

A competition to select the team to represent the

UNITED KINGDOM

at the

**XXXVIIth INTERNATIONAL CHEMISTRY
OLYMPIAD**

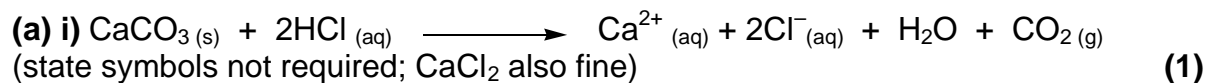
ANSWER BOOKLET FOR MARKERS

Round I - 2005

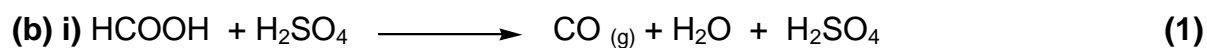
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Olympiad Round 1 2005 – Mark Scheme

1. This question is about carbon oxides



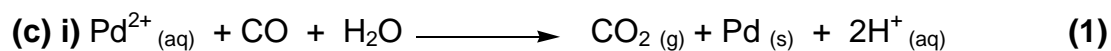
ii)



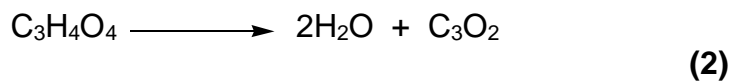
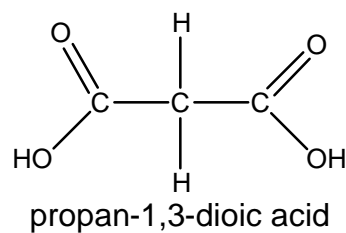
ii)



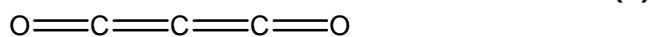
iii) TRIPLE bond (1)



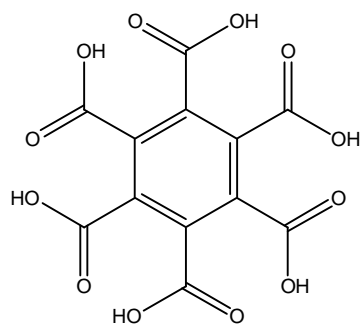
(d) i)



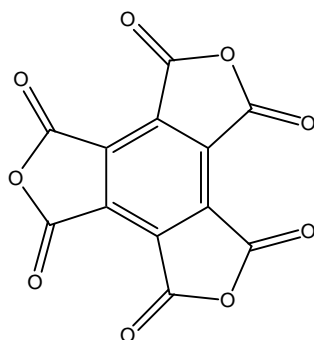
ii)



(e)



benzene hexacarboxylic acid

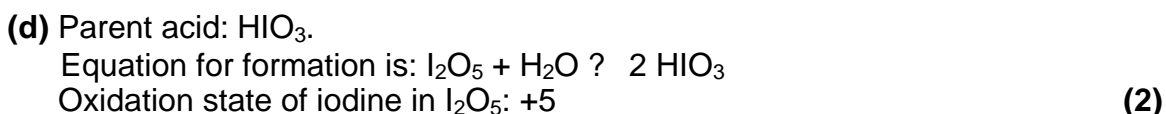
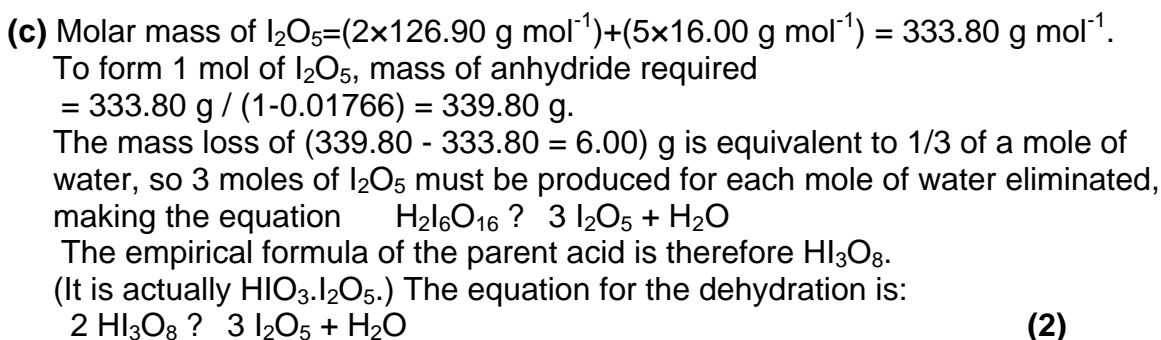
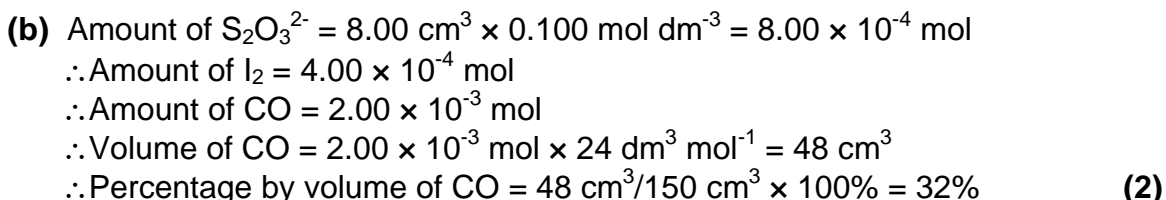
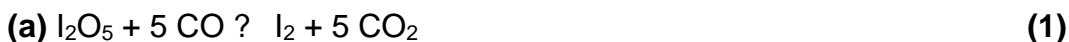


C₁₂O₉

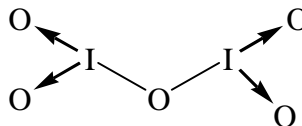
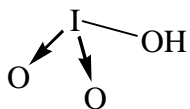
(2)

Total: 11

2. This question is about diiodine pentoxide

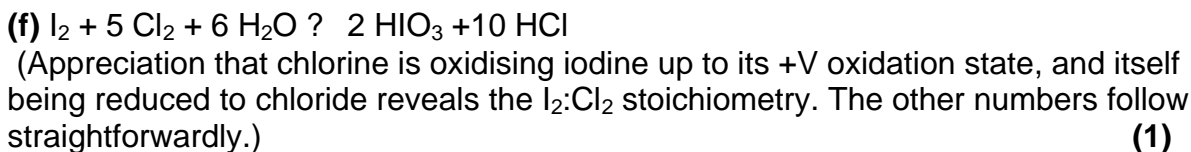


(e)



Accept chemically sensible alternatives.

(2)

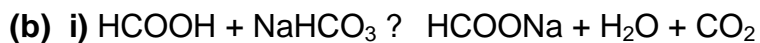


Total: 10

3. This question is about ants

(a) i) $6.0 \times 10^{-3} \times 0.5 \times 100 / 80 = 3.75 \times 10^{-3} \text{ cm}^3$ so accept $3.8 \times 10^{-3} \text{ cm}^3$

ii) $1000 / 3.75 \times 10^{-3} = 2.7 \times 10^5$



ii) $6.0 \times 10^{-3} \times 0.5 \times 1.2 / 46 = 7.8 \times 10^{-5} \text{ moles}$

iii) $7.8 \times 10^{-5} \times 84 = 6.6 \times 10^{-3} \text{ g} = 6.6 \text{ mg}$

(c) $7.8 \times 10^{-2} \text{ mol dm}^{-3}$

(d) $3.7 \times 10^{-3} \text{ mol dm}^{-3}$

(e) $3.7 \times 10^{-3} / 7.8 \times 10^{-2} \times 100 = 4.8 \%$

(f) $(3.7 \times 10^{-3})^2 / (7.8 \times 10^{-2} - 3.7 \times 10^{-3}) = 1.8 \times 10^{-4} \text{ mol dm}^{-3}$ (also accept 1.9×10^{-4}). This means $\text{pK}_a = 3.73$.

1 mark for each part

Total: 9

4. This question is about the NMR spectra of NanoPutians

(a) $6 \equiv 8$, $9 \equiv 11$, $19 \equiv 23$, $20 \equiv 22$
8 signals in total due to benzene ring carbons (2)

(b) $4 \equiv 13$, $5 \equiv 12$, $24 \equiv 30$, $25 \equiv 31$
4 signals in total due to triple bond carbons (2)

(c) $1 \equiv 16$, $27 \equiv 28 \equiv 29 \equiv 33 \equiv 34 \equiv 35$, 40 (unique), 41 (unique)
4 signals in total due to methyl group carbons (3)

(d) 23 different environments (i.e. 23 different signals)
(2 marks for the correct answer. 1 if the answer given is 22)

(e) signal split into 6, ratio 1 : 5 : 10 : 10 : 5 : 1 (1)

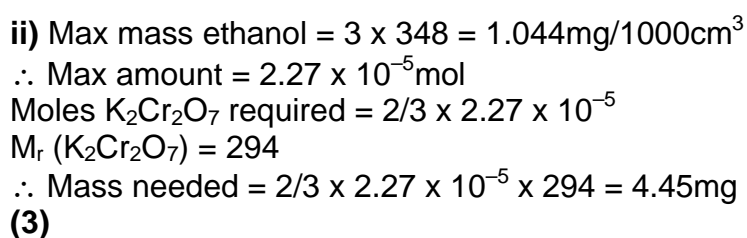
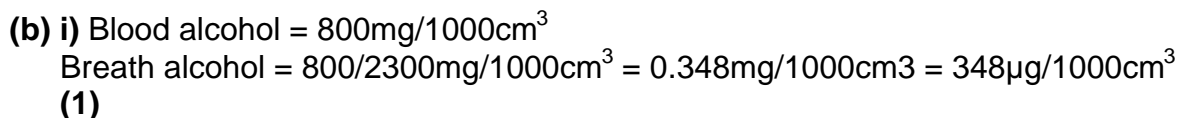
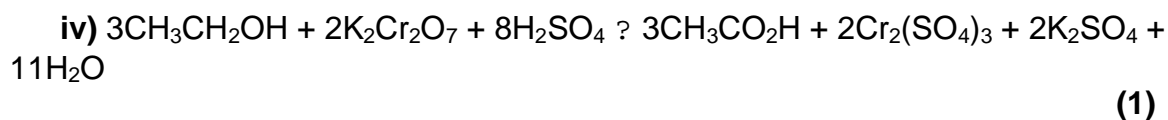
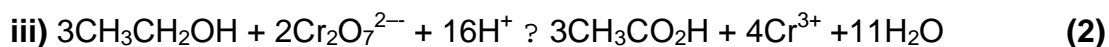
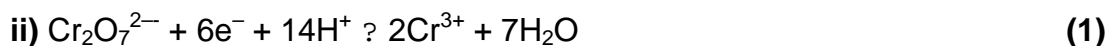
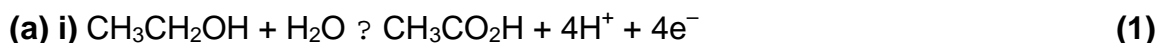
(f)

¹ H NMR Signal	Hydrogen(s) on Carbon(s)
A	7
B	19, 23
C	9, 11
D	36
E	17
F	37 and 39
G	37 and 39
H	3, 14
I	2, 15
J	40 or 41
K	27, 28, 29, 33, 34, 35
L	1, 16
M	41 or 40

(6)

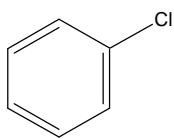
Total: 16

5. This question is about the Breathalyser

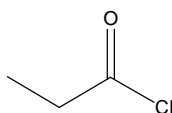


Total: 10

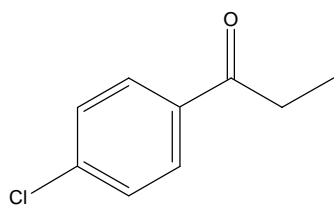
6. This question is about the synthesis of the new wonder-drug 'Rimonabant'



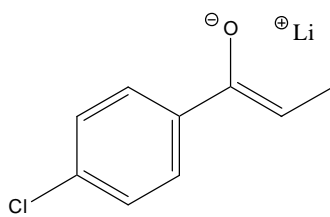
chlorobenzene



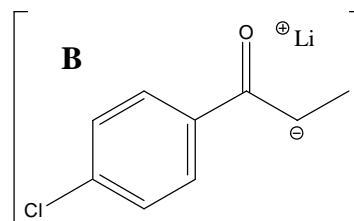
propanoyl chloride



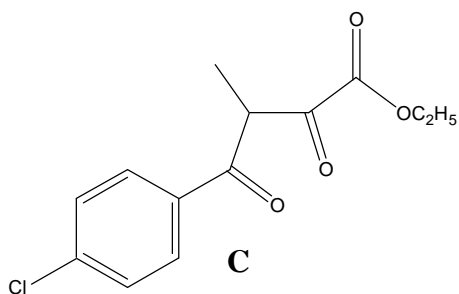
A



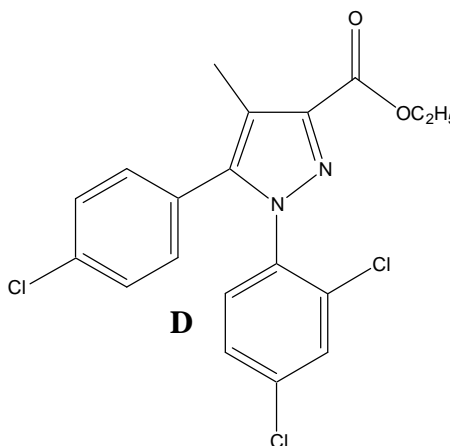
B



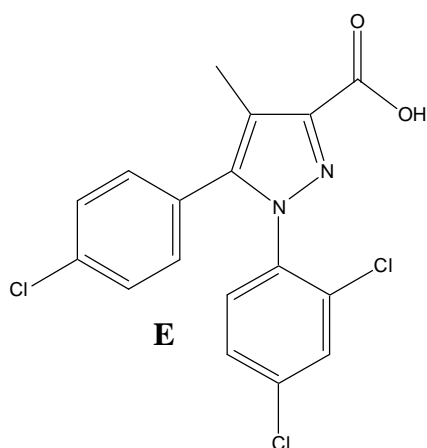
allow structure with
negative charge on carbon



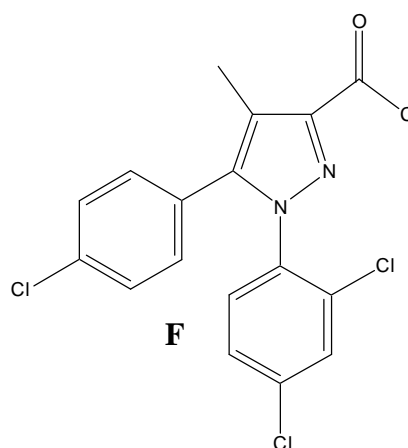
C



D



E



F

(1 mark for each structure
2 bonus marks if all correct)

Total: 8

Total for paper 64 (plus 2 possible bonus marks)