CHEMISTRY 2021

Unit 3
Key Topic Test 2 - Combustion

Recommended writing time*: 45 minutes
Total number of marks available: 50 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: B

Explanation:

Carbon monoxide is formed instead of carbon dioxide when there is a shortage of oxygen. ΔH is lower and less energy is produced. There is some oxygen involved in the reaction.

Question 2

Answer: D

Explanation:

$q = mc\Delta T = 2.50 \times 4.18 \times 15 = 157$ J

Question 3

Answer: B

Explanation:

$\Delta T = q/mc = 12000 / 200 \times 4.18 = 14$
$25+14=39°C$

Question 4

Answer: A

Explanation:

$n(CO_2) = 4n(C_4H_{10})$
$n \alpha V$, so $V(CO_2) = 4V(C_4H_{10}) = 4 \times 10 = 40$ mL

Question 5

Answer: C

Explanation:

$n(CH_4) = m/M = 2.5/16 = 0.1563$ mol
$V = nRT/P = 0.1523 \times 8.31 \times 283 / 2.5 \times 101.3 = 1.45L$

Question 6

Answer: A

Explanation:

Once the reaction starts, the energy required to break the bonds is less than the energy produced when the bonds reform in the products. Therefore once the reaction starts, the energy produced is then used to break more bonds.

Question 7

Answer: D

Explanation:

Chemical energy is converted to heat energy and the heat content of the products is less than the heat content of the reactants. For the reverse reaction, 283 kJ of energy is required.

Question 8

Answer: C

Explanation:

With twice the amount of water and the same amount of energy being absorbed, the temperature rise would be halved.

Question 9

Answer: A

Explanation:

n = m/M = 16/32 = 0.50 mol
V = n x 24.8 = 0.50 x 24.8 = 12.4 L

Question 10

Answer: D

Explanation:

When water is converted from a gas to a liquid, $\Delta H = -41 kJmol^{-1}$
There is 9 mol of water, so $\Delta H = -41 \times 9 = 369\ kJmol^{-1}$
$-369 + -5054 = -5423\ kJmol^{-1}$

SECTION B: Short-answer questions

Question 1

a. $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$ $\Delta H = -2220\ kJmol^{-1}$ (1 mark for a balanced equation and 1 for a correct ΔH.)

2 marks

b. $n = \frac{V}{24.8} = \frac{15}{24.8} = 0.6048mol$

$n(C_3H_8) = \frac{1}{5} \times 0.6028 = 0.1210mol$

$m = n \times M = .1210 \times 44.0 = 5.32g$

3 marks

c. **i.** $V(O_2) = 5V(C_3H_8) = 5 \times 60 = 300\ mL$

ii. final volume – initial volume = 420mL – 360mL = 60mL (increase)

2 marks

Total 7 marks

Question 2

a. $C_5H_{12}O_{(g)} + 7.5O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(l)}$ (one mark for correct formulae and one mark for correct balancing)

2 marks

b. 3331 kJ for 88g

x kJ for 1g

$x = \frac{3331}{88} = 37.85\ kJg^{-1}$

2 marks

c. 1.0g → 37.85 kJ

20.0g → 37.85 x 20 = 757 kJ

2 marks

Total 6 marks

Question 3

a. 1.00 kg → 25.5 MJ

x → 100MJ

$x = \frac{100}{25.5} = 3.92\ kJ$

2 marks

b. $n = \frac{n}{M} = \frac{1\ 500\ 000}{12} = 125\ 000$ mol of CO_2*

$V = \frac{nRT}{P} = \frac{125\ 000\ x\ 8.31\ x\ (42+273)}{110}$ * = 2 975 000 L*

3 marks

Total 5 marks

Question 4

a. $q = mc\Delta T = 99.7 \times 4.18 \times 25.3 = 10\,580$ J = 10.58 kJ

1 mark

b. 10.58 kJ for 0.560 g
x for 1.00 g
$x = \frac{10.58}{0.560} =$ -18.88 kJg^{-1}

2 marks

c. 18.88 kJ for 1.00 g
So for 1 mol or 60.0 g, 18.88 x 60 = - 1133 $kJmol^{-1}$

1 mark

d. A lot of energy is absorbed by the container, thermometer and air. (any 2)

2 marks

e. 1133 x $\frac{4}{3}$ = 1510 $kJmol^{-1}$
(any reasonable estimation *, any logical working*)

2 marks
Total 8 marks

Question 5

a. Endothermic

1 mark

b. **i.** 40 $kJmol^{-1}$
ii. 100 $kJmol^{-1}$

2 marks

c. **i.** -40 $kJmol^{-1}$
ii. 60 $kJmol^{-1}$

2 marks
Total 5 marks

Question 6

a. 1 mol → 1360 kJ
x mol → 1000 kJ
$x = \frac{1000}{1360}$ = 0.7353 mol *
$n(CO_2) = 2n(C_2H_5OH)$ = 1.471mol *
$V = \frac{nRT}{P} = \frac{1.471\ x\ 8.31\ x\ 283}{101.3}$ * = 34.1 L*

4 marks

b. The carbon dioxide produced is theoretically balanced by the carbon dioxide consumed in producing the plants* which undergo fermentation to produced ethanol.*

2 marks
Total 6 marks

Question 7

a. 2 mol → 286 kJ
So 1 mol → 143 kJ

1 mark

b. The equation is reversed and doubled so $\Delta H = -572\ kJmol^{-1}$

1 mark

c. 286 kJ

1 mark

Total 3 marks