

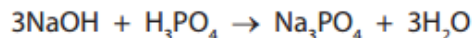
ACTIVITY 2

STRUCTURED OR UNSTRUCTURED?

This is an example of a recent structured calculation question:

- (f) The student uses a similar method to find the concentration of a solution of phosphoric acid (H_3PO_4).

The equation for the reaction is



The table shows her results.

volume of sodium hydroxide solution added to conical flask	25.0 cm ³
concentration of sodium hydroxide solution	0.180 mol/dm ³
average volume of phosphoric acid solution added from burette	28.30 cm ³

- (i) Calculate the amount, in moles, of NaOH in 25.0 cm³ of the sodium hydroxide solution. (2)

amount of NaOH =mol

- (ii) Calculate the amount, in moles, of H_3PO_4 in the phosphoric acid solution. (1)

amount of H_3PO_4 =mol

- (iii) Calculate the concentration, in mol/dm³, of the phosphoric acid. (2)

concentration of phosphoric acid = mol/dm³

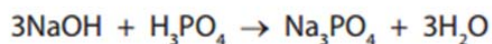
This is the mark scheme for the question:

f		In part (f):	
		<ul style="list-style-type: none"> accept values in standard form, eg 4.5×10^{-3} do not accept unevaluated fractions, eg $0.0045 \div 3$ in (ii) do not penalise too many sig figs correct answer without working scores 2 marks in (i) and (iii) penalise missing use of 1000 in (i) and (iii) once only 	
i	M1 $\frac{0.18(0) \times 25(.0)}{1000}$		2
	M2 0.0045(0)	Award 1 mark for 4.5	
ii	$(0.0045 \div 3 =) 0.0015(0)$	CQ on answer to (i)	1
iii	M1 $\frac{0.0015 \times 1000}{28.3(0)}$	CQ on answer to (ii)	2
	M2 0.053(0)	Award 1 mark out of 2 for 0.000053 Award 1 mark out of 2 for 0.05 If correct final answer obtained by omission of 1000 in both (i) and (iii), award marks of 1,1, 2	

Here is the question rewritten without structuring:

(f) The student uses a similar method to find the concentration of a solution of phosphoric acid (H_3PO_4).

The equation for the reaction is



The table shows her results.

volume of sodium hydroxide solution added to conical flask	25.0 cm ³
concentration of sodium hydroxide solution	0.180 mol/dm ³
average volume of phosphoric acid solution added from burette	28.30 cm ³

Calculate the concentration, in mol/dm³, of the phosphoric acid.

concentration of phosphoric acid = mol/dm³

Consider how deleting the instructions in parts (i) and (ii) would affect the way students answer.

- Is the question still worth a total of 5 marks?
- Will self-cancelling errors (eg omitting 1000 in (i) and (iii)) be penalised or not?
- Can different methods be comparably marked?

Next, consider these answers:

Answer 1

$$V_1M_1 = V_2M_2$$

$$25 \times 0.180 = 28.3 \times M_2$$

$$\therefore M_2 = 0.159 \text{ mol/dm}^3$$

Answer 2

$$\frac{V_1M_1}{n_1} = \frac{V_2M_2}{n_2}$$

$$\frac{25 \times 0.180}{3} = \frac{28.3 \times M_2}{1}$$

$$\therefore M_2 = 0.053 \text{ mol/dm}^3$$

Answer 3

$$\text{moles of NaOH} = 25 \times 0.180 = 4.5$$

$$\text{moles of H}_3\text{PO}_4 = 1.5$$

$$\text{concentration} = \frac{1.5}{28.3} = 0.053$$

What mark would you give to each of these answers? Use the original mark scheme.

Answer 1 is worth marks

Answer 2 is worth marks

Answer 3 is worth marks

Next, on the other side of this sheet, try writing a mark scheme for the unstructured calculation. You may decide that the total mark is less than the original total of 5 marks for the structured question.