

40th INTERNATIONAL CHEMISTRY OLYMPIAD

UK Round One - 2008

MARKING SCHEME

Notes

Chemical equations may be given as sensible multiples of those given here.

State symbols do not need to be included in the chemical equations to obtain the mark(s).

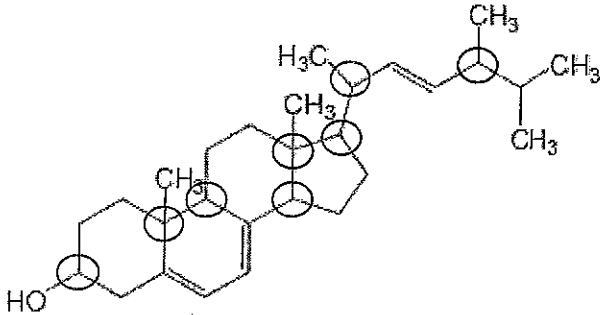
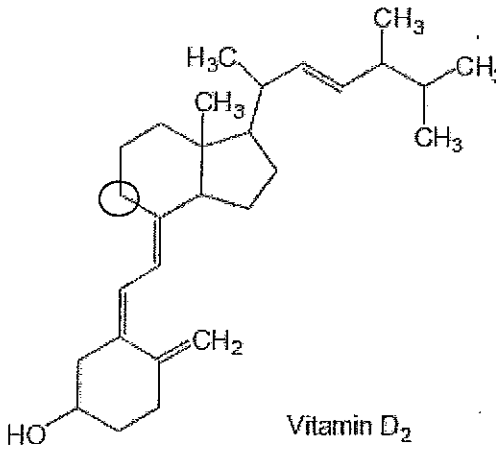
Answers should be given to an appropriate number of significant figures although the marker should only penalise this once.

Total 62 marks.

| Question 1 | | Answer | Marks |
|------------|-----|---|-------|
| (a) | | $\text{SiO}_2 + \text{C} \rightarrow \text{Si} + \text{CO}_2$ <i>(also accept $\text{SiO}_2 + 2\text{C} \rightarrow \text{Si} + 2\text{CO}$)</i> | 1 |
| (b) | i) | 109 ° | 1 |
| | ii) | $\text{SiHCl}_3 + \text{H}_2 \rightarrow \text{Si} + 3\text{HCl}$ | 1 |
| (c) | i) | $4\text{SiH}(\text{OCH}_2\text{CH}_3)_3 \rightarrow \text{SiH}_4 + 3\text{Si}(\text{OCH}_2\text{CH}_3)_4$ | 1 |
| | ii) | $\text{SiH}_4 + 2\text{O}_2 \rightarrow \text{SiO}_2 + 2\text{H}_2\text{O}$ | 1 |
| (d) | i) | $C_x = 2.00 \times 10^{-3} \times 3300 (1 - 0.95)^{-0.998} = 131 \text{ ppm}$ | 2 |
| | ii) | If k is small, $k - 1 \approx -1$ $\therefore 10 = 8.00 \times 10^{-6} \times 1300 (1 - x)^{-1}$ $1 - x = 0.00104$ 0.104% would have to be discarded | 2 |

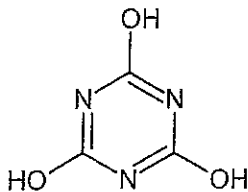
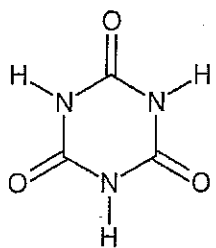
9 marks

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| Question 2 | | Answer | Marks |
|------------|--|--|-------|
| (a) | |  <p>Ergosterol</p> | 3 |
| (b) | |  <p>Vitamin D₂</p> | 2 |
| (c) | | Zero | 1 |
| (d) | | <p>In 40 min, (42-7) µg/g dry mushroom of vitamin D₂ produced $(42-7)/40 = 0.875 \mu\text{g}(\text{g dry mushroom})^{-1}\text{min}^{-1}$ $\therefore k = 0.0146 \mu\text{g}(\text{g dry mushroom})^{-1}\text{s}^{-1}$ <i>(1 mark for the value of k, and 1 mark for the correct units)</i></p> | 2 |
| (e) | | <p>In 40 min, (14-3) µg/g dry mushroom of vitamin D₂ produced \therefore In 60 min, $((14-3) \times 60/40) + 3 = 19.5 \mu\text{g/g dry mushroom}$ In 10g of dry mushrooms, $19.5 \times 10 = 195 \mu\text{g}$ of vitamin D₂</p> | 1 |
| (f) | | <p>At 25 °C, $k_{(T)} = A \times e^{(-E_a / (8.314 \times 298))}$ At 35 °C, $2k_{(T)} = A \times e^{(-E_a / (8.314 \times 308))}$ $e^{(-E_a / (8.314 \times 308))} = 2 \times e^{(-E_a / (8.314 \times 298))}$ $-E_a / (8.314 \times 308) = \log_e 2 - E_a / (8.314 \times 298)$ $0.0004036 E_a - 0.0003905 E_a = 0.693$ $0.0000131 E_a = 0.693$ $E_a = 53 \text{ kJ mol}^{-1}$</p> | 2 |

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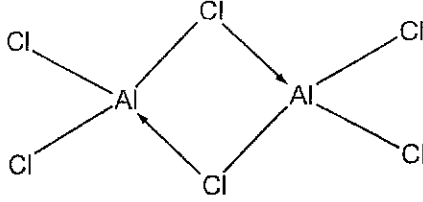
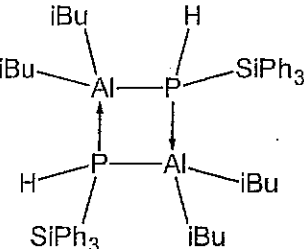
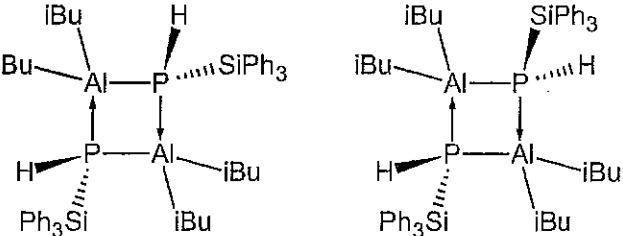
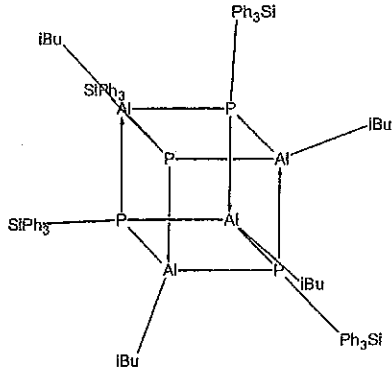
11 marks

| Question 3 | | Answer | Marks |
|------------|--|--|-------|
| (a) | | $\text{Hg}(\text{CNO})_2 \rightarrow \text{Hg} + \text{N}_2 + 2\text{CO}$ | 1 |
| (b) | | $2(-111) - 386 = -608 \text{ kJ mol}^{-1}$ | 2 |
| (c) | | $\text{O} \leftarrow \text{N} \equiv \text{C} - \text{Hg} - \text{C} \equiv \text{N} \rightarrow \text{O}$ (also accept $^-\text{O} - ^+\text{N} \equiv \text{C} - \text{Hg} - \text{C} \equiv \text{N}^+ - \text{O}^-$) | 1 |
| (d) | | $\text{N} \equiv \text{C} - \text{O} - \text{Hg} - \text{O} - \text{C} \equiv \text{N}$ (also accept $\text{Hg}^{2+} (\text{C} \equiv \text{N}^+ - \text{O}^-)_2$) | 1 |
| (e) | | <p>Aromatic structure:</p>  <p>Non-aromatic structure:</p>  | 2 |

7 marks

| Question 4 | | Answer | Marks |
|------------|----|--------------------------|-------|
| (a) | | 6 | 1 |
| (b) | i) | Al_2Cl_6 | 1 |

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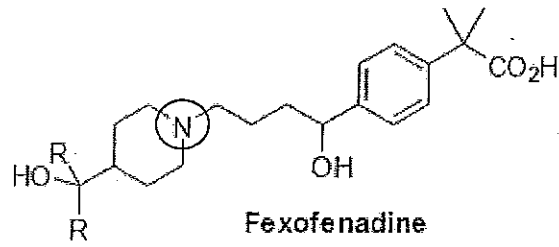
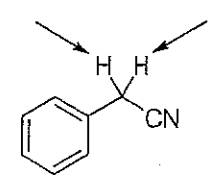
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|-----|------|--|---|
| | ii) |  <p>(Dative bond arrows not essential)</p> | 1 |
| | iii) | 8 | 1 |
| (c) | | $\text{AlP} + 3\text{H}_2\text{O} \longrightarrow \text{Al}(\text{OH})_3 + \text{PH}_3$ <p>(also accept $2\text{AlP} + 3\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 2\text{PH}_3$)</p> | 1 |
| (d) | | 6 | 1 |
| (e) | i) |  | 1 |
| | ii) |  | 2 |
| (f) | |  | 3 |
| (g) | | methylpropene | 1 |

13 marks

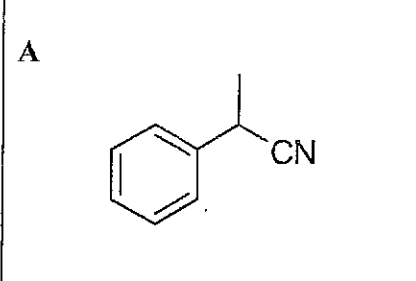
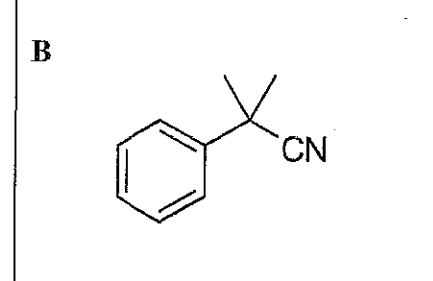
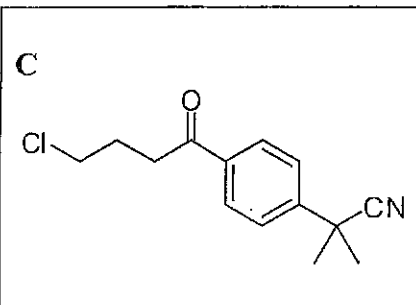
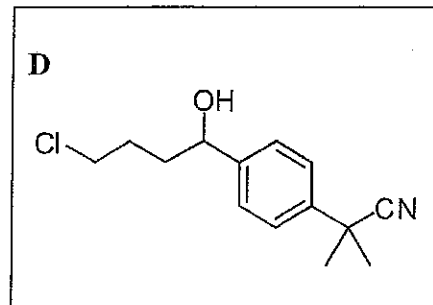
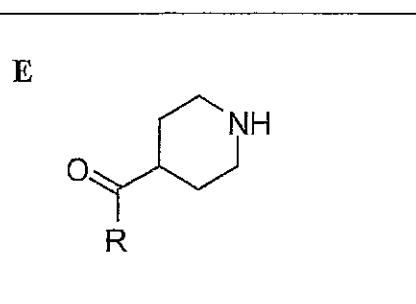
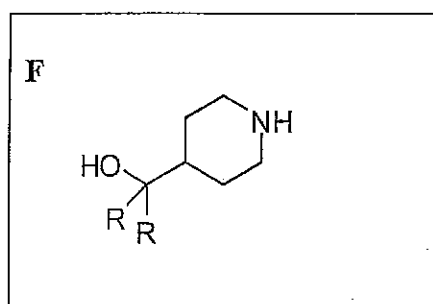
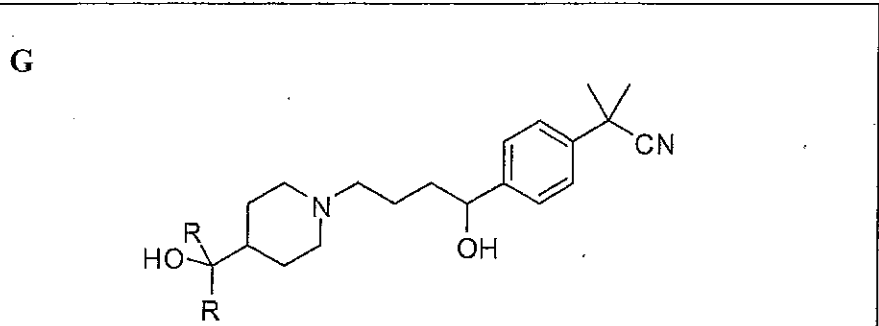
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| Question 5 | | Answer | Marks |
|------------|------|---|-------|
| (a) | i) | 301 | 1 |
| | ii) | 114 | 1 |
| | iii) | 227 | 1 |
| (b) | | $9!/2 = 181440$ | 2 |
| (c) | | 1- Cysteine 2- Isoleucine 3- Leucine 4- Glutamine 5- Aspartic Acid 6- Cysteine 7- Proline <i>(Lose one mark for each incorrect amino acid)</i> | 5 |

10 marks

| Question 6 | | Answer | Marks |
|------------|------|--|-------|
| (a) | i) |  <p style="text-align: center;">Fexofenadine</p> | 1 |
| | ii) | $(120.14 - 112.00)/112.00 = 36.458 / (\text{RMM of fexofenadine})$ $\therefore \text{RMM of fexofenadine} = 501.6$ | 1 |
| | iii) | $\text{RMM of structure} = (2 \times M_r(\text{R})) + 347.4$ $\therefore 2 \times M_r(\text{R}) = 501.6 - 347.4 = 154.2$ $M_r(\text{R}) = 77.1$ $\text{R} = \text{C}_6\text{H}_5$ <i>(accept 'phenyl group')</i> | 1 |
| (b) | |  | 1 |

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| | | | |
|--|---|--|---|
| (c) | <p>A</p>  | <p>B</p>  | 7 |
| <p>C</p>  | <p>D</p>  | | |
| <p>E</p>  | <p>F</p>  | | |
| <p>G</p>  | | | |
| <p>Award 1 mark for each correct structure</p> <p>Award 1 additional mark if all structures in parts c) are given correctly.</p> | | | 1 |

12 marks