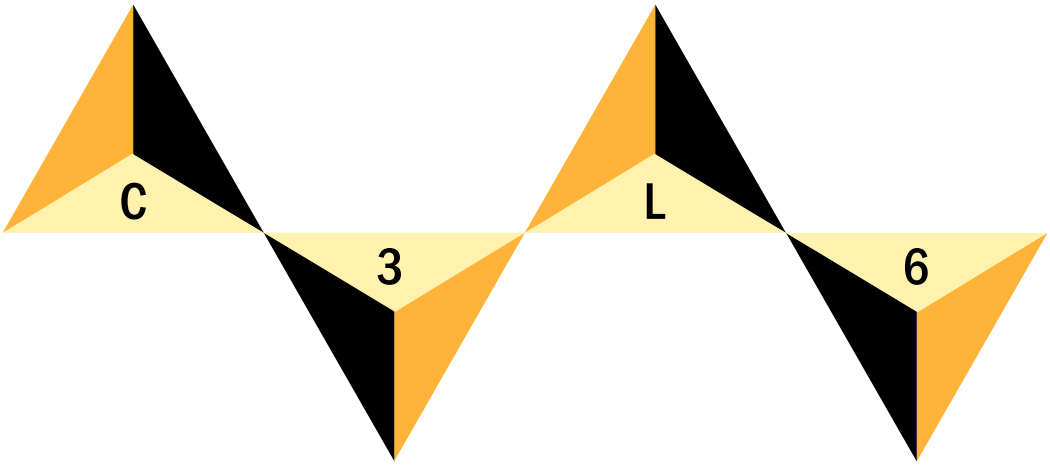


Cambridge Chemistry Challenge Lower 6th

June 2015

Marking scheme for teachers

(please also read the additional instructions)

	p2	p3	p4	p5	p6	p7	Total
mark	16	12	13	6	10	3	**60**

leave blank

1(a) **equations (underline reduced element):**

(i) **from mercury(II) oxide:**

$\underline{2HgO} \longrightarrow 2Hg + O_2$ ✓✓ 2

(ii) **from silver(I) carbonate:**

$\underline{2Ag_2CO_3} \longrightarrow 4Ag + 2CO_2 + O_2$ ✓✓ 2

(iii) **from potassium nitrate(V):**

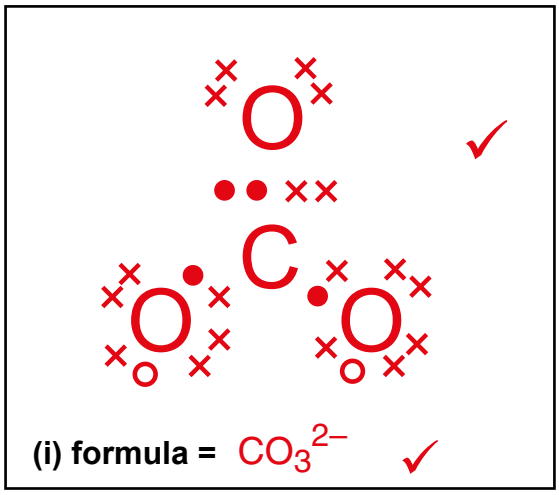
$\underline{2KNO_3} \longrightarrow 2KNO_2 + O_2$ ✓✓ 2

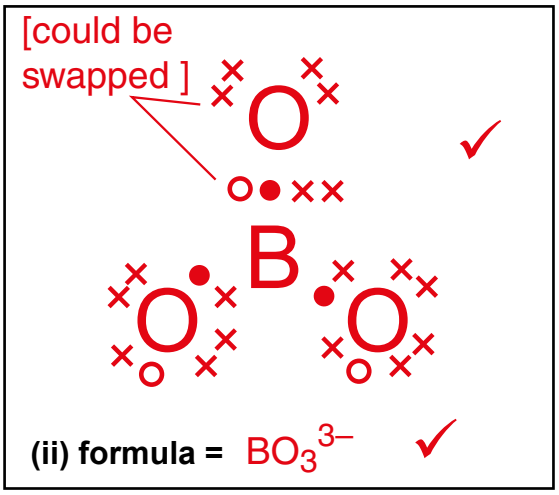
(iv) **from sulfuric acid and manganese(IV) oxide:**

$2H_2SO_4 + \underline{2MnO_2} \longrightarrow 2MnSO_4 + 2H_2O + O_2$

[Half quantities accepted. 1 mark for equation; 1 for underlined] ✓✓ 2

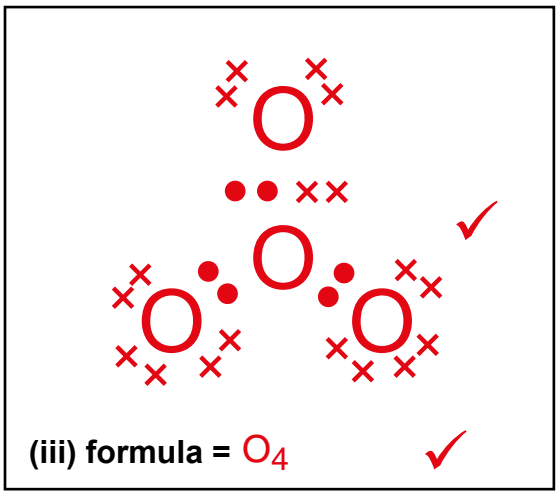
1(b) **dot & cross diagrams**





2

2



2

1(c) **neutral compound isoelectronic with nitrate(III) ion:** 2

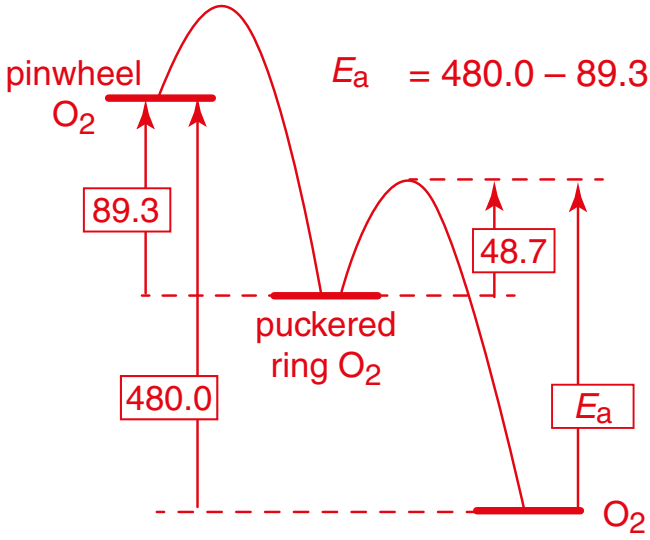
formula: O_3 ✓ **name:** ozone ✓

[also allow CF_2, difluorocarbene, or O=N–F, nitrosyl fluoride]

Page total 16

leave blank

1(d) **activation energy for puckered-ring O_4 from O_2:**



E_a = 480.0 – 89.3 + 48.7 = **439.4 kJ mol^{-1}** ✓✓✓✓

4

[2 marks if worked out standard enthalpy of formation of puckered-ring O_2 = 390.7 kJ mol^{-1}]

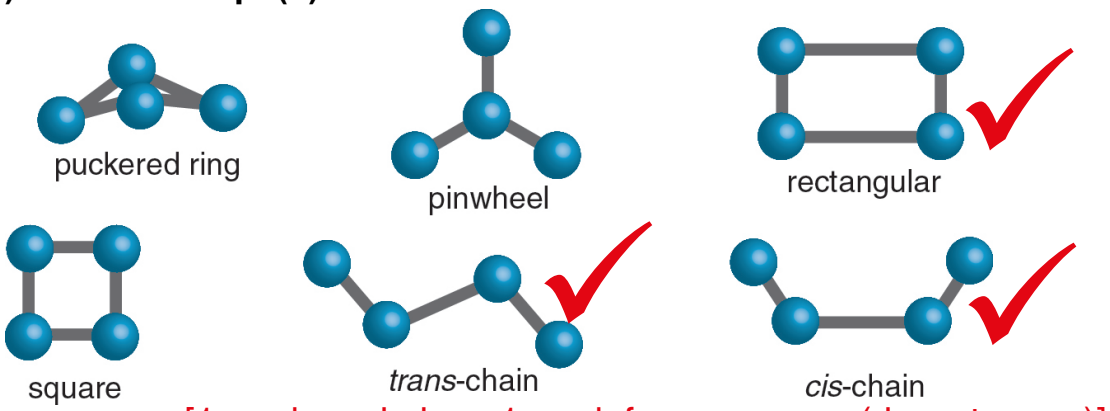
1(e) **A =** $^{16}O_2^+$ **B =** $^{18}O_2^+$ ✓

C = $^{16}O_2{}^{18}O_2^+$

[1 mark if all three correct]

1

1(f) tick the shape(s) most consistent with the data:



[1 mark each; lose 1 mark for any wrong (down to zero)]

3

1(g) time taken:

k.e. of O_4 molecule = 4.00 keV = 4000 × 1.602 × 10^{-19} J

= 6.408 × 10^{-16} J ✓

k.e. = ½ m v^2 ∴ $v = \sqrt{\dfrac{2 \times (\text{k.e.})}{m}}$

mass of $^{18}O_4$ = 18.00 × 4 g mol^{-1} ≡ $\dfrac{18.00 \times 4}{6.022 \times 10^{23} \times 10^3}$ kg molecule^{-1}

= 1.1956 × 10^{-25} kg ✓

4

$v = \sqrt{\dfrac{2 \times 6.408 \times 10^{-16}}{1.1956 \times 10^{-25}}}$ = 103 500 m s^{-1} ✓

time of flight = $\dfrac{0.100 \text{ m}}{103\,500 \text{ m s}^{-1}}$ = 9.66 × 10^{-7} s (≈ 0.1 μs) ✓

[lose 1 mark each time a power of ten is incorrectly used]

Page total 12

leave blank

2(a)

i) zero ✓

ii) 3, 5 ✓

iii) 4, 6, 9 ✓

iv) 1, 8 ✓

4

[zero marks for part containing missing / additional wrong answers]

2(b) circle one or more:

Free radical **Nucleophilic** **Substitution**

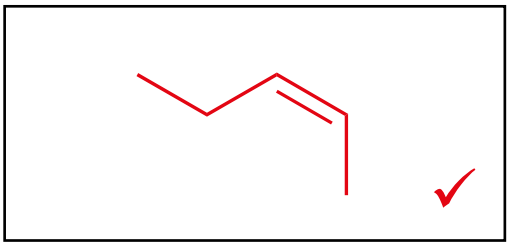
Electrophilic ✓ **Addition** ✓

2

[–1 mark for any wrong down to zero]

2(c) three alkenes:







3

2(d)

i) 13, 16 ✓

ii) 14, 18 ✓

iii) 12, 18 ✓

iv) 16, 17 ✓

4

[zero marks for part containing missing / additional wrong answers]

Page total 13

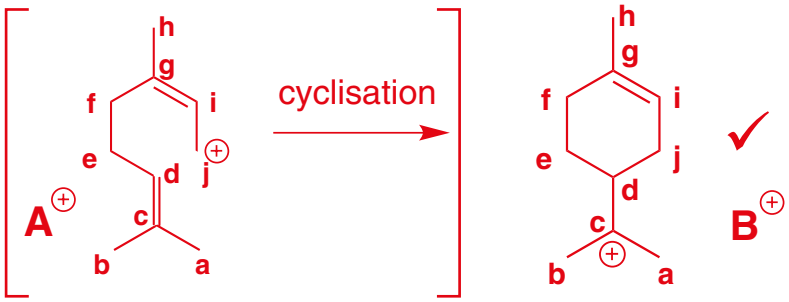
leave blank

2(e) **for α-terpineol**

i) connect: d & j ✓

ii) Carbocation B^+:

[only structure of B^+ required no labels on it needed]



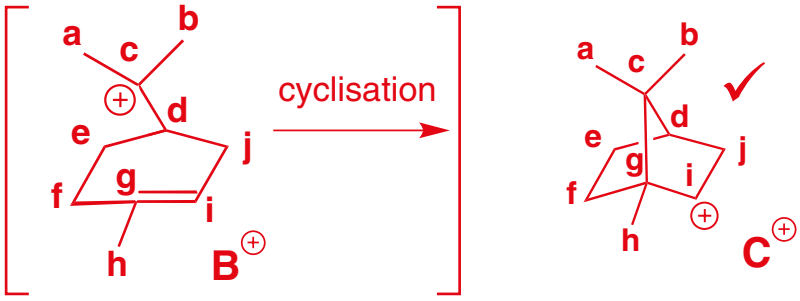
2

2(f) **for borneol**

i) connect: c & g ✓

ii) Carbocation C^+:

[only structure of C^+ required no labels on it needed]



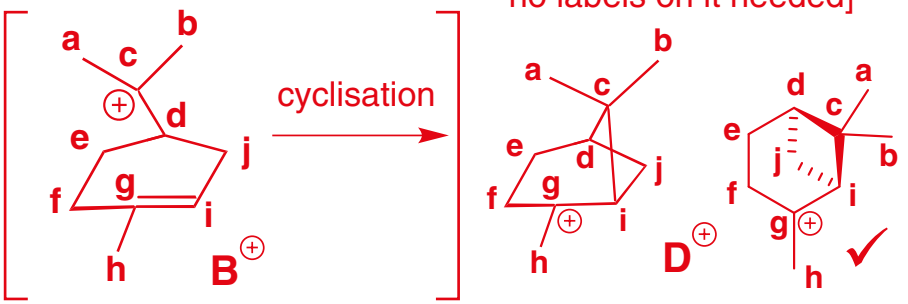
2

2(g) **for β-pinene**

i) connect: c & i ✓

ii) Carbocation D^+:

[only structure of D^+ required no labels on it needed]



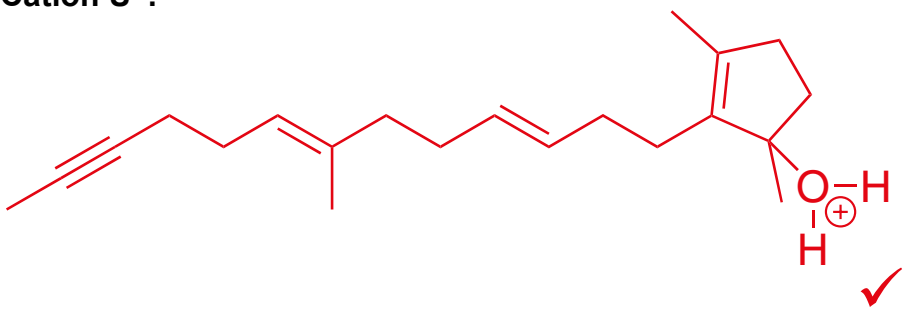
2

Page total 6

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2(h)

Cation U^+:

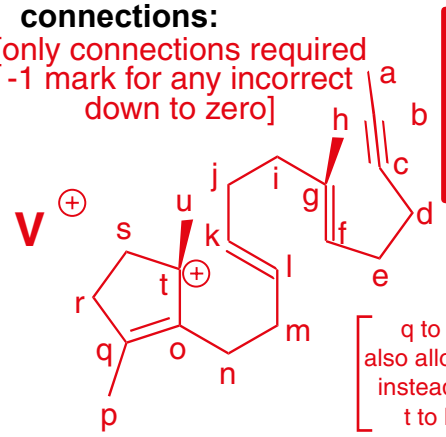


1

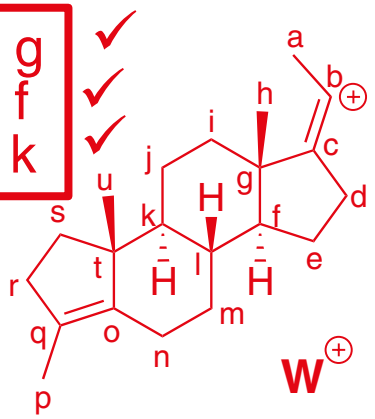
2(i)

connections:
[only connections required
-1 mark for any incorrect
down to zero]

c to g
l to f
t to k



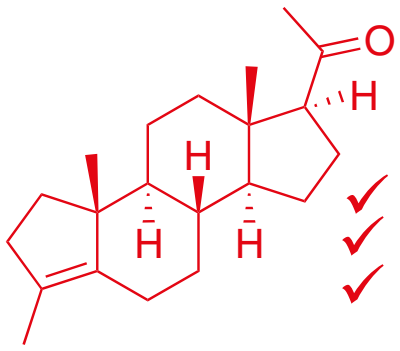
q to k
also allowed
instead of
t to k



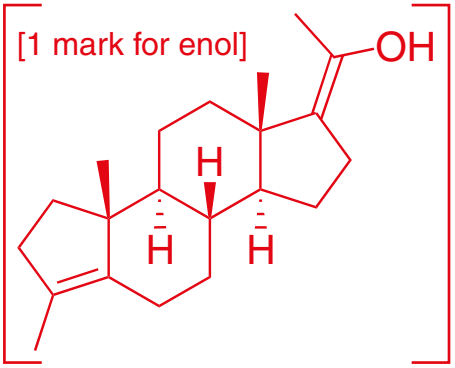
3

2(j)

Compound X

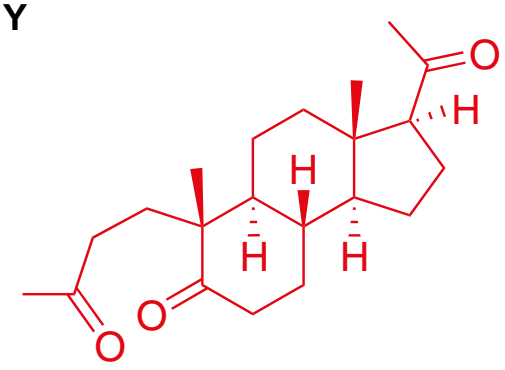


[1 mark for enol]



3

Compound Y



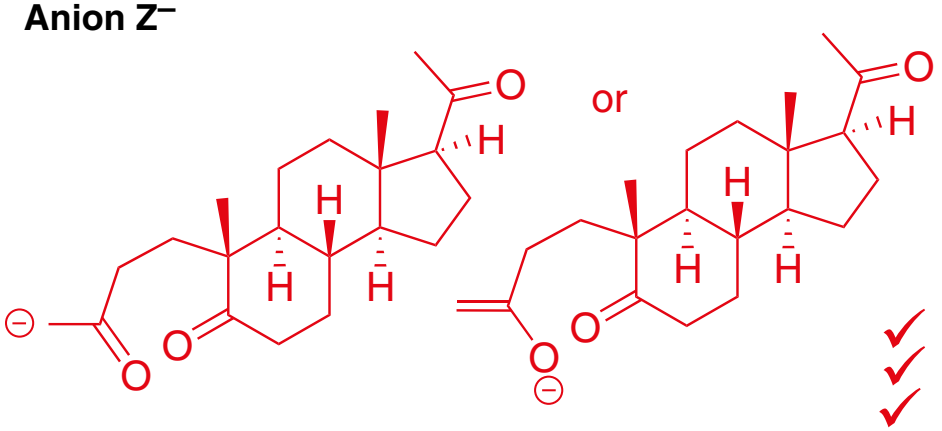
3

Page total 10

leave blank

2(j)

Anion Z^-



[either structure fine]

3

Page total 3