8.1 Theories & Reactions of Acids & Bases

Question Paper

Course	DP IB Chemistry
Section	8. Acids & Bases
Topic	8.1 Theories & Reactions of Acids & Bases
Difficulty	Hard

Time allowed: 40

Score: /33

Percentage: /100

Question 1a

a)
Explain why an ammonium ion can not behave as a Brønsted-Lowry base.

[2]

[2 marks]

Question 1b

b)
State and explain the acid-base character of aqueous ammonia at 298 K.

[2]

[2 marks]

Question 1c

c)
Acids can be classed as monoprotic, diprotic and triprotic. Sulfuric acid is a diprotic acid.

i)
State the equation for the first ionisation step of sulfuric acid, including state symbols.

ii)
Label the conjugate acid and base pairs in your answer to part i).

[2 marks]

Question 1d

d)
The second ionisation step is for the ionisation of sulfuric acid is as follows.

$$HSO_4^- (aq) + H_2O (aq) \rightleftharpoons SO_4^{2-} (aq) + H_3O^+ (aq)$$

Suggest why the second ionisation step reaches equilibrium.

[1 mark]

Question 2a

a)
Sodium hydrogen carbonate solution, $NaHCO_3$ (aq) , can act as an amphiprotic species. State the equation for the reaction fo $NaHCO_3$ (aq) with the following compounds:

i)
Sodium hydroxide solution.

[1]

ii)
Hydrochloric acid.

[1]

[2 marks]

Question 2b

b)
Using your answer to part a) i) and ii), explain why $NaHCO_3$ is amphiprotic.

[3]

[3 marks]

Question 2c

c)
Phosphine is usually prepared by heating white phosphorus, one of the allotropes of phosphorus, with concentrated aqueous sodium hydroxide.

The equation for the reaction is.

$$P_4\,(s) + 3OH^-\,(aq) + 3H_2O\,(l) \rightarrow PH_3\,(g) + 3H_2PO_2^-\,(aq)$$

Identify the amphiprotic species in this reaction giving the formulas of both species it is converted to when it behaves in this manner.

[3]

[3 marks]

Question 2d

d)

1.68 g of white phosphorus was used to make phosphine

i)

Calculate the amount, in mol, of white phosphorus used.

[1]

ii)

This phosphorus was reacted with 50.0 cm^3 of 3.00 mol dm^{-3} aqueous sodium hydroxide. Deduce, showing your working, which was the limiting reagent.

[1]

iii)

Determine the excess amount, in mol, of the other reagent.

[1]

iv)

Using section 2 of the data booklet. Determine the volume of phosphine, measured in cm^3 at standard temperature and pressure, that was produced.

[1]

[4 marks]

Question 3a

a)

Oxalic acid, $H_2C_2O_4$, is a weak diprotic acid and can be used in titrations. State the equation for the reaction of oxalic acid with sodium hydroxide.

[2]

[2 marks]

Question 3b

b)

The ionisation of oxalic acid occurs in two steps. State equations for both of these steps.

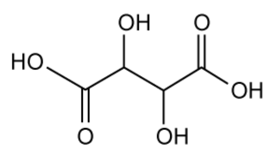
[2]

[2 marks]

Question 3c

c)

Tartaric acid shown below behaves as a Brønsted-Lowry acid when it reacts with calcium hydroxide, $Ca(OH)_2$. Sketch the structure of the salt formed from this reaction.



[3]

[3 marks]

Question 4a

Using ionic equations state how HPO_4^{2-} can behave as an amphiprotic and amphoteric species.

[4 marks]

Question 4b

Gallium oxide behaves as an amphoteric oxide. State two equations to show how gallium oxide reacts with a strong monoprotic acid and strong base.

Reaction with strong monoprotic acid ....

Reaction with strong base ....

[2]

[2 marks]

Question 4c

c)
Identify the BrØnsted-Lowry acids in the following reaction.

$$CH_3CH_2O^- (aq) + H_2O (l) \rightleftharpoons CH_3CH_2OH (aq) + OH^- (aq)$$

[1]

[1 mark]