

# Interactive Example Candidate Responses

## Paper 22 (May/June 2016), Question 3

### Cambridge International AS & A Level Chemistry 9701

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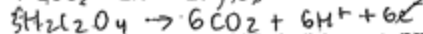
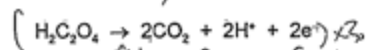
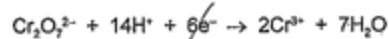
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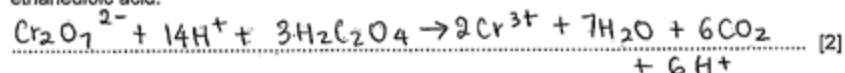
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- 3 Acidified potassium dichromate(VI) can oxidise ethanedioic acid,  $\text{H}_2\text{C}_2\text{O}_4$ .  
The relevant half-equations are shown.



- (a) State the overall equation for the reaction between acidified dichromate(VI) ions and ethanedioic acid.



- (b) In an experiment a 0.242 g sample of hydrated ethanedioic acid,  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ , was reacted with a 0.0200 mol dm<sup>-3</sup> solution of acidified potassium dichromate(VI).

32.0 cm<sup>3</sup> of the acidified potassium dichromate(VI) solution was required for complete oxidation of the ethanedioic acid.

- (i) Calculate the amount, in moles, of dichromate(VI) ions used to react with the sample of ethanedioic acid.

$$\begin{aligned} n &= c \times v \\ &= 0.02 \times 32 \times 10^{-3} \\ &= 6.4 \times 10^{-4} \end{aligned}$$

$$\text{amount} = 6.4 \times 10^{-4} \text{ mol} \quad [1]$$

- (ii) Calculate the amount, in moles, of ethanedioic acid in the sample.

$$\begin{aligned} n &= 6.4 \times 10^{-4} \times 3 \\ n &= 1.92 \times 10^{-3} \end{aligned}$$

$$\text{amount} = 1.92 \times 10^{-3} \text{ mol} \quad [1]$$

- (iii) Calculate the relative molecular mass,  $M_r$ , of the hydrated ethanedioic acid.

$$M_r = \frac{m}{n} = \frac{0.242}{1.92 \times 10^{-3}} = 126$$

$$M_r = 126 \quad [1]$$

- (iv) Calculate the value of  $x$  in  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ .

$$M_r \text{ of } \text{H}_2\text{C}_2\text{O}_4 = (2 \times 1) + (12 \times 2) + (16 \times 4) = 90$$

$$x = \frac{126 - 90}{18} \quad M_r \text{ of } \text{H}_2\text{O} = 18 \quad x = 2 \quad [1]$$

$$x = 2$$

[Total: 6]

Select  
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Your  
Mark

3(a)

3(b)(i)

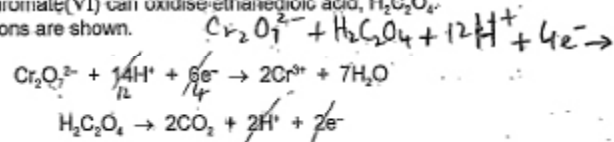
3(b)(ii)

3(b)(iii)

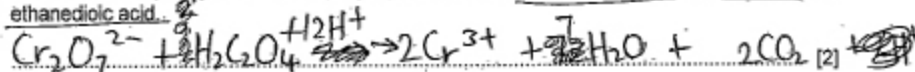
3(b)(iv)

| Q3       | Mark scheme  |
|----------|--|
| (a)      | $\text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ + 3\text{H}_2\text{C}_2\text{O}_4 \rightarrow 2\text{Cr}^{3+} + 6\text{CO}_2 + 7\text{H}_2\text{O}$<br>M1 = species [1]<br>M2 = balancing [1]<br>[2] |
| (a)(i)   | $(0.02 \times 32.0/1000) = 6.40 \times 10^{-4}$ [1]  |
| (a)(ii)  | $(6.4 \times 10^{-4} \times 3) = 1.92 \times 10^{-3}$ [1]  |
| (a)(iii) | $(0.242 / 1.92 \times 10^{-3}) = 126(0)$ [1]   |
| (a)(iv)  | $(126 - 90 = 36; 36 / 18 = 2 \text{ hence}) x = 2$ [1]<br>[Total: 6]   |

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- (i) Calculate the amount, in moles, of dichromate(VI) ions used to react with the sample of ethanedioic acid.

$$0.0200 \times \frac{32}{1000} = 6.4 \times 10^{-4}$$

amount =  $6.4 \times 10^{-4}$  mol [1]

- (ii) Calculate the amount, in moles, of ethanedioic acid in the sample.

$$\text{Cr}_2\text{O}_7^{2-} : \text{H}_2\text{C}_2\text{O}_4$$

$$1 : 1$$

amount =  $6.4 \times 10^{-4}$  mol [1]

- (iii) Calculate the relative molecular mass,  $M_r$ , of the hydrated ethanedioic acid.

$$M_r = \frac{\text{Mass}}{\text{moles}}$$

$$M_r = \frac{0.242}{6.4 \times 10^{-4}} = 378.125$$

- (iv) Calculate the value of  $x$  in  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ .

$$\text{H}_2\text{O} = 18$$

$$378.125 - 80 = 298.125$$

$$x = \frac{298.125}{18} = 16.5625$$

[Total: 6]

Your  
Mark

3(a)

3(b)(i)

3(b)(ii)

3(b)(iii)

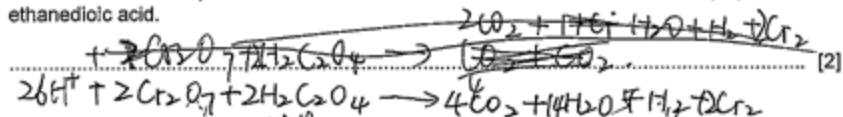
3(b)(iv)

| Q3       | Mark scheme  |
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32.0 cm<sup>3</sup> of the acidified potassium dichromate(VI) solution was required for complete oxidation of the ethanedioic acid.

- (i) Calculate the amount, in moles, of dichromate(VI) ions used to react with the sample of ethanedioic acid.

$$n(\text{Cr}_2\text{O}_7^{2-}) = \frac{0.242}{90} = 2.69 \times 10^{-3}$$

$$n = \frac{m}{M} \quad n = \frac{0.242}{90} = 2.69 \times 10^{-3}$$

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- (ii) Calculate the amount, in moles, of ethanedioic acid in the sample.

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$$M_r = \frac{m}{n} = \frac{0.242}{2.69 \times 10^{-3}} = 378$$

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- (iv) Calculate the value of  $x$  in  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ .

$$378 - 90 = 288$$

$$288 \div 18 = 16$$

$$x = 16$$

[Total: 6]

Your  
Mark

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