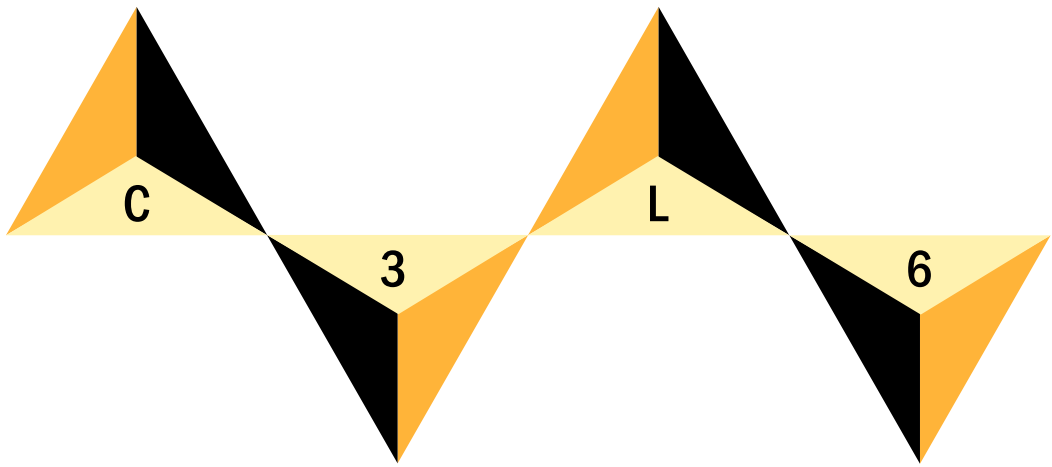


Cambridge Chemistry Challenge Lower 6th

June 2011

Marking scheme for teachers

(please also read the additional instructions)

leave blank

1(a)

name of isomer	class of compound
cyclopropane ✓	cycloalkane ✓
propene ✓	alkene ✓

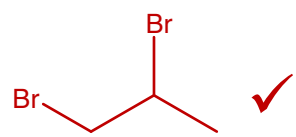
[answers can be either way round]

4

(b)

Structure of A

Structure of F

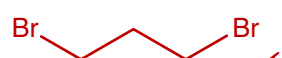


2

(c)

Structure of B

Structure of G



2

(d) (i) Equation for combusion:

$$C_3H_6(g) + 9/2\ O_2(g) \longrightarrow 3CO_2(g) + 3H_2O(g)$$ ✓

[quantities may be doubled]

1

(ii) Standard enthalpy of formation of A:

$$[9/2\ O_2(g)] + 3C(s) + 3H_2(g) \xrightarrow{\Delta_f H^{\ominus}(A)} \text{  } + [9/2\ O_2(g)]$$

$3(-393.5)$ $3(-241.8)$ -2058

$$3CO_2(g) + 3H_2O(g)$$

$\Delta_f H^{\ominus}(A) = 2058 - 3(393.5) - 3(241.8) = +152.1\ kJ\ mol^{-1}$ ✓✓

[one mark if correct value but wrong sign;
also one mark if equation is doubled and value is doubled]

2

leave blank

(d) (iii) Standard enthalpy of formation of B:

$\Delta_f H^{\ominus}(A) = 2091 - 3(393.5) - 3(241.8) = +185.1 \text{ kJ mol}^{-1}$ ✓✓ 2

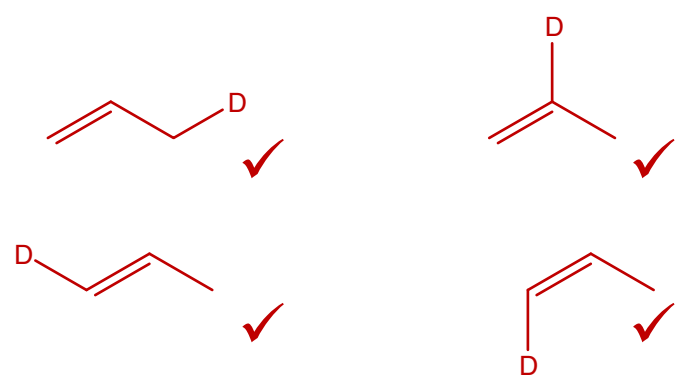
[one mark if correct value but wrong sign;
also one mark if equation is doubled and value is doubled]

(e) Standard enthalpy change for reaction B → A:

$\Delta_r H^{\ominus} = 152.1 - 185.1 = -33 \text{ kJ mol}^{-1}$ ✓ 1

[or $\Delta_r H^{\ominus} = -2081 - (-2058) = -33 \text{ kJ mol}^{-1}$]

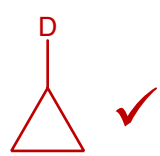
(f) (i) Structure(s) of A with one D.



4

[+1 for each correct structure
–1 for any additional repetition]

(ii) Structure(s) of B with one D.

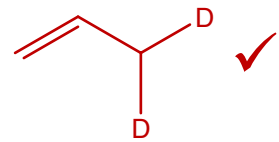


1

[+1 for correct structure,
0 if more than one structure is drawn]

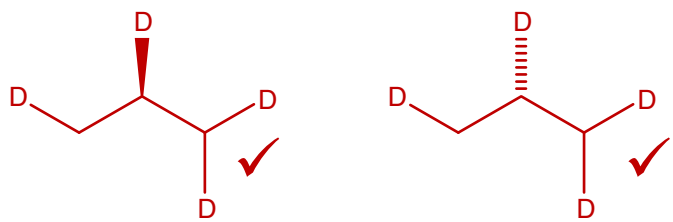
leave blank

(g) **Structure of A1:**



1

(h) **Structures of X1 and X2:**



[answers can be either way round]

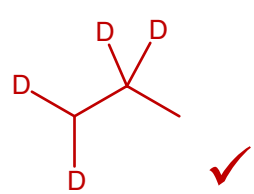
2

(i) **Structures of A2 and A3:**

[answers can be either way round]

2

(j) (i) **Structure of Y:**



1

(ii) **Structures of A4 and A5:**

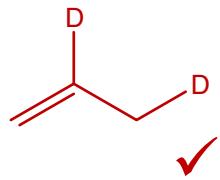
[answers can be either way round]

2

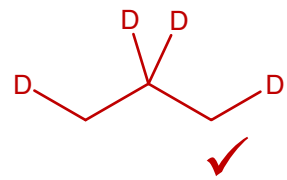
leave blank

(k)

Structure of A6:



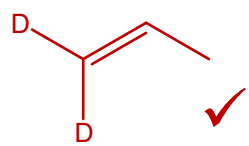
Structure of Z:



2

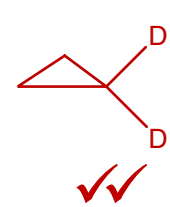
(l)

Structure of A7:



1

(m)

	NO plane of symmetry	Plane of symmetry
NO rotational symmetry	**Structure(s)**	**Structure(s)** 
Rotational symmetry	**Structure(s)**  (enantiomers) 	**Structure(s)** 

2 marks for each correct structure in the correct box
1 mark for a correct structure but in the wrong box (up to 4 marks)
–1 mark for any duplicate structure (down to zero)

8

Total 38

leave blank

2(a)

(i) oxidation state **(ii) shape:**

+4 ✓ octahedral ✓

2

(b)(i)

Formula for W

NaF ✓

1

(ii)

Formula for X **shape:**

SiF_4 ✓ tetrahedral ✓

2

(iii)

Equation for formation of W and X

$Na_2SiF_6(s) \longrightarrow 2NaF(s) + SiF_4(g)$ ✓

1

(c)(i)

Formula for Y **Formula for Z**

CaF_2 ✓ SiH_4 ✓

Equation for formation of Y and Z

$2CaH_2(s) + SiF_4(g) \longrightarrow 2CaF_2(s) + SiH_4(g)$ ✓

3

(ii)

Equation for combustion of Z:

$SiH_4(g) + 2O_2(g) \longrightarrow SiO_2(s) + 2H_2O(l)$ ✓

1

(d)

Equation for decomposition of Z

$SiH_4(g) \longrightarrow Si(s) + 2H_2(g)$ ✓

1

leave blank

(e)(i) **calculate n**

$n = (8 \times 1/8) + (6 \times 1/2) + 4 = 8$ ✓✓

2

(ii) **number of atoms in sphere**

n atoms in a^3 pm^3 $\equiv a^3 \times 10^{-36}$ m^3

volume of sphere = V cm^3 $\equiv V \times 10^{-6}$ m^3

atoms in volume V = $\frac{V\,n}{a^3} \times 10^{30}$ ✓✓✓

2 marks for expression
3rd mark if with factor of $\times 10^{30}$

3

(iii) **Expression for Avogadro constant**

atoms in m g = $\frac{V\,n}{a^3} \times 10^{30}$

atoms in 1 g = $\frac{V\,n}{ma^3} \times 10^{30}$

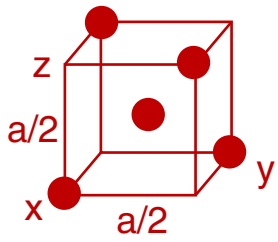
atoms in Ar g = $\frac{A_r\,V\,n}{m\,a^3} \times 10^{30}$ ✓✓✓

2 marks for expression
3rd mark if with factor of $\times 10^{30}$

3

leave blank

(f) **Si–Si bond length**



$xy = \sqrt{\frac{a^2}{4} + \frac{a^2}{4}} = \frac{a}{\sqrt{2}}$

$yz = \sqrt{\frac{a^2}{2} + \frac{a^2}{4}} = \frac{\sqrt{3}\,a}{2}$

yz = twice bond length

Si–Si bond length = $\frac{\sqrt{3}\,a}{4}$ pm (=0.433a pm) ✓✓✓✓

[3 marks if correct but no unit; 2 marks for twice the answer; 1 mark for some Pythagorean working but wrong answer]

4

(g) **A_r for silicon**

$A_r = (1 - 41.2\times10^{-6} - 1.3\times10^{-6}) \times 27.97692653$

$+ (41.2\times10^{-6} \times 28.97649470)$

$+ (1.3\times10^{-6} \times 29.97377017)$

$= 27.97697031$ ✓✓

[1 mark for some correct working but wrong answer]

2

(h) **Calculated value for Avogadro constant**

putting values into expression gives

$6.02214096 \times 10^{23}$ ✓

1 mark if this answer. No carry forward.

1

Total 26