MOLE CALCULATIONS 1 MARK SCHEME

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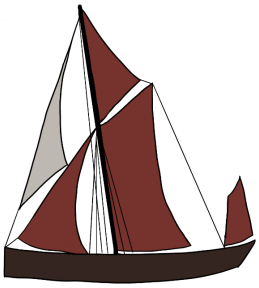

2020

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Mole Calculation Mark Scheme

1. What mass of oxygen reacts with 12g of magnesium?

$$2Mg + O_2 \rightarrow 2MgO$$

Step 1	
24g = 1 mol 1g = $\frac{1}{24}$ mol 12g = $\frac{1}{24}$ x 12 12g = $\frac{1}{2}$ mol	(1)
Step 2	
Ratio = 2:1 So, we must halve the number of moles. $\frac{1}{2}$ x 0.5 = $\frac{1}{4}$	
Step 3	
Mass = mol x Mr Mass = $\frac{1}{4}$ x 32 **Mass = 8g**	(1)
	Total: 2 marks

2. What mass of calcium hydroxide is made from 14kg of calcium oxide?

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Step 1	
56g = 1 mol 1g = $\frac{1}{56}$ mol 14g = $\frac{1}{56}$ x 14 14g = $\frac{1}{4}$ mol	(1)
Step 2	
Ratio = 1:1	
Step 3	
Mass = mol x Mr Mass = $\frac{1}{4}$ x 74 **Mass = 18.5 kg or 18500g**	(1)
	Total: 2 marks

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3. What mass of aluminium is needed to react with 640g of iron oxide?

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Step 1	
160g = 1 mol 1g = $\frac{1}{160}$ mol 640g = $\frac{1}{160}$ x 640 640g = 4 mols	(1)
Step 2	
Ratio = 1:2 So, we must multiply the number of moles by 2. 4 x 2 = 8	
Step 3	
Mass = mol x Mr Mass = 8 x 27 **Mass = 216g**	(1)
	Total: 2 marks

4. What mass of titanium chloride reacts with 460g of sodium?

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

Step 1	
23g = 1 mol 1g = $\frac{1}{23}$ mol 460g = $\frac{1}{23}$ x 460 460g = 20 mols	(1)
Step 2	
Ratio = 1:4 So, we must divide the number of moles by 4. 20 ÷ 4 = 5	
Step 3	
Mass = mol x Mr Mass = 5 x 190 **Mass = 950g**	(1)
	Total: 2 marks

5. Calculate the mass of aluminium that can be formed from 1020g of aluminium oxide.

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Step 1	
102g = 1 mol 1g = $\frac{1}{102}$ mol 1020g = $\frac{1}{102}$ x 1020 1020g = 10 mols	(1)
Step 2	
Ratio = 2:4 So, we must double the number of moles. 10 x 2 = 20 mols	
Step 3	
Mass = mol x Mr Mass = 20 x 27 **Mass = 540g**	(1)
	Total: 2 marks

6. Calculate the mass of oxygen needed to react 10.0g of calcium to form calcium oxide.

$$2Ca + O_2 \rightarrow 2CaO$$

Step 1	
40g = 1 mol 1g = $\frac{1}{40}$ mol 10g = $\frac{1}{40}$ x 10 10g = 0.25 mols	(1)
Step 2	
Ratio = 2:1 So, we must halve the number of moles. 0.25 ÷ 2 = 0.125	
Step 3	
Mass = mol x Mr Mass = 0.125 x 32 **Mass = 4g**	(1)
	Total: 2 marks

7. What mass of propane could burn in 48.0g of oxygen?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Step 1	
32g = 1 mol 1g = $\frac{1}{32}$ mol 48g = $\frac{1}{32}$ x 48 48g = 1.5 mols	(1)
Step 2	
Ratio = 5:1 So, we must divide the number of moles by 5. 1.5 ÷ 5 = 0.3mol	
Step 3	
Mass = mol x Mr Mass = 0.3 x 44 **Mass = 13.2g**	(1)
	Total: 2 marks

8. What mass of ammonia can be made from 20.0g of hydrogen?

$$3H_2 + N_2 \rightarrow 2NH_3$$

Step 1	
2g = 1 mol 1g = $\frac{1}{2}$ mol 20g = $\frac{1}{2}$ x 20 20g = 10 mols	(1)
Step 2	
Ratio = 3:2 So, we must divide the number of moles by 3 and then multiply by 2. 10 ÷ 3 x 2 = 0.66666mol	(1)
Step 3	
Mass = mol x Mr Mass = 0.66666 x 17 **Mass = 113.3g**	(1)
	Total: 3 marks

9. What mass of sodium hydroxide is needed to neutralise 24.5kg of sulfuric acid?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Step 1	
98g = 1 mol 1g = $\frac{1}{98}$ mol 24.5g = $\frac{1}{98}$ x 24.5 24.5g = 0.25 mols	(1)
Step 2	
Ratio = 1:2 So, we must multiply the number of moles by 2. 0.25 x 2 = 0.5 mol	(1)
Step 3	
Mass = mol x Mr Mass = 0.5 x 40 **Mass = 20kg or 20000g**	(1)
	Total: 3 marks

10. Calculate the mass of calcium oxide that can be obtained by heating 25kg of Calcium carbonate.

$$CaCO_3 \rightarrow CaO + CO_2$$

Step 1	
100g = 1 mol 1g = $\frac{1}{100}$ mol 25g = $\frac{1}{100}$ x 25 25g = 0.25 mols	(1)
Step 2	
Ratio = 1:1	(1)
Step 3	
Mass = mol x Mr Mass = 0.25 x 56 **Mass = 14kg or 14000g**	(1)
	Total: 3 marks

11. What mass of carbon dioxide is formed when 7.41g of copper (II) carbonate decomposes on heating?

$$CuCO_3 \rightarrow CuO + CO_2$$

Step 1	
123.5g = 1 mol 1g = $\frac{1}{123.5}$ mol 7.41g = $\frac{1}{123.5}$ x 7.41 7.41g = 0.06 mols	(1)
Step 2	
Ratio = 1:1	(1)
Step 3	
Mass = mol x Mr Mass = 0.06 x 44 **Mass = 2.64g**	(1)
	Total: 3 marks

12. What mass of carbon monoxide is needed to react with 2.08kg of iron oxide?

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

No marks are awarded for balancing equations. This skill should be mastered by now.

Step 1	
160g = 1 mol 1g = $\frac{1}{160}$ mol 2.08g = $\frac{1}{160}$ x 2.08 2.08g = $\frac{13}{1000}$ mols	(1)
Step 2	
Ratio = 1:3 So, we must multiply the number of moles by 3. $\frac{13}{1000}$ x 3 = $\frac{39}{1000}$	(1)
Step 3	
Mass = mol x Mr Mass = $\frac{39}{1000}$ x 28 **Mass = 1.092kg**	(1)
	Total: 3 marks

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13. What mass of chlorine reacts with 20.0g of iron to form iron(III) chloride?

$$2Fe + 3Cl_2 \rightarrow 2FeCl_3$$

Step 1	
56g = 1 mol 1g = $\frac{1}{56}$ mol 20g = $\frac{1}{56}$ x 20 20g = $\frac{5}{14}$ mols	(1)
Step 2	
Ratio = 2:3 So, we must divide the number of moles by 2 and then multiply by 3. $\frac{5}{14}$ mols ÷ 2 x 3 = $\frac{15}{28}$ mols	(1)
Step 3	
Mass = mol x Mr Mass = $\frac{15}{28}$ mols x 71 **Mass = 38.04g**	(1)
	Total: 3 marks

14. Hydrazine (N_2H_4) is used as a rocket fuel. It can be made by reacting ammonia with hydrogen peroxide. What mass of ammonia is needed to make 148g of hydrazine?

$$2NH_3 + H_2O_2 \rightarrow N_2H_4 + 2H_2O$$

Step 1	
32g = 1 mol 1g = $\frac{1}{32}$ mol 148g = $\frac{1}{32}$ x 148 148g = 4.625 mols	(1)
Step 2	
Ratio = 1:2 So, we must multiply the number of moles by 2. 4.625 mols x 2 = 9.25	(1)
Step 3	
Mass = mol x Mr Mass = 9.25 mols x 17 **Mass = 157.25g**	(1)
	Total: 3 marks

15. Titanium is extracted from titanium chloride as shown. Calculate the mass of sodium needed to react with 126g of titanium chloride.

$TiCl_4$ + 4Na → Ti + 4NaCl

Step 1	
190g = 1 mol 1g = $\frac{1}{190}$ mol 126g = $\frac{1}{190}$ x 126 126g = $\frac{63}{95}$ mols	(1)
Step 2	
Ratio = 1:4 So, we must multiply the number of moles by 4. $\frac{63}{95}$ mols x 4 = 2.65	(1)
Step 3	
Mass = mol x Mr Mass = 2.65 mols x 23 **Mass = 61g**	(1)
	Total: 3 marks

16. Calculate the mass of oxygen needed to react 9.60g of magnesium to form magnesium oxide.

2Mg + O_2 → 2MgO

Step 1	
24g = 1 mol 1g = $\frac{1}{24}$ mol 9.60g = $\frac{1}{24}$ x 9.60 9.60g = 0.4 mols	(1)
Step 2	
Ratio = 2:1 So, we must divide the number of moles by 2. 0.4 mols ÷ 2 = 0.2 mol	(1)
Step 3	
Mass = mol x Mr Mass = 0.2 mols x 32 **Mass = 6.4g**	(1)
	Total: 3 marks

17. What mass of ethanol could burn in 100g of oxygen?

$$2C_2H_5OH + 6O_2 \rightarrow 4CO_2 + 6H_2O$$

Step 1	
32g = 1 mol 1g = $\frac{1}{32}$ mol 100g = $\frac{1}{32}$ x 100 100g = 3.125 mols	(1)
Step 2	
Ratio = 3:1 So, we must divide the number of moles by 6 and multiply by 2. 3.125 mols ÷ 6 x 2 = $\frac{25}{24}$ mol	(1)
Step 3	
Mass = mol x Mr Mass = $\frac{25}{24}$ mol x 46 **Mass = 47.91g**	(1)
	Total: 3 marks

18. What mass of hydrogen is formed when 2.00g of magnesium reacts with sulphuric acid?

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

Step 1	
24g = 1 mol 1g = $\frac{1}{24}$ mol 2g = $\frac{1}{24}$ x 2 2g = $\frac{1}{12}$ mols	(1)
Step 2	
Ratio = 1:1	(1)
Step 3	
Mass = mol x Mr Mass = $\frac{1}{12}$ mols x 2 **Mass = 0.167g**	(1)
	Total: 3 marks

19. What mass of aluminium reacts with 50.0g of chlorine to form aluminium chloride?

$$2Al + 3Cl_2 \rightarrow 2AlCl_3$$

Step 1	
71g = 1 mol 1g = $\frac{1}{71}$ mol 50g = $\frac{50}{71}$ mols	(1)
Step 2	
Ratio = 3:2 So, we must divide the number of moles by 3 and multiply by 2. $\frac{50}{71}$ mols ÷ 3 x 2 = $\frac{100}{213}$ mol	(1)
Step 3	
Mass = mol x Mr Mass = $\frac{100}{213}$ mol x 27 **Mass = 12.67g**	(1)
	Total: 3 marks