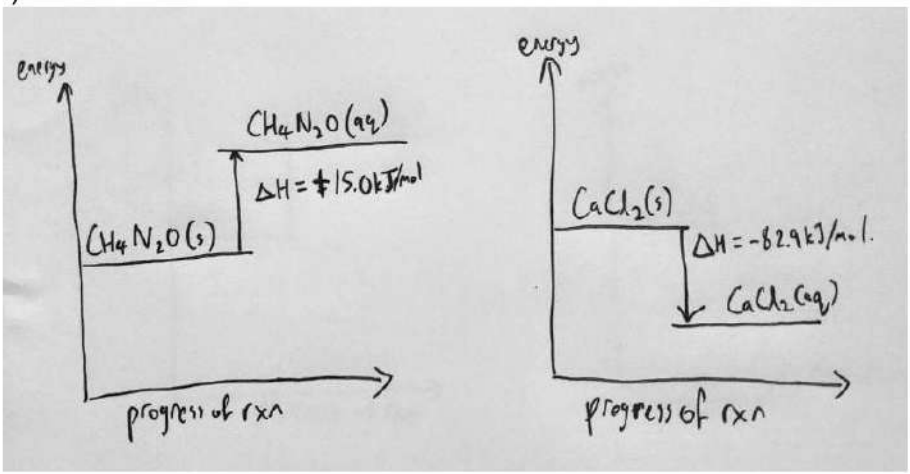
c) De-icers which have exothermic reactions when dissolved, and are gyroscopic are better de-icers.
Both calcium chloride and magnesium chloride, which are exothermic, have the lowest effective temperature as they release heat when dissolved, which can contribute to melting ice.
They are also gyroscopic, which attracts water vapour towards it and form a solution on the surface which allows for the de-icer to dissolve.

d) i)



ii) Urea has low toxicity to plants as compared to calcium chloride, which is harmful to plants.

e) The ion is the Chloride ion.
Sodium chloride, calcium chloride, magnesium chloride and potassium chloride all contain the chloride ion, and are harmful to plants, while urea, which does not contain the chloride ion, has a low toxicity.

8) **Removed due to CLT*

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9) EITHER

a) The ball and stick model does not represent the size of the atoms of carbon, hydrogen and oxygen accurately. In this model, all atoms are of the same size, however, carbon and oxygen have a significantly longer atomic radius than the hydrogen atom.
Both the 'dot-and-cross' diagram and the ball and stick model also do not represent bond length correctly. Due to the way the 'dot-and-cross' diagram is drawn, bond length cannot be interpreted, while the ball and stick model has all bonds the same length, despite the bond length of the four different bonds being of different lengths.

b) i) C_2H_6O

ii) Since the ratio of carbon to hydrogen to oxygen atoms is in its simplest ratio, molecular and empirical formula will be the same.

c) i) Amount of ethene = 1000dm3 / 24dm3
= 41.66mol
Theoretical amt of ethanol formed
= 41.66mol
Actual amt of ethanol formed
= 5/100 x 41.66
= 2.083 mol
Mass of ethanol formed
= 2.083mol x (12x2+ 6x1 +16)
= 95.83g
= 95.8g (3sf)

ii) The unused ethene gas can be refunneled into the reactor further reaction.

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OR

a) i) Mr of $(NH_4)_2SO_4$ = 14x2 + 8 + 32 + 4x16
= 132 g/mol

Mr of $CaCO_3$ = 40 + 12 + 16x3
= 100

Atom economy = 132 / (100+132) x100%
= 56.89%
= 56.9% (3sf)

ii) In process 1, ammonium sulfate is the only product and thus will have an atom economy of 100%. In process 2, since calcium carbonate is also produced as a by-product, the atom economy will be reduced.

b) amt of ammonia = 1000dm3 / 24dm3
= 41.66 mol

amt of H_2SO_4 = ½ x 41.66
= 20.83 mol

Mass of H_2SO_4 = 20.83 x (2 + 32 + 4x16)
= 2041.6g
= 2040g (3sf)

c) i) Filter the mixture to remove calcium carbonate and obtain ammonium sulfate solution as the filtrate. Heat the solution to saturation and allow to cool for ammonium sulfate crystals to form. Filter to obtain crystals as residue, wash with cold distilled water and dry with filter paper.

ii) Due to additional substances in process 2, it has more impurities and thus will have a lower percentage yield.