

GCSE Chemistry A (Gateway Science) J248/04 Chemistry A C4-C6 and C7 (Higher Tier)

Question Set 23

1 The reversible reaction between carbon dioxide and hydrogen makes methane and water.

(a) In a sealed container, this reversible reaction forms a dynamic equilibrium.What is meant by the term dynamic equilibrium?

Refer to both concentration and rate of reaction in your answer.

(b) A student investigates this reaction between carbon dioxide and hydrogen.

He predicts that 11.0 g of carbon dioxide should make 4.0 g of methane.

In an experiment, he finds that 11.0 g of carbon dioxide makes 2.2 g of methane.

Calculate the percentage yield of methane.

Answer =% [2]

(c)* The student investigates the effect of changing pressure and changing temperature on this reaction.

 $CO_2(g) + 4H_2(g) \rightleftharpoons CH_4(g) + 2H_2(I)$

The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

| | | Pressure (in atmospheres) | | | | | |
|---------------------|------|---------------------------|-----|-----|-----|--|--|
| | | 100 | 200 | 300 | 400 | | |
| Temperature (in °C) | 300 | 35% | 52% | 65% | 80% | | |
| | 600 | 30% | 46% | 58% | 74% | | |
| | 900 | 23% | 37% | 47% | 62% | | |
| | 1200 | 14% | 25% | 36% | 48% | | |

He predicts that the reaction between carbon dioxide and hydrogen is endothermic and involves a reduction in the volume of gases.

Describe and explain whether his predictions are supported by the reaction and results in the table.

[6]

[2]

Total Marks for Question Set 23: 10

Resource Materials

| (0) | 18 He He 4.0 | 10 Neon 20.2 | 18 Ar 39.9 | 36 Kr krypton 83.8 | 54 Xe ^{xenon} 131.3 | 86 Rn ^{radon} | |
|---|--------------------|----------------------------|---------------------------------------|---|--|--|---------------------------------------|
| (2) | 1 | 9 19.0 | 17 C1 chlorine 35.5 | 35 Br ^{bromine} 79.9 | 53 I lodine 126.9 | 85 At _{astatine} | |
| (9) | 16 | 8 0 0 16.0 | 16 S 32.1 | 34 Se selenium 79.0 | 52 Te tellurium 127.6 | 84 Po Polonium | 116 Lv livermorium |
| (5) | | 7 N nitrogen 14.0 | 15 Phosphorus 31.0 | 33 As arsenic 74.9 | 51 Sb ^{antmony} 121.8 | 83 Bi ^{bismuth} 209.0 | |
| (4) | 14 | 6 C carbon 12.0 | 14 Si 28.1 | 32 Ge germanium 72.6 | 50 Sn ^{tin} 118.7 | 82 Pb lead 207.2 | 114 F1 fierovium |
| (3) | 13 | 5 Baron 10.8 | 13 A1 aluminium 27.0 | 31 Ga ^{gallium} 69.7 | 49 In ^{indium} 114.8 | 81 T1 thallium 204.4 | |
| | | | 12 | 30 Zn ^{zinc} 65.4 | 48 Cd cadmium 112.4 | 80 Hg ^{mercury} 200.6 | 112 Cn copernicium |
| | | | 5 | 29 Cu 63.5 | 47 Ag silver 107.9 | 79 Au ^{gold} 197.0 | 111 Rg roentgenium |
| 5 | | | | 28 Ni 58.7 | 46 Pd ^{palladum} 106.4 | 78 Pt platinum 195.1 | 110 DS ^{darmsta dijum} |
| თ | | | | 27 Co cobalt 58.9 | 45 Rh ^{thodium} 102.9 | 77 Ir ^{iidum} 192.2 | 109 Mt ^{meitnerium} |
| œ | | | | 26 Fe ^{Iron} | 44 Ru ruthenium 101.1 | 76 Os ^{osmium} 190.2 | 108 Hs ^{hassium} |
| | | _ | 7 | 25 Mn ^{manganese} 54.9 | 43 Tc technetium | 75 Re ^{rhenium} 186.2 | 107 Bh ^{bohrium} |
| | ber mass | | 9 | 24 Cr chronium 52.0 | 42 Mo ^{molybdenum} 95.9 | 74 W tungsten 183.8 | 106 Sg ^{seaborgium} |
| Key mic numb Symbol e atomic /e atomic / | | | ъ | 23 V vanadlum 50.9 | 41 Nb ^{niobium} 92.9 | 73 Ta tantalum 180.9 | 105 Db ^{dubnium} |
| | atc relativ | | 4 | 22 Ti ttanium 47.9 | 40 Zr ≊rconium 91.2 | 72 Hf hathium 178.5 | 104 Rf rutherfordium |
| | | | | 21 Sc scandium 45.0 | 39 yttrium 88.9 | 57-71 lanthanoids | 89—1 03 actinolds |
| (2) | ~ | Be beryllum 9.0 | 12 Mg 24.3 | 20 Ca calclum 40.1 | 38 Sr 87.6 | 56 Ba barium 137.3 | 88 Ra ^{rađium} |
| (1) | hydrogen 1.0 | 3 Li Bithium 6.9 | 11 Na ^{sodium} 23.0 | 19 K potassium 39.1 | 37 Rb ^{rubidium} 85.5 | 55 Cs caesium 132.9 | 87 Fr francium |

The Periodic Table of the Elements



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