BioMedical Admissions Test (BMAT)

Section 2: Chemistry

Questions by Topic

C14 - Metals

C14: Metals - Question by Topic

(Mark Scheme and explanations at the end)

1 An iron nail rusts when exposed to air.

Using the equation for this reaction or otherwise, determine what will occur when the rust on the nail is placed in a beaker of concentrated sodium hydroxide, and which ion is responsible for this observation.

A Cloudy precipitate forms, Fe^{3+}
B Green precipitate forms, Fe^{2+}
C Brown precipitate forms, Fe^{3+}
D Green precipitate forms, Fe^{3+}
E Brown precipitate forms, Fe^{2+}

2 Chromium oxide can be reacted with magnesium to form chromium and magnesium oxide. By balancing this reaction, and determine the effect of raising the pressure in the reaction chamber on the yield of chromium.

Note that chromium forms an ion with a 3+ charge as part of chromium oxide.

A Decreases yield of chromium because there are 2 moles on LHS and 1 on RHS.
B Increases yield of chromium because there are 2 moles on LHS and 1 on RHS.
C Decreases yield of chromium because there are 4 moles on LHS and 5 on RHS.
D Increases yield of chromium because there are 4 moles on LHS and 5 on RHS.
E Decreases yield of chromium because there are 2 moles on LHS and 1 on RHS.

3 A geologist wishes to extract zinc metal from its ore.

Which of the following methods should he choose, taking into account effectiveness and cost?

A Reaction with pure potassium metal
B Reaction with carbon
C Electrolysis of the molten ore
D Reaction with iron
E Fractional distillation

4 Aluminium oxide traditionally exists as Al_2O_3, which contains 3 oxygen atoms. However, it has also been detected as Al_2O. Using the balanced equation for the decomposition of Al_2O_3, calculate the expected mass of Al_2O if 3.22g of Al_2O_3 is reacted and the change in oxidation state of aluminium in this reaction.

(Molecular weights: Al = 27, O = 16)

A 2.21g, oxidation change -2
B 1.97g, oxidation change -3
C 3.01g, oxidation change -3
D 1.91g, oxidation change -1
E 2.01g, oxidation change -3

5 Below are three statements about metals. Which of the following are correct?

1 Alloys are a mixture of two metals.
2 Malleable metals are able to be drawn out into a wire.
3 Ductile metals are easily shaped.

A 1 only
B 2 only
C 3 only
D 1 and 2 only
E 2 and 3 only
F None of the above
G All of them

Answers and Explanations

1 **The answer is C**

A brown precipitate forms. The rust reaction is $4Fe + nH_2O + 3O_2 \rightarrow 2Fe_2O_3.nH_2O$. (or similar). The primary ion in rust is Fe^{3+}, which when reacted with sodium hydroxide, will produce a **brown** precipitate.

2 **The answer is C**

Chromium forms a Cr^{3+} ion, so chromium oxide is Cr_2O_3.
The balanced reaction is $Cr_2O_3 + 3Mg \rightarrow 2Cr + 3MgO$.
By Le Chatelier's Principle, increasing the pressure in the reaction chamber will result in the position of equilibrium shifting to the side with the fewest moles (the left), which will decrease the yield of the chromium product.

3 **The answer is B**

Zinc lies just below carbon in the reactivity series, so carbon can be used to extract it.
Extraction with potassium metal will work, as it is higher than zinc in the reactivity series, but it is a highly reactive and expensive metal - making this process inefficient.
Electrolysis will also work, but it is significantly more expensive than heating with carbon.
Iron is below zinc in the reactivity series, and fractional distillation does not work with solid compounds.

4 **The answer is A**

The reaction for the decomposition of Aluminium oxide is:
$Al_2O_3 \rightarrow Al_2O + O_2$
Using method below uses the formula **Mass = Mr x Moles**
First the moles of Al_2O_3 are 3.22/102 (molecular weight of Al_2O_3)=0.0316
As the reaction has a 1:1 ratio the moles of Al_2O are also 0.0316
The mass of Al_2O is then calculated by 0.0316 x 70 = 2.21g
The oxidation state of aluminium changes from +3 to +1 so a change of -2.

5 **The answer is F** - None of the statements are correct.

Statement 1 is incorrect - an alloy can be made of more than two metals.
Statement 2 is incorrect - this is the definition of ductile.
Statement 3 is incorrect - this is the definition of malleable.