Unit 8 · Chemical Reaction

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 49

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Spot the errors

ANSWER U · 3

1. The mole ratio is missing: $2KClO_3 \rightarrow 2KCl + 3O_2$, so 3 mol O_2 come from 2 mol $KClO_3$. $n(KClO_3) = 0.075 \times 2 \div 3 = 0.05$ mol.
2. Manganese dioxide is a catalyst: it isn't used up and gives no oxygen, so nothing is taken off. The mass is $0.05 \times 122.5 =$ **6.125 g**, about 6.13 g.

MARKING SCHEME

- ✓ 0.075 mol O_2 needs 0.05 mol $KClO_3$ (the ratio 2 : 3).
- ✓ The catalyst isn't used up and gives no oxygen.
- ✓ Mass = $0.05 \times 122.5 = 6.13$ g.

2 Three unlabeled solutions

ANSWER A · 5

i. **A is iron(III) chloride, B copper sulphate, C potassium nitrate.**

ii. $FeCl_3 + 3NaOH \rightarrow Fe(OH)_3\downarrow + 3NaCl$.

iii. $Ag^+ + Cl^- \rightarrow AgCl$.

iv. Add barium chloride solution: a white precipitate of barium sulphate shows a sulphate.

v. A and B turn blue litmus red: they are salts of a strong acid and a weak base, so they hydrolyze to give an acidic solution. C changes neither: it is the salt of a strong acid and a strong base, so it is neutral.

MARKING SCHEME

- ✓ A, B and C named.
- ✓ $FeCl_3 + 3NaOH \rightarrow Fe(OH)_3\downarrow + 3NaCl$.
- ✓ $Ag^+ + Cl^- \rightarrow AgCl$.
- ✓ Barium chloride gives a white precipitate.
- ✓ A and B acidic (strong acid, weak base); C neutral.

3 Reading the results

ANSWER A · 5

i. With MnO_2: $30 \div 1 =$ **30 mL/min**. Without: **1 mL/min**, thirty times slower.

ii. All the hydrogen peroxide has decomposed, so no more oxygen can form.

iii. **No.** A catalyst doesn't change how much product forms, only how soon. Without it, the sample also ends at 56 mL, after a much longer time.

iv. 56 mL = 0.056 L; $n(O_2) = 0.056 \div 22.4 = 0.0025$ mol. $2H_2O_2 \rightarrow 2H_2O + O_2$, so $n(H_2O_2) = 0.005$ mol. Mass = $0.005 \times 34 =$ **0.17 g**.

MARKING SCHEME

- ✓ 30 mL/min and 1 mL/min.
- ✓ The hydrogen peroxide has all decomposed.
- ✓ Disagree: a catalyst changes the time, not the amount.
- ✓ $n(O_2) = 0.0025$ mol, so $n(H_2O_2) = 0.005$ mol.
- ✓ Mass = 0.17 g.

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4 Balance by electrons

MARKING SCHEME A · 3

- ✓ Both half-equations, with Al's as the oxidation.
- ✓ 2 Al and 3 Cu^{2+}, 6 electrons each way.
- ✓ The balanced equation, with aluminium as the reducing agent.

5 One reaction, several names

ANSWER U · 4

Reaction	Names	Redox?
$2AgBr \rightarrow 2Ag + Br_2$	photochemical, decomposition	yes: silver ions gain electrons, bromide ions lose them
$FeCl_3 + 3NaOH$	precipitation (double displacement)	no: ions only swap partners; no electrons pass
$2NaCl \rightarrow 2Na + Cl_2$	electrolytic, decomposition	yes: Na^+ gains electrons at the cathode, Cl^- loses them at the anode
$N_2 + 3H_2 \rightleftharpoons 2NH_3$	catalytic, reversible	yes: nitrogen gains hydrogen (reduced), so hydrogen is oxidized

MARKING SCHEME

- ✓ AgBr: photochemical and decomposition; redox.
- ✓ $FeCl_3$: precipitation; not redox.
- ✓ NaCl: electrolytic and decomposition; redox.
- ✓ N_2: catalytic; redox, as nitrogen gains hydrogen.

6 What if?

ANSWER A · 4

i. $n(AgNO_3) = 3.4 \div 170 = 0.02$ mol. $n(NaCl) = 0.585 \div 58.5 = 0.01$ mol. They react 1 : 1, so **sodium chloride** is used up first.

ii. 0.01 mol AgCl: $0.01 \times 143.5 =$ **1.435 g**, about 1.44 g.

iii. 0.01 mol of silver nitrate left over (Ag^+ and NO_3^-), with the sodium nitrate formed (Na^+).

iv. Add more sodium chloride solution to the clear liquid: another white precipitate forms.

MARKING SCHEME

- ✓ 0.02 and 0.01 mol, so sodium chloride runs out first.
- ✓ 1.44 g of silver chloride.
- ✓ 0.01 mol of silver nitrate is left, with sodium nitrate.
- ✓ More chloride gives more white precipitate.

7 A pipe on a fire

ANSWER A · 4

i. $2 \times 12 + 3 + 35.5 =$ **62.5 g/mol**.

ii. $2{,}000 \times 62.5 =$ **125,000 g/mol**.

iii. $1{,}000 \div 62.5 = 16$ mol of units, each with one Cl atom: $16 \times 35.5 =$ **568 g**.

iv. 16 mol of Cl gives 16 mol of HCl: $16 \times 22.4 =$ **358 L** (358.4 L). (The answer doesn't depend on the chain length.)

MARKING SCHEME

- ✓ 62.5 g/mol.
- ✓ 125,000 g/mol.
- ✓ 16 mol of units, 568 g of chlorine.
- ✓ 16 mol of HCl, 358 L at STP.

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8 Work backward

ANSWER HA · 3

i. n units have n − 1 links: 75n − 18(n − 1) = 75n − 18n + 18 = **57n + 18**.
ii. 57n + 18 = 5,718, so 57n = 5,700 and **n = 100**.
iii. 100 − 1 = **99 water molecules**.

MARKING SCHEME

✓ 75n − 18(n − 1) = 57n + 18.
✓ n = 100.
✓ 99 water molecules.

9 Which explanation fits the evidence?

ANSWER HA · 3

Kanchan's. Cellulose is a polymer too, with long chains of glucose units, so chain length can't be the reason: Dipesh's idea would make cotton last as well. A cow's microbes make an enzyme that hydrolyzes cellulose's links, adding water to split them back to glucose. Cellulose has such a link, made by condensation; polythene, made by addition, has none.

MARKING SCHEME

✓ Kanchan's explanation.
✓ Cellulose is also a long polymer, so length isn't the reason.
✓ Cellulose's condensation links can be hydrolyzed by enzymes; polythene has no such link.

10 Prove it's a catalyst

ANSWER A · 4

i. Two equal samples of hydrogen peroxide, one with weighed manganese dioxide and one without. The one with it froths at once and relights a glowing splint; the other shows hardly any gas.
ii. Filter off the powder when the fizzing ends, wash and dry it, and weigh it: the mass is the same as at the start.
iii. Add the recovered powder to fresh hydrogen peroxide: it froths again.
iv. Any one: the same volume and strength of hydrogen peroxide; the same temperature.

MARKING SCHEME

✓ With and without, compared by the froth and a glowing splint.
✓ Filter, dry and weigh: the same mass.
✓ The recovered powder works again on fresh solution.
✓ One thing kept the same.

11 Correct the misconceptions

ANSWER U · 3

1. Hydrogen is the **reducing** agent: it takes the oxygen and is itself oxidized. Copper oxide is the oxidizing agent, and it is reduced.
2. A balanced equation says nothing about whether a reaction happens. Copper doesn't react with dilute hydrochloric acid.
3. Dissolved sugar stays sugar. Hydrolysis needs water to take part and new substances to form, such as sucrose splitting into glucose and fructose.

MARKING SCHEME

✓ Hydrogen is the reducing agent; the reducing agent is the one oxidized.
✓ Balancing doesn't prove a reaction happens: copper doesn't react with dilute HCl.
✓ Dissolving isn't hydrolysis: no new substance forms.

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12 Choose the material

MARKING SCHEME U · 3

- ✓ PTFE: nothing sticks; it stands heat.
- ✓ Nylon: strong and elastic.
- ✓ PVC: it insulates and doesn't rot.

13 Think

ANSWER HA · 3

$100 \div 162 = 0.617$ mol of units. Glucose $= 0.617 \times 180 =$ **111 g**. Water used $= 0.617 \times 18 =$ **11 g**. The law isn't broken: 100 g of starch + 11 g of water = 111 g of glucose. He left out the water, a reactant in hydrolysis.

MARKING SCHEME

- ✓ 0.617 mol of units gives 111 g of glucose.
- ✓ It takes in 11 g of water.
- ✓ 100 + 11 = 111 g: mass is conserved, since water is a reactant.

14 Make your own

ANSWER HA · 2

For example: "Is $2AgCl \rightarrow 2Ag + Cl_2$ in sunlight a redox reaction, a photochemical reaction, or both?" Both, and a decomposition too: light drives it, silver ions gain electrons and chloride ions lose them.

MARKING SCHEME

- ✓ A correct reaction with two correct names.
- ✓ A question and answer that use both.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **3D Printer** (exhibit): The printer melts a plastic filament, a polymer of long chains, which hardens as it cools: a thermoplastic softens again whenever it is heated.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	0	13	25	11	**49**

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