

## CHEMISTRY A-level Induction Summer Task: Mole Calculations

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Useful Equations

Name: .....

- Relationship between moles and mass of a substance:

$$\text{Moles} = \frac{\text{Mass}}{M_r}$$

(where  $M_r$  is the relative formula mass of that substance)

- Relationship between moles and number of particles of a substance:

$$\text{Moles} = \frac{\text{Number of particles}}{\text{Avogadro's Constant}}$$

(where Avogadro's Constant is  $6.0 \times 10^{23}$ )

- Relationship between moles and volume of a gas:

$$\text{Moles} = \frac{\text{Volume}}{M_v}$$

(where  $M_v$  is the molar volume of a gas which is equal to  $24\text{dm}^3 \text{mol}^{-1}$  at rtp)

- Relationship between moles and concentration of a solution:

$$\text{Moles} = \text{Concentration} \times \text{Volume}$$

- To calculate percentage yield:

$$\text{Percentage Yield} = \frac{\text{Actual yield of desired product}}{\text{Theoretical yield of desired product}} \times 100$$

- To calculate atom economy:

$$\text{Atom Economy} = \frac{\text{Total relative formula mass of desired product}}{\text{Total relative formula mass of all products}} \times 100$$

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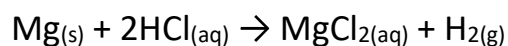
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Circle the correct answer...

1. What is the minimum mass of calcium carbonate that would be required to produce 140g of calcium oxide?



- A. 30g  
B. 110g  
C. 140g  
D. 250g
2. What mass of magnesium chloride could be created if 0.48g of magnesium is reacted with 24cm<sup>3</sup> of 2.0mol dm<sup>-3</sup> hydrochloric acid?



- A. 1.9g  
B. 2.3g  
C. 3.8g  
D. 4.6g
3. What mass of oxygen could be created if 15g of potassium nitrate, KNO<sub>3</sub>, decomposes according to the equation below?

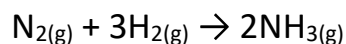


- A. 0.6g  
B. 1.2g  
C. 2.4g  
D. 4.8g

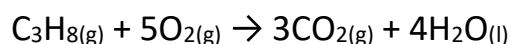
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4. What is the maximum mass of ammonia that could be created if 14g of nitrogen is combined with 6g hydrogen?



- A. 8.5g
  - B. 17.0g
  - C. 20.0g
  - D. 34.0g
5. What is the maximum mass of carbon dioxide that could be created if 2.2g of propane is combined with 9.6g oxygen?



- A. 2.2g
  - B. 3.3g
  - C. 6.6g
  - D. 7.9g
6. What is the total number of **molecules** in 3.2g of methane, CH<sub>4</sub>?  
[The Avogadro constant is  $6.0 \times 10^{23} \text{ mol}^{-1}$ ]

- A.  $6.0 \times 10^{22}$
- B.  $1.2 \times 10^{23}$
- C.  $2.4 \times 10^{23}$
- D.  $6.0 \times 10^{23}$

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7. What is the total number of **atoms** in 1.8g of water, H<sub>2</sub>O?  
[The Avogadro constant is  $6.0 \times 10^{23} \text{ mol}^{-1}$ ]
- A.  $6.0 \times 10^{22}$
  - B.  $6.0 \times 10^{23}$
  - C.  $1.8 \times 10^{23}$
  - D.  $1.8 \times 10^{24}$
8. What is the total number of **ions** in 3.42g of aluminium sulfate, Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>?  
[The Avogadro constant is  $6.0 \times 10^{23} \text{ mol}^{-1}$ ]
- A.  $6.0 \times 10^{21}$
  - B.  $1.8 \times 10^{22}$
  - C.  $3.0 \times 10^{22}$
  - D.  $1.0 \times 10^{23}$
9. 0.05moles of calcium carbonate was added to a solution containing 0.08moles of nitric acid. Which of the following statements is true?
- $$\text{CaCO}_{3(s)} + 2\text{HNO}_{3(s)} \rightarrow \text{Ca}(\text{NO}_3)_{2(aq)} + \text{H}_2\text{O}_{(l)} + \text{CO}_{2(g)}$$
- A. 0.05moles of carbon dioxide is produced
  - B. 0.08moles of calcium nitrate is produced
  - C. Calcium carbonate is in excess by 0.01moles
  - D. Nitric acid is in excess by 0.03moles.

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10. A compound was found to contain 2.8g of nitrogen and 8.0g of oxygen.  
What is the empirical formula of the compound?
- A. NO
  - B. NO<sub>2</sub>
  - C. N<sub>2</sub>O<sub>3</sub>
  - D. N<sub>2</sub>O<sub>5</sub>
11. In an experiment, 3.425g of lead oxide was reduced to form 3.105g of lead.  
What is the empirical formula of the lead oxide?
- A. PbO<sub>2</sub>
  - B. Pb<sub>3</sub>O<sub>2</sub>
  - C. Pb<sub>3</sub>O<sub>4</sub>
  - D. Pb<sub>4</sub>O<sub>3</sub>
12. A compound Z contains by mass, 26.7% carbon, 2.2% hydrogen and 71.1% oxygen. What is the empirical formula of Z?
- A. CHO<sub>2</sub>
  - B. C<sub>2</sub>H<sub>2</sub>O<sub>4</sub>
  - C. CHO
  - D. C<sub>2</sub>H<sub>2</sub>O<sub>2</sub>

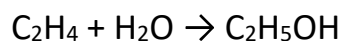
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13. A hydrocarbon contains, by mass, 82.7% carbon and 17.3% hydrogen.  
Which of the following could be the **molecular** formula of the hydrocarbon?

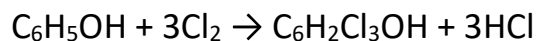
- A. CH<sub>3</sub>
- B. C<sub>2</sub>H<sub>6</sub>
- C. C<sub>2</sub>H<sub>5</sub>
- D. C<sub>4</sub>H<sub>10</sub>

14. Ethanol is manufactured by the hydration of ethene. In a typical process 28tonnes of ethene produces 43.7tonnes of ethanol. What is the percentage yield of ethanol in this process?



- A. 64%
- B. 95%
- C. 100%
- D. 156%

15. Phenol, C<sub>6</sub>H<sub>5</sub>OH, is converted into trichlorophenol (known as TCP), C<sub>6</sub>H<sub>2</sub>Cl<sub>3</sub>OH, according to the equation below. If 50.0g of phenol produces 97.6g of TCP, what is the percentage yield of the TCP?

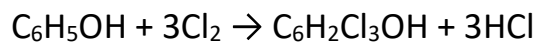


- A. 47.6%
- B. 49.4%
- C. 51.2%
- D. 92.9%

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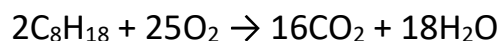
16. What is the atom economy for the production of trichlorophenol,  $C_6H_2Cl_3OH$ , from phenol and chlorine?



- A. 11.9%
  - B. 35.7%
  - C. 64.3%
  - D. 100.0%
17. What is the atom economy for the production of calcium oxide from calcium nitrate?



- A. 9.8%
  - B. 17.1%
  - C. 34.1%
  - D. 51.2%
18. What volume of oxygen gas would be required for the complete combustion of 1.14kg of octane? [Molar volume of a gas =  $24\text{dm}^3 \text{mol}^{-1}$  at room temperature and pressure]



- A.  $240 \text{ dm}^3$
- B.  $300 \text{ dm}^3$
- C.  $3000 \text{ dm}^3$
- D.  $6000 \text{ dm}^3$

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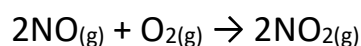
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19. What is the maximum volume of gas, in  $\text{dm}^3$ , at room temperature and pressure which could be obtained from 0.100 moles of magnesium nitrate? [Molar volume of a gas =  $24\text{dm}^3 \text{mol}^{-1}$  at room temperature and pressure]



- A.  $0.24 \text{dm}^3$   
B.  $2.4 \text{dm}^3$   
C.  $4.8 \text{dm}^3$   
D.  $6.0 \text{dm}^3$
20. In which of the following pairs does each gas occupy the same volume? All volumes are measured at the same temperature and pressure.
- A. 2g of hydrogen and 14g of nitrogen  
B. 32g of methane and 88g carbon dioxide  
C. 7g of carbon monoxide and 16g of oxygen  
D. 10g of hydrogen chloride and 10g of sulfur dioxide

21. What is the maximum volume of nitrogen dioxide that could be obtained in the reaction of  $1\text{dm}^3$  nitrogen monoxide with  $2\text{dm}^3$  of oxygen? Assume all measurements are made at the same temperature and pressure.

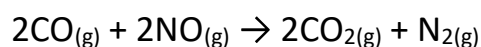


- A.  $1\text{dm}^3$   
B.  $2\text{dm}^3$   
C.  $3\text{dm}^3$   
D.  $4\text{dm}^3$

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22. 500cm<sup>3</sup> of CO reacts with 500cm<sup>3</sup> of NO. What is the **total** volume of gases produced assuming the temperature and pressure remain the same?

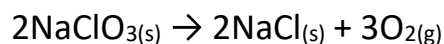


- A. 250cm<sup>3</sup>
- B. 500cm<sup>3</sup>
- C. 750cm<sup>3</sup>
- D. 1000cm<sup>3</sup>

23. Complete combustion of 50cm<sup>3</sup> of a hydrocarbon vapour gave 350cm<sup>3</sup> of carbon dioxide, both gas volumes being measured at the same temperature and pressure. Which one of the following formulae could be correct for this hydrocarbon?

- A. C<sub>8</sub>H<sub>18</sub>
- B. C<sub>7</sub>H<sub>16</sub>
- C. C<sub>6</sub>H<sub>14</sub>
- D. C<sub>5</sub>H<sub>12</sub>

24. What mass of sodium chlorate(V), NaClO<sub>3</sub>, is needed to produce 120cm<sup>3</sup> of oxygen gas? [Molar volume of a gas = 24dm<sup>3</sup> mol<sup>-1</sup> at rtp]

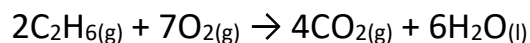


- A. 266mg
- B. 355mg
- C. 533mgs
- D. 799mgs

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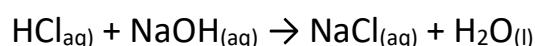
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25. What volume of oxygen, measured at room temperature and pressure, is needed to completely burn 3.0g of ethane? [Molar volume of a gas =  $24\text{dm}^3\text{mol}^{-1}$  at rtp]



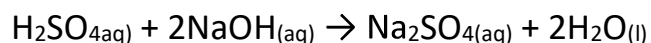
- A.  $2.4\text{ dm}^3$
- B.  $4.8\text{ dm}^3$
- C.  $8.4\text{ dm}^3$
- D.  $16.8\text{ dm}^3$

26. What volume of  $0.16\text{mol dm}^{-3}$  hydrochloric acid is required to neutralise  $25\text{cm}^3$  of  $0.20\text{mol dm}^{-3}$  sodium hydroxide?



- A.  $16\text{ cm}^3$
- B.  $25\text{ cm}^3$
- C.  $31\text{ cm}^3$
- D.  $48\text{ cm}^3$

27. What volume of  $0.25\text{mol dm}^{-3}$  sulfuric acid is required to neutralise  $50\text{cm}^3$  of  $0.40\text{mol dm}^{-3}$  sodium hydroxide?

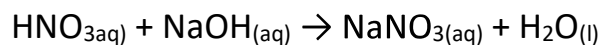


- A.  $10\text{ cm}^3$
- B.  $20\text{ cm}^3$
- C.  $40\text{ cm}^3$
- D.  $80\text{ cm}^3$

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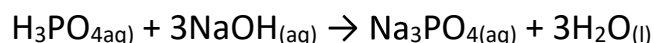
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28. If  $18\text{cm}^3$  of  $0.18\text{mol dm}^{-3}$  nitric acid is required to neutralise  $20\text{cm}^3$  of sodium hydroxide, then what is the concentration of the sodium hydroxide?



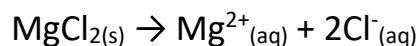
- A.  $0.16\text{ mol dm}^{-3}$
- B.  $0.18\text{ mol dm}^{-3}$
- C.  $0.22\text{ mol dm}^{-3}$
- D.  $0.24\text{ mol dm}^{-3}$

29. If  $15\text{cm}^3$  of  $0.20\text{mol dm}^{-3}$  phosphoric acid is required to neutralise  $25\text{cm}^3$  of sodium hydroxide, then what is the concentration of the sodium hydroxide?



- A.  $0.06\text{ mol dm}^{-3}$
- B.  $0.12\text{ mol dm}^{-3}$
- C.  $0.24\text{ mol dm}^{-3}$
- D.  $0.36\text{ mol dm}^{-3}$

30. If  $1.9\text{g}$  of magnesium chloride,  $\text{MgCl}_2$ , is dissolved in  $250\text{cm}^3$  water then what is the concentration of chloride ions,  $\text{Cl}^-$ , in the solution?



- A.  $0.08\text{ mol dm}^{-3}$
- B.  $0.16\text{ mol dm}^{-3}$
- C.  $0.0008\text{ mol dm}^{-3}$
- D.  $0.0016\text{ mol dm}^{-3}$

# The periodic table of the elements

1	2	3	4	5	6	7	0										
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>Na</b> sodium 11	12 <b>Mg</b> magnesium 12	13 <b>Al</b> aluminium 13	14 <b>C</b> carbon 6	15 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	17 <b>F</b> fluorine 9	18 <b>Ne</b> neon 10								
19 <b>K</b> potassium 19	20 <b>Ca</b> calcium 20	23 <b>Sc</b> scandium 21	24 <b>Ti</b> titanium 22	25 <b>V</b> vanadium 23	26 <b>Cr</b> chromium 24	27 <b>Mn</b> manganese 25	28 <b>Fe</b> iron 26	29 <b>Co</b> cobalt 27	30 <b>Ni</b> nickel 28	31 <b>Cu</b> copper 29	32 <b>Zn</b> zinc 30	33 <b>Ga</b> gallium 31	34 <b>Ge</b> germanium 32	35 <b>As</b> arsenic 33	36 <b>Se</b> selenium 34	37 <b>Br</b> bromine 35	38 <b>Kr</b> krypton 36
37 <b>Rb</b> rubidium 37	38 <b>Sr</b> strontium 38	39 <b>Y</b> yttrium 39	40 <b>Zr</b> zirconium 40	41 <b>Nb</b> niobium 41	42 <b>Mo</b> molybdenum 42	43 <b>Tc</b> technetium 43	44 <b>Ru</b> ruthenium 44	45 <b>Rh</b> rhodium 45	46 <b>Pd</b> palladium 46	47 <b>Ag</b> silver 47	48 <b>Cd</b> cadmium 48	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51	52 <b>Te</b> tellurium 52	53 <b>I</b> iodine 53	54 <b>Xe</b> xenon 54
55 <b>Cs</b> caesium 55	56 <b>Ba</b> barium 56	57 <b>La*</b> lanthanum 57	72 <b>Hf</b> hafnium 72	73 <b>Ta</b> tantalum 73	74 <b>W</b> tungsten 74	75 <b>Re</b> rhenium 75	76 <b>Os</b> osmium 76	77 <b>Ir</b> iridium 77	78 <b>Pt</b> platinum 78	79 <b>Au</b> gold 79	80 <b>Hg</b> mercury 80	81 <b>Tl</b> thallium 81	82 <b>Pb</b> lead 82	83 <b>Bi</b> bismuth 83	84 <b>Po</b> polonium 84	85 <b>At</b> astatine 85	86 <b>Rn</b> radon 86

1	<b>H</b> hydrogen 1
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relative atomic mass atomic symbol name atomic (proton) number
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\* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

*The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.*

