CHEMISTRY A-level Induction Summer Task: Mole Calculations

Useful Equations **Name: ……**

- Relationship between moles and mass of a substance:

$$Moles = \frac{\text{Mass}}{\text{M}r}$$

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

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

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

(where Avogadro's Constant is 6.0×10^{23})

- Relationship between moles and volume of a gas:

$$Moles = \frac{\text{Volume}}{\text{M}v}$$

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

- Relationship between moles and concentration of a solution:

$$Moles = Concentration\ x\ Volume$$

- To calculate percentage yield:

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

- To calculate atom economy:

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

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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?

   $CaCO_3 \rightarrow CaO + CO_2$

   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 $24cm^3$ of 2.0mol dm^{-3} hydrochloric acid?

   $Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$

   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_3, decomposes according to the equation below?

   $2KNO_{3(s)} \rightarrow 2KNO_{2(aq)} + O_{2(g)}$

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

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

   $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

   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?

   $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}$

   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_4?
   [The Avogadro constant is 6.0×10^{23} mol^{-1}]

   A. 6.0×10^{22}
   B. 1.2×10^{23}
   C. 2.4×10^{23}
   D. 6.0×10^{23}

7. What is the total number of **atoms** in 1.8g of water, H_2O?
   [The Avogadro constant is 6.0×10^{23} mol^{-1}]

   A. 6.0×10^{22}
   B. 6.0×10^{23}
   C. 1.8×10^{23}
   D. 1.8×10^{24}

8. What is the total number of **ions** in 3.42g of aluminium sulfate, $Al_2(SO_4)_3$?
   [The Avogadro constant is 6.0×10^{23} mol^{-1}]

   A. 6.0×10^{21}
   B. 1.8×10^{22}
   C. 3.0×10^{22}
   D. 1.0×10^{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?

   $CaCO_{3(s)} + 2HNO_{3(s)} \rightarrow Ca(NO_3)_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

   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.

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_2

C. N_2O_3

D. N_2O_5

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_2

B. Pb_3O_2

C. Pb_3O_4

D. Pb_4O_3

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_2

B. $C_2H_2O_4$

C. CHO

D. $C_2H_2O_2$

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_3

B. C_2H_6

C. C_2H_5

D. C_4H_{10}

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?

$C_2H_4 + H_2O \rightarrow C_2H_5OH$

A. 64%

B. 95%

C. 100%

D. 156%

15. Phenol, C_6H_5OH, is converted into trichlorophenol (known as TCP), $C_6H_2Cl_3OH$, according to the equation below. If 50.0g of phenol produces 97.6g of TCP, what is the percentage yield of the TCP?

$C_6H_5OH + 3Cl_2 \rightarrow C_6H_2Cl_3OH + 3HCl$

A. 47.6%

B. 49.4%

C. 51.2%

D. 92.9%

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

$C_6H_5OH + 3Cl_2 \rightarrow C_6H_2Cl_3OH + 3HCl$

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?

$2Ca(NO_3)_{2(s)} \rightarrow 2CaO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

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 = $24dm^3\ mol^{-1}$ at room temperature and pressure]

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

A. 240 dm^3

B. 300 dm^3

C. 3000 dm^3

D. 6000 dm^3

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

$2Mg(NO_3)_{2(s)} \rightarrow 2MgO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

A. 0.24 dm^3
B. 2.4 dm^3
C. 4.8 dm^3
D. 6.0 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 $1dm^3$ nitrogen monoxide with $2dm^3$ of oxygen? Assume all measurements are made at the same temperature and pressure.

$2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

A. $1dm^3$
B. $2dm^3$
C. $3dm^3$
D. $4dm^3$

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

$2CO_{(g)} + 2NO_{(g)} \rightarrow 2CO_{2(g)} + N_{2(g)}$

A. 250cm^3
B. 500cm^3
C. 750cm^3
D. 1000cm^3

23. Complete combustion of 50cm^3 of a hydrocarbon vapour gave 350cm^3 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_8H_{18}
B. C_7H_{16}
C. C_6H_{14}
D. C_5H_{12}

24. What mass of sodium chlorate(V), $NaClO_3$, is needed to produce 120cm^3 of oxygen gas? [Molar volume of a gas = 24dm^3 mol^{-1} at rtp]

$2NaClO_{3(s)} \rightarrow 2NaCl_{(s)} + 3O_{2(g)}$

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

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 = 24dm^3 mol^{-1} at rtp]

$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$

A. 2.4 dm^3
B. 4.8 dm^3
C. 8.4 dm^3
D. 16.8 dm^3

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

$HCl_{aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

A. 16 cm^3
B. 25 cm^3
C. 31 cm^3
D. 48 cm^3

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

$H_2SO_{4aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

A. 10 cm^3
B. 20 cm^3
C. 40 cm^3
D. 80 cm^3

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

$HNO_{3aq)} + NaOH_{(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

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

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

$H_3PO_{4aq)} + 3NaOH_{(aq)} \rightarrow Na_3PO_{4(aq)} + 3H_2O_{(l)}$

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

30. If 1.9g of magnesium chloride, $MgCl_2$, is dissolved in 250cm^3 water then what is the concentration of chloride ions, Cl^-, in the solution?

$MgCl_{2(s)} \rightarrow Mg^{2+}_{(aq)} + 2Cl^-_{(aq)}$

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

The periodic table of the elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* 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.