Question 36 (17 marks)

Glycoluril is an organic compound composed of carbon, hydrogen, nitrogen and oxygen atoms. It is used in paper making and water disinfection. A chemist was given the task of determining the empirical formula and also the molecular formula of glycoluril.

To do this, the chemist combusted 2.30 g of glycoluril in excess air, producing 2.85 g of carbon dioxide and 0.874 g of water.

The chemist then used the Kjeldahl Method to determine the nitrogen content of another 2.30 g sample of the compound. This involved converting all of the nitrogen atoms in the sample into ammonia with the ammonia then distilled into 25.0 mL of 1.35 mol L⁻¹ sulfuric acid, which was in excess. The reaction between ammonia and sulfuric acid is:

$$2~\text{NH}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{aq})$$

The excess sulfuric acid needed 15.40 mL of 0.186 mol L^{-1} sodium hydroxide for complete reaction. The reaction equation is:

2 NaOH(aq) +
$$H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2 H_2O(\ell)$$

Determine the empirical form	ula of glycoluril.	(12 r
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@36 $\Lambda(CO_1) = M$ 2.85 % C=07164 n(co) = n(c) = 0.0647 Ns. = 0,7764 -33.790 2(40) = ____ 0.874 18 n(40) x2 = x(4) = 0.04855 x2 = 0.09711 x/9 9-11 = 0.09711 = 4.290 = 1.32 x (52 x10-3) = 0.033751 = CV = 01186 x (1514 x103) N(Nooy) n(Naon) x 1(= ~(Nray) = 0.001437 ml ~(U,Say) axay 1 (K104) - 0:03775-0:001492 = 0.0323 2 ~ (hsoy) + 2 = 0,0646 mg of (NU) N(NY) = N(N) = 0,06x6x MN) =0.0646×14

> = 0.9044g 90N = 0.9044 =39.3%

2.70g - m(c) -m(h) -m(n) 0.7764 - 0.09711, - 0.9044 %0 - 100 - (33.7+4.2+39.3) %0 = 22.8% M(0) = 0.525 gV(0) = 0.2555 = 0.03503 mby of 39.3 33.7 2.808-2 (14) 3 Tuni 7.425 2 H 0,09711 0,0646 0,09263 0,0647 0,03263 0,03263 0,03263 EF GHZ NO PU= NRT 242 × 0,633 = ~×8,314 ×/865+273 N=0.01619 mg N= N = N 2.30 = 142 0.01619 M 4 FF = 24+3+28+16= 71

MF = C4H6N402