Cambridge Chemistry Challenge Lower 6th

June 2011

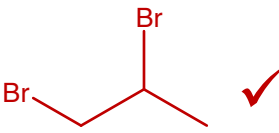# Marking scheme for teachers
(please also read the additional instructions)

1(a)

name of isomer	class of compound
cyclopropane ✓	cycloalkane ✓

name of isomer	class of compound
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 combustion:

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

[quantities may be doubled]

1

(ii) Standard enthalpy of formation of A:

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

3(−393.5)   3(−241.8)   −2058

$$3CO_2(g) + 3H_2O(g)$$
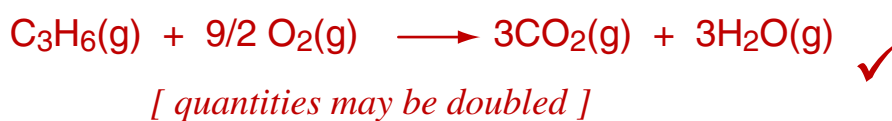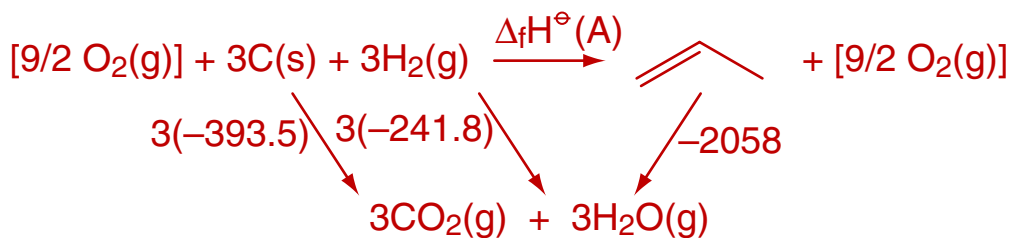
$$\Delta_fH^{\ominus}(A) = 2058 - 3(393.5) - 3(241.8) = +152.1\ kJ\ mol^{-1}$$ ✓✓

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

2

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

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

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

2

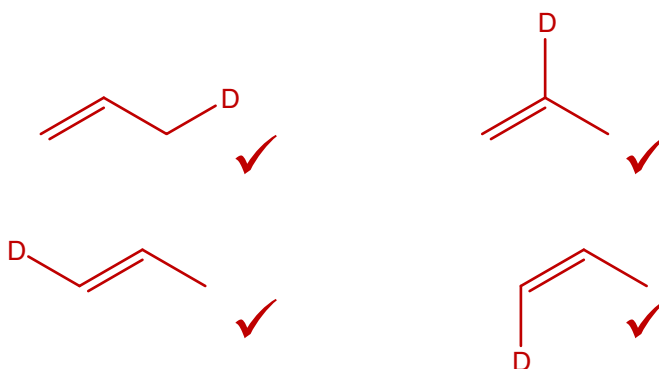**(e) Standard enthalpy change for reaction B → A:**

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

1

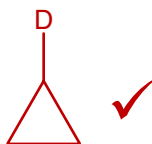[or $\Delta_r H^\ominus = -2081 - (-2058) = -33 \text{ kJ mol}^{-1}$]

(f) (i)

Structure(s) of A with one D.

[+1 for each correct structure
−1 for any additional repetition]
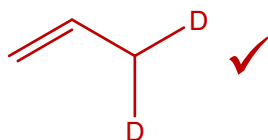
4

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

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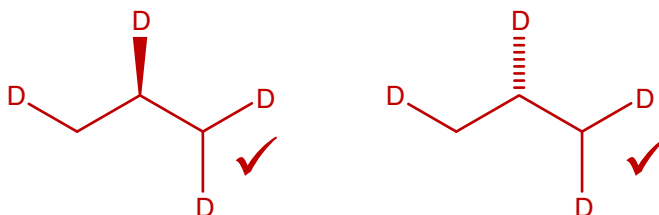0 if more than one structure is drawn]

1

(g)

Structure of A1:

✔

1

(h)

Structures of X1 and X2:

✔   ✔

[answers can be either way round]

2

(i)
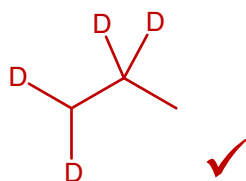
Structures of A2 and A3:

✔   ✔

[answers can be either way round]

2

(j) (i)

Structure of Y:

✔

1

(ii)

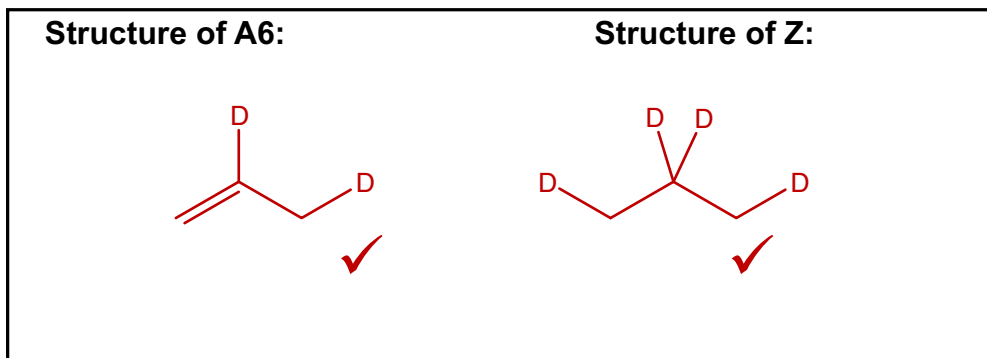**Structures of A4 and A5:**

✔   ✔

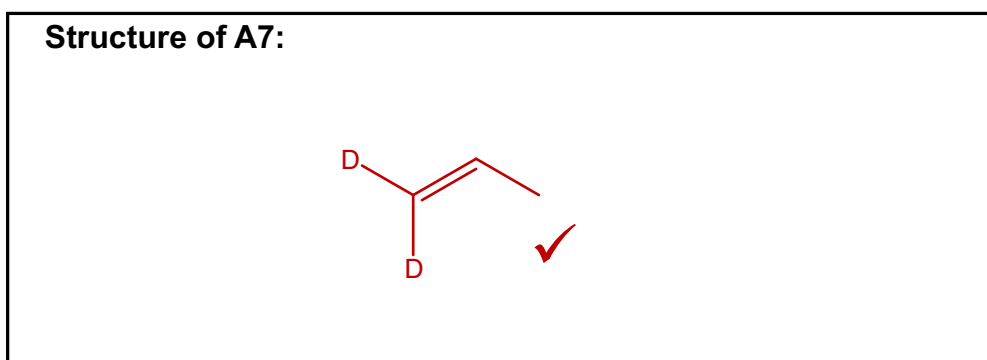*[answers can be either way round]*

2

(k)

Structure of A6:	Structure of Z:

2

(l)

Structure of A7:

1

(m)

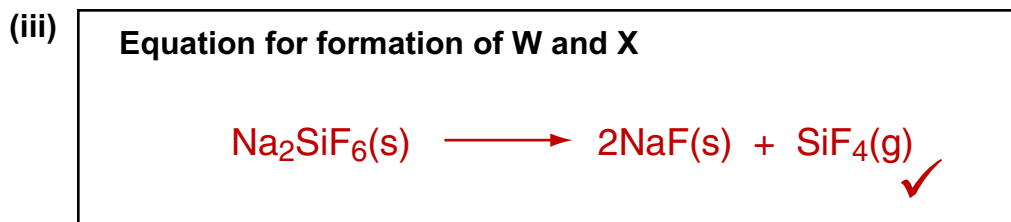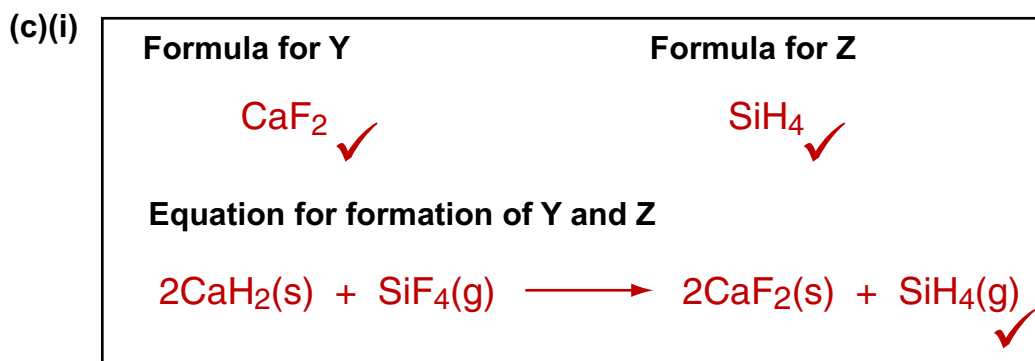|	NO plane of symmetry	Plane of symmetry
	Structure(s)	Structure(s)
NO rotational symmetry		
	2 marks for each correct structure in the correct box 1 mark for a correct structure but in the wrong box (up to 4 marks) −1 mark for any duplicate structure (down to zero)	
	Structure(s)	Structure(s)
Rotational symmetry	 (enantiomers) 	

8

Total 38

2(a)

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

+4 ✓   octahedral ✓

(b)(i)

Formula for W

NaF ✓

(ii)

Formula for X   **shape:**

SiF_4 ✓   tetrahedral ✓

(iii)

Equation for formation of W and X

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

(c)(i)

Formula for Y   **Formula for Z**

CaF_2 ✓ SiH_4 ✓

Equation for formation of Y and Z

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

(ii)

Equation for combustion of Z:

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

(d)

Equation for decomposition of Z

$SiH_4(g) \longrightarrow Si(s) + 2H_2(g)$ ✓
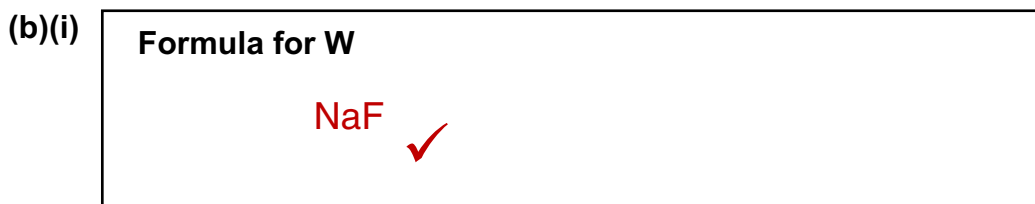
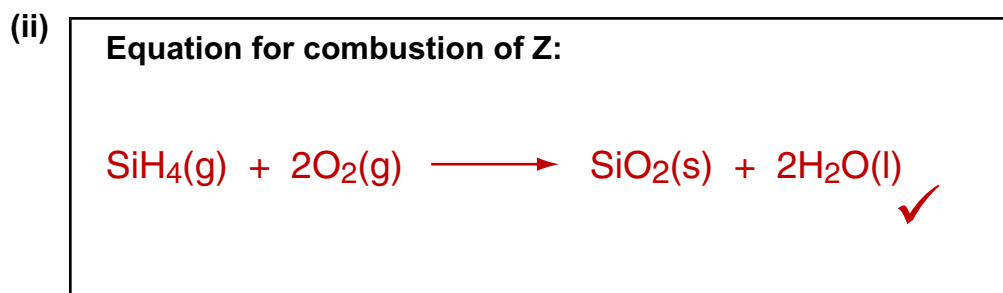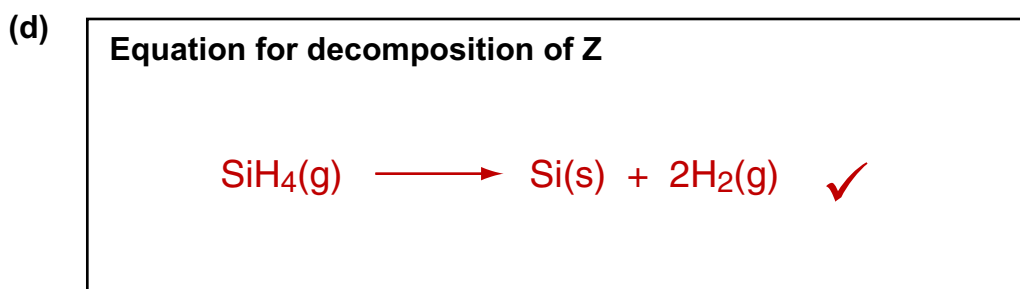**(e)(i)** calculate n

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

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 = $\dfrac{V\,n}{a^3} \times 10^{30}$ ✓✓✓

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

3

(iii) Expression for Avogadro constant

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

atoms in 1 g = $\dfrac{V\,n}{m\,a^3} \times 10^{30}$

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

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

3
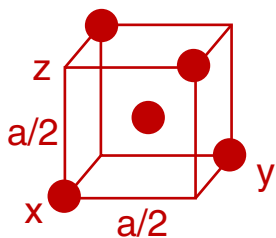
(f) **Si–Si bond length**

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

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

yz = twice bond length

Si–Si bond length = $\dfrac{\sqrt{3}\,a}{4}$ 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**

$A_r = (1 - 41.2 \times 10^{-6} - 1.3 \times 10^{-6}) \times 27.97692653$

$\qquad + (41.2 \times 10^{-6} \times 28.97649470)$

$\qquad + (1.3 \times 10^{-6} \times 29.97377017)$

$\qquad\qquad = 27.97697031$ ✓✓

[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