

IB Chemistry HL - R2.1

How much? The amount of chemical change

Exercises + Practice questions

Official answers appended at the end

Exercise

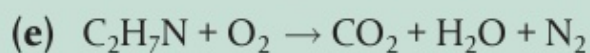
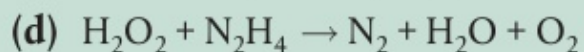
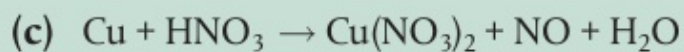
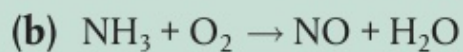
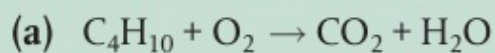
Q1. Write balanced chemical equations, including state symbols, for the following reactions:

- (a) The decomposition of copper(II) carbonate powder (CuCO_3) into copper(II) oxide powder (CuO) and carbon dioxide gas (CO_2).
- (b) The combustion of a magnesium strip (Mg) in oxygen gas (O_2) to form magnesium oxide powder (MgO).
- (c) The neutralization of sulfuric acid solution (H_2SO_4) with sodium hydroxide solution (NaOH) to form aqueous sodium sulfate (Na_2SO_4) and water (H_2O).
- (d) The synthesis of ammonia gas (NH_3) from nitrogen gas (N_2) and hydrogen gas (H_2).
- (e) The combustion of methane gas (CH_4) to produce gaseous carbon dioxide (CO_2) and water vapour (H_2O).

Q2. Write balanced chemical equations for the following reactions:

- (a) $\text{K} + \text{H}_2\text{O} \rightarrow \text{KOH} + \text{H}_2$
- (b) $\text{C}_2\text{H}_5\text{OH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- (c) $\text{Cl}_2 + \text{KI} \rightarrow \text{KCl} + \text{I}_2$
- (d) $\text{CrO}_3 \rightarrow \text{Cr}_2\text{O}_3 + \text{O}_2$
- (e) $\text{Fe}_2\text{O}_3 + \text{C} \rightarrow \text{CO} + \text{Fe}$

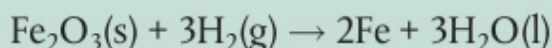
Q3. Use the same processes to balance the following more difficult examples:



the validity of these assumptions in the calculation.

Exercise

Q4. Iron ore can be reduced to iron by the following reaction:

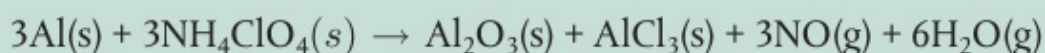


- (a) How many moles of Fe can be made from 1.25 moles of Fe_2O_3 ?
- (b) How many moles of H_2 are needed to make 3.75 moles of Fe?
- (c) If the reaction yields 12.50 moles of H_2O , what mass of Fe_2O_3 was used up?

Q5. Lighters commonly use butane, C_4H_{10} , as the fuel.

- (a) Formulate the equation for the combustion of butane.
- (b) Determine the mass of butane that burnt when 2.46 g of water were produced.

Q6. The fuel used in booster rockets for the Space Shuttle is a mixture of aluminium and ammonium perchlorate. The reaction equation is as follows:



Calculate the mass of NH_4ClO_4 that should be added to this fuel mixture to react completely with every kilogram of Al.

Q7. Limestone is mostly calcium carbonate, CaCO_3 , but it also contains other minerals. When heated, the CaCO_3 decomposes into CaO and CO_2 . A sample of 1.605 g of limestone was heated and gave off 0.657 g of CO_2 .

- (a) Formulate the equation for the thermal decomposition of calcium carbonate.
- (b) Determine the percentage mass of CaCO_3 in the limestone.
- (c) State the assumptions you are making in this calculation.

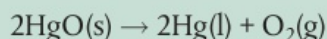
Q8. How many moles are present in each of the following at STP?

- (a) $54.5 \text{ dm}^3 \text{ CH}_4$
- (b) $250.0 \text{ cm}^3 \text{ CO}$
- (c) $1.0 \text{ m}^3 \text{ O}_2$

Q9. What is the volume of each of the following gases at STP?

- (a) 44.00 g N_2
- (b) 0.25 mol NH_3

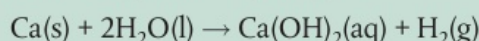
Q10. Pure oxygen gas was first prepared by heating mercury(II) oxide, HgO .



What volume of oxygen, at STP, is released by heating 12.45 g of HgO ?

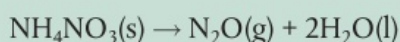
Q11. At STP, which sample contains more molecules, 3.14 dm^3 of bromine, Br_2 , or 11.07 g of chlorine, Cl_2 ?

Q12. Calcium reacts with water to produce hydrogen.



Calculate the volume of hydrogen gas produced, at STP, when 0.200 g of calcium reacts completely with water.

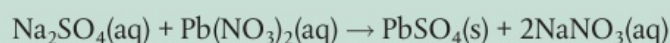
Q13. Dinitrogen oxide, N_2O , is a greenhouse gas produced from the decomposition of artificial nitrate fertilizers. Calculate the volume of N_2O produced from 1.0 g of ammonium nitrate when it reacts, at STP, according to the equation:



Q14. In a titration, a 15.00 cm^3 sample of H_2SO_4 required 36.42 cm^3 of $0.147 \text{ mol dm}^{-3}$ NaOH solution for complete neutralization. What was the concentration of the H_2SO_4 ?

Q15. Gastric juice contains hydrochloric acid, HCl . A 5.00 cm^3 sample of gastric juice required 11.00 cm^3 of $0.0100 \text{ mol dm}^{-3}$ KOH for neutralization in a titration. What was the concentration of HCl in this fluid? If we assume a density of 1.00 g cm^{-3} for the fluid, what was the percentage by mass of HCl ?

Q16. Sodium sulfate, Na_2SO_4 , reacts in aqueous solution with lead nitrate, $\text{Pb(NO}_3)_2$, as follows:



In an experiment, 35.30 cm^3 of a solution of sodium sulfate reacted exactly with 32.50 cm^3 of a solution of lead nitrate. The precipitated lead sulfate was dried and found to have a mass of 1.13 g . Determine the concentrations of the original solutions of lead nitrate and sodium sulfate. State what assumptions are made.

Exercise

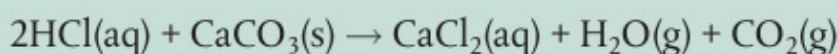
Q17. 0.40 moles of magnesium are mixed with 0.20 moles of hydrochloric acid.



Which is correct?

	Limiting reactant	Theoretical yield of H ₂ (mol)
A	HCl	0.20
B	Mg	0.40
C	HCl	0.10
D	Mg	0.20

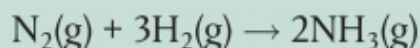
Q18. 0.30 moles of hydrochloric acid are mixed with 0.30 moles of calcium carbonate.



Which is correct?

	Limiting reactant	Theoretical yield of CO ₂ (mol)
A	HCl	0.30
B	HCl	0.15
C	CaCO ₃	0.15
D	CaCO ₃	0.30

Q19. 5 cm³ of nitrogen are reacted with 20 cm³ of hydrogen in the reaction:



Assuming that all volumes are measured at the same temperature and pressure:

- What volume of ammonia would you expect to be produced?
- What volume of H₂ would remain unreacted?