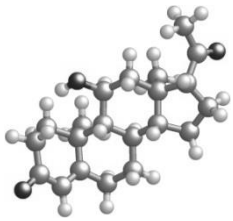


Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Jigsaw Puzzle – A Strategy for Sequencing the Essential Steps of a Mole Calculation

Instructions:

Cut-out the jigsaw puzzle pieces given below. When answering a question that requires you to complete a mole calculation, arrange the relevant jigsaw puzzle pieces in order to help you sequence the essential steps of the calculation. Examples are given on page 3 and page 4.

Start with mass in grams...

• moles = mass in g ÷ A_r

or

• moles = mass in g ÷ M_r

A_r = relative atomic mass

M_r = relative molecular mass

...finish with moles.

Start with moles...

• mass in g = moles × A_r

or

• mass in g = moles × M_r

A_r = relative atomic mass

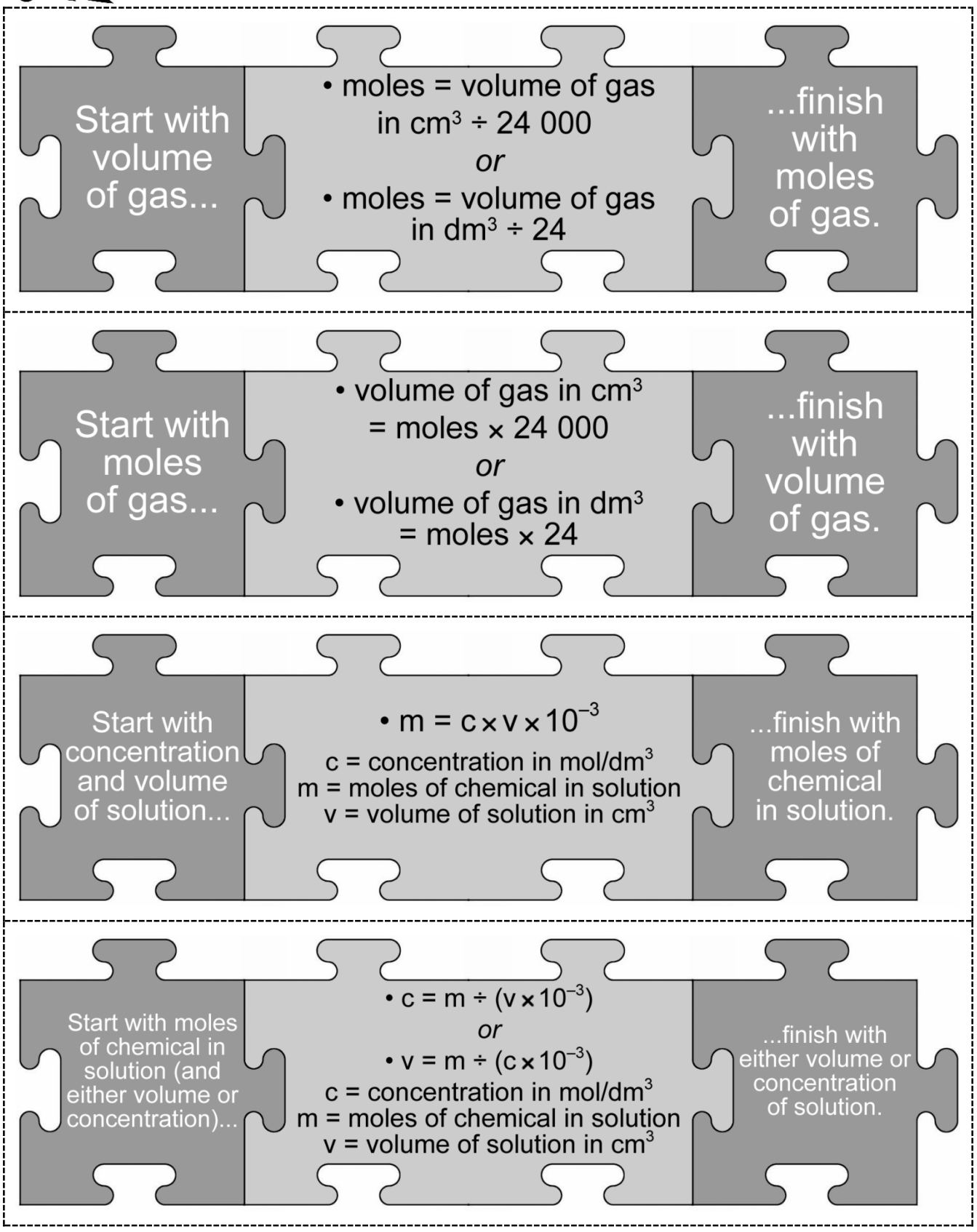
M_r = relative molecular mass

...finish with mass in grams.

Convert moles of chemical *A*...

• Determine the mole ratio of the chemicals from the balanced chemical equation.

...to moles of chemical *B*.


Start with volume of gas...
• moles = volume of gas in cm^3 ÷ 24 000
or
• moles = volume of gas in dm^3 ÷ 24
...finish with moles of gas.
Start with moles of gas...
• volume of gas in cm^3 = moles × 24 000
or
• volume of gas in dm^3 = moles × 24
...finish with volume of gas.
Start with concentration and volume of solution...
• $m = c \times v \times 10^{-3}$
c = concentration in mol/dm^3
m = moles of chemical in solution
v = volume of solution in cm^3
...finish with moles of chemical in solution.
Start with moles of chemical in solution (and either volume or concentration)...
• $c = m \div (v \times 10^{-3})$
or
• $v = m \div (c \times 10^{-3})$
c = concentration in mol/dm^3
m = moles of chemical in solution
v = volume of solution in cm^3
...finish with either volume or concentration of solution.

Example One

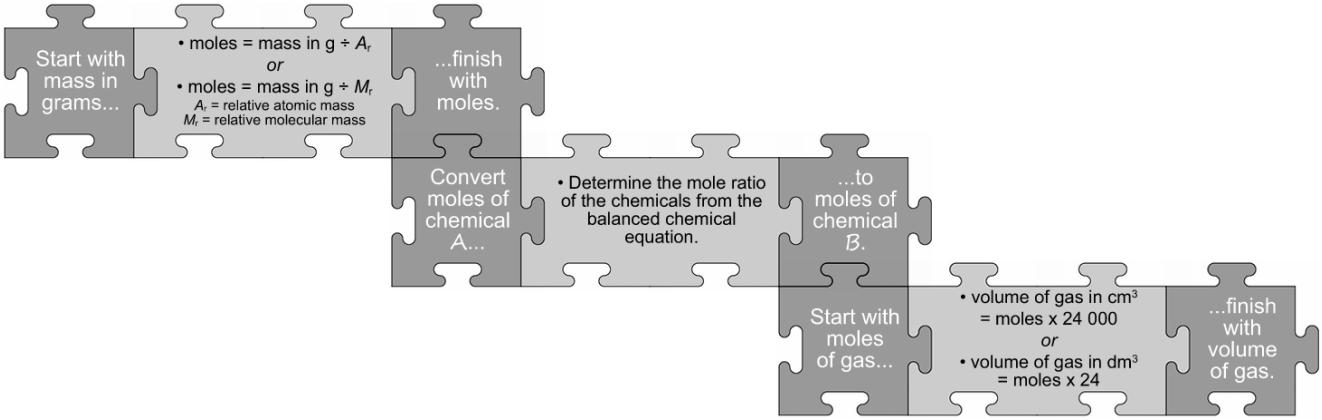
Question:

The balanced chemical equation for the reaction between calcium carbonate and nitric acid is given below:

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$

Calculate the volume of carbon dioxide gas, in cm^3, produced when 15.0 g of powdered calcium carbonate reacts with excess dilute nitric acid.

Answer:



Step 1:

• Calculate moles of $CaCO_3(s)$ used from the mass of $CaCO_3(s)$ in grams and the M_r of $CaCO_3(s)$:

moles of $CaCO_3(s)$ = mass of $CaCO_3(s)$ in grams ÷ M_r of $CaCO_3(s)$

M_r of $CaCO_3(s)$ = 40 + 12 + (3 × 16) = 100

∴ moles of $CaCO_3(s)$ = 15.0 ÷ 100

= <u>0.150 mol</u>

Step 2:

• Determine the mole ratio between $CaCO_3(s)$ and $CO_2(g)$ from the balanced chemical equation.

From the balanced chemical equation, 1 mol of $CaCO_3(s)$ produces 1 mol of $CO_2(g)$ ∴ 0.150 mol of $CaCO_3(s)$ will produce $^1/_1$ × 0.150 = <u>0.150 mol</u> of $CO_2(g)$.

Step 3:

• Convert moles of $CO_2(g)$ into a volume of $CO_2(g)$ in cm^3:

volume of $CO_2(g)$ in cm^3 = moles of $CO_2(g)$ × 24 000

= 0.150 × 24 000

= <u>3 600 cm^3</u>

Example Two

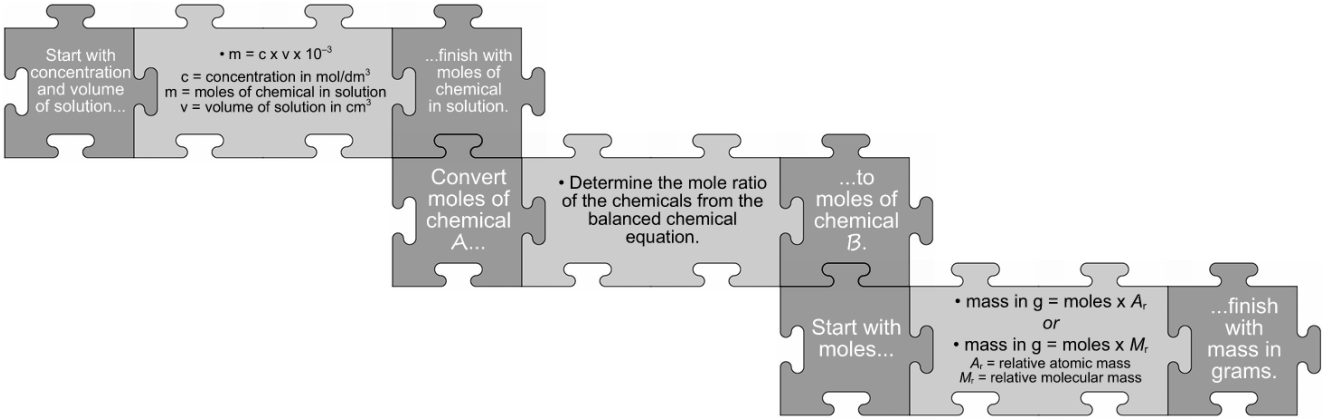
Question:

The balanced chemical equation for the reaction between aqueous calcium chloride and aqueous silver nitrate is given below:

$$CaCl_2(aq) + 2AgNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + 2AgCl(s)$$

Calculate the mass in grams of AgCl(s) formed when 40.0 cm^3 of 0.20 mol/dm^3 $CaCl_2(aq)$ are added to excess $AgNO_3(aq)$.

Answer:



Step 1:

• Calculate moles of $CaCl_2(aq)$ used from the concentration and volume of $CaCl_2(aq)$:

moles of $CaCl_2(aq)$ = concentration of $CaCl_2(aq)$ in mol/dm^3 $\times$ volume of $CaCl_2(aq)$ in cm^3 $\times$ 10^{-3}

= $0.20 \times 40.0 \times 10^{-3}$

= <u>0.00800 mol</u>

Step 2:

• Determine the mole ratio between $CaCl_2(aq)$ and AgCl(s) from the balanced chemical equation.

From the balanced chemical equation, 1 mol of $CaCl_2(aq)$ produces 2 mol of AgCl(s)

$\therefore$ 0.00800 mol of $CaCl_2(aq)$ will produce $^2/_1 \times$ 0.00800 = <u>0.0160 mol</u> of AgCl(s).

Step 3:

• Convert moles of AgCl(s) into a mass in grams:

mass of AgCl(s) in grams = moles of AgCl(s) $\times$ M_r of AgCl(s)

M_r of AgCl(s) = 108 + 35.5 = 143.5

$\therefore$ mass of AgCl(s) in grams = 0.0160 $\times$ 143.5

= 2.296 g

= <u>2.30 g</u> (to 3 s.f.)