Cambridge Chemistry Challenge Lower 6th

December 2024

Marking scheme for teachers

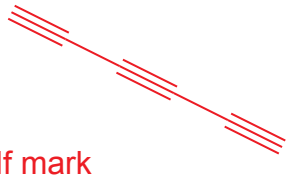
(please also read the additional instructions)

	p2	p3	p4	p5	p6	p7	Total
mark	12	18	9	9	7	11	66

Marks available

1(a) (i)

A



half mark

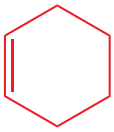
B



half mark

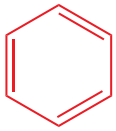
1

C



half mark

D



half mark

1

(ii) 8 DBE ✓

1

1(b) (i) C_nH_{2n} ✓

(ii) C_nH_{2n-6} ✓

2

(iii) C_nH_{2n-2} ✓

(iv) $C_nH_{2n-2x+2}$ ✓

2

1(c) $DBE = (2n + 2 - y) / 2$ ✓

1

1(d) (i) 4 DBE ✓

(ii) 5 DBE ✓

2

(iii) 4 DBE ✓

(iv) 5 DBE ✓

2

Page total 12

Marks available

1(e) (i) number 4 DBE; formula $C_4H_2O_4$ (half each) ✓ — 2

(ii) number 3 DBE; formula $C_8H_{12}O_6$ ✓

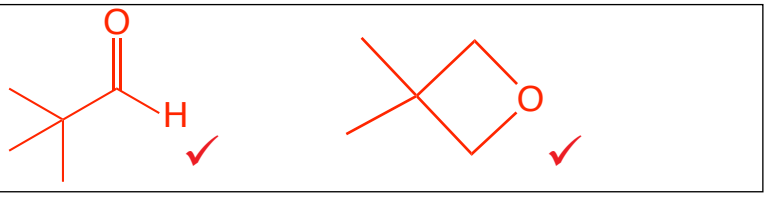
(iii) number 13 DBE; formula $C_{12}O_9$ ✓ — 1

1(f) (i) number 17 DBE ✓✓ — 2

(ii) formula $C_{62}H_{92}O_{19}$ ✓✓ ✓

give 2 marks e.c.f. from 1(f)(i) — 3

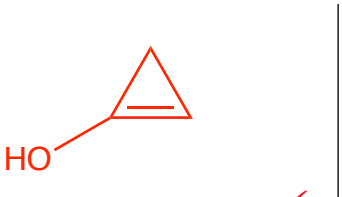
1(g) (i)

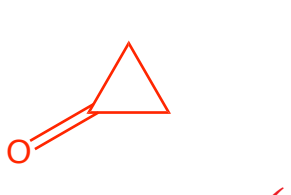


✓ ✓ — 2

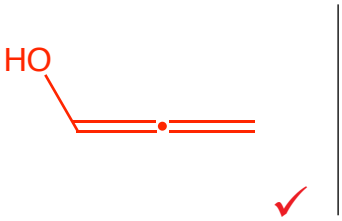
(ii) number 20 unique carbon environments ✓✓ — 2

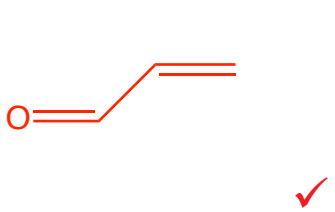
1(h) (i)



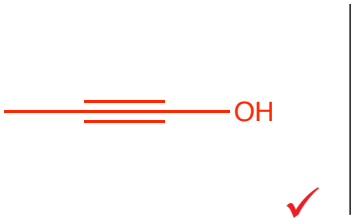


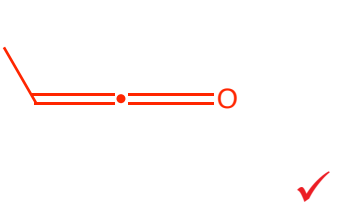
✓ ✓ — 2





✓ ✓ — 2





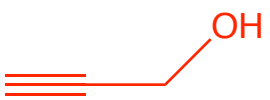
✓ ✓ — 2

Page total 18

Marks available

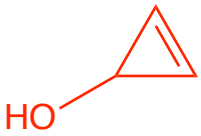
1(h) (ii)

K



✓

L



✓

2

1(h) (iii)

M



✓

number

3 Hydrogen environments

✓

2

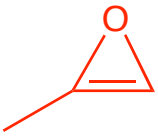
1(h) (iv)

N



✓

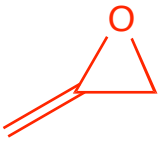
O



✓

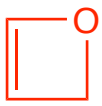
2

P



✓

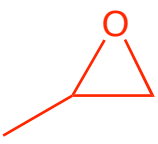
Q



✓

2

R



✓

1

Page total 9

Marks available

2(a) (i)



✓

1

2(a) (ii)

$6Hg + 8HNO_3 \longrightarrow 3Hg_2(NO_3)_2 + 2NO + 4H_2O$

no marks if $HgNO_3$ ✓

1

2(a) (iii)

$3Hg + 8HNO_3 \longrightarrow 3Hg(NO_3)_2 + 2NO + 4H_2O$ ✓

1

2(a) (iv)

$NO + \frac{1}{2}O_2 \longrightarrow NO_2$ ✓

1

2(b)

$H_2NHg_2NO_3$ ✓ | H_2NHgNO_3 ✓

2

2(c) (i)

original stock solution concentration

$= 8.21 \times 10^{-16} \times (100)^6$ mg mL^{-1} = 8.21×10^{-4} mg mL^{-1}

8.21×10^{-4} mg mL^{-1} = 8.21×10^{-4} g dm^{-3}

$= 8.21 \times 10^{-4} / 200.59$ mol dm^{-3}

$= 4.09 \times 10^{-6}$ mol dm^{-3} ✓✓

2

2(c) (ii)

30C solution

$= 4.09 \times 10^{-6} / 10^{30} = 4.09 \times 10^{-66}$ mol dm^{-3} ✓

[allow e.c.f. from 2(c)i i.e. answer / 10^{60}]

1

Page total 9

Marks available

2(c) (iii) — 1

28 mL of 6C solution contains
$28 \times 8.21\times10^{-16}$ mg of Hg^{2+} ions = $28 \times 8.21\times10^{-19}$ g

RMM $Hg(NO_3)_2$ = 324.61

So 28 mL of 6C solution contains
$28 \times 8.21\times10^{-19} \times 324.61 / 200.59$ g of $Hg(NO_3)_2$
$= 3.72 \times10^{-17}$ g

$3.72 \times10^{-17} / 10^{388}$ g = 3.72×10^{-405} g ✓

[no e.c.f.]

2(d) (i) — 1

RMM $Hg(NO_3)_2$ = 324.61
mass of Hg2+ in 0.5 g of $Hg(NO_3)_2$

$= 0.5 \times 200.59 / 324.61$ g = 0.3 g ✓

2(d) (ii) — 2

1 L of 6C solution contains
8.21×10^{-16} g of Hg^{2+} ions

So the toxic dose is contained in

$0.5 \times 200.59 / 324.61 \times 8.21\times10^{-16} = 3.76 \times10^{14}$ L

i.e. 4×10^{14} L ✓✓

2(d) (iii) — 1

3.7×10^{14} L = $3.7 \times10^{14} / 2.5 \times10^{6}$

times the volume of the pool

$= 1.5 \times10^{8}$ ✓

2(e) (i) — 1

1C

$1 / 100^2 = 1 \times10^{-4}$

½ mark

(ii)

3C

$1 / 100^3 = 1 \times10^{-6}$

½ mark

(iii) — 1

4C

$1 / 100^4 = 1 \times10^{-8}$

½ mark

(iv)

1M

$1 / 100^{1000} = 1 \times10^{-2000}$

½ mark

Page total 7

Marks available

2(f) (i)

pH = 7.0 $[H^+] = 10^{-pH} = 10^{-7}$ ✓

1

2(f) (ii)

$pH = -\log_{10}[1.0] = 0$ ✓

1

2(f) (iii)

(i)

2C

$pH = -\log_{10}[1.0 \times 10^{-4}]$

$= \underline{\underline{4.0}}$

½ mark

(ii)

3C

$pH = -\log_{10}[1.0 \times 10^{-6}]$

$= \underline{\underline{6.0}}$

½ mark

1

(iii)

4C

$[H+] = 1\times10^{-7} + 1\times10^{-8}$

$= 1.1 \times10^{-7}$

$pH = -\log_{10}[1.1 \times10^{-7}]$

$= 6.96$ i.e. $\underline{\underline{7.0}}$ ½ mark

(iv)

1M

$[H+] = 1.0\times10^{-7}$

$pH = -\log_{10}[1.0 \times10^{-7}]$

$= \underline{\underline{7.0}}$ ½ mark

1

2(g) (i)

density is 1.41 g cm^{-3} so 1 dm^{-3} has a mass of 1410 g

mass of HNO_3 in 1410 g = 1410 × 0.68 g = 958.8 g ✓

RMM of HNO_3 = 63.018

number moles in 958.8 g = 958.8 / 63.018 = 15.2

concentration = $\underline{\underline{15.2 \text{ mol dm}^{-3}}}$ ✓✓

3

2(g) (ii)

$pH = -\log_{10}[12]$

$= -1.1$ ✓

1

2(g) (iii)

moles of water in 1 kg = 1000 / (18.016) = 55.5

concentration of water = 55.5 mol dm^{-3} ✓

1

2(h)

$[H^+] = 10^{31.3}$ mol dm^{-3} ✓

mass of 1000 cm^3 = $1.008 \times 10^{31.3}$ g

so mass of 5 cm^3 = $1.008 \times 10^{31.3} \times 5 / 1000$

= 1.0×10^{29} g (which is ca. 17 times the mass of the Earth) ✓

2

Page total 11