12 Days of Chemistry (Level 1)

Each of the boxes in the table below has a chemistry question. The answers to the question are whole number values between 1-12. Can you match each box to the right number? If you can – can you write a new '12 Days of Chemistry' song?

Guidance:

- *You may refer to a periodic table and any other values you think might be useful.*
- *If you use relative atomic masses, round the values to whole numbers.*
- *All gas volumes are measured at room temperature and pressure – under these conditions, one mole of gas occupies 24 dm^3.*

How many protons are there in a sodium atom?		How many moles of oxygen gas are there in 48 dm^3?	
A student has four test tubes, each containing one of the following metal ions: Ca^{2+}, Na^+, Cu^{2+} and K^+. How many of the solutions produce a white precipitate when sodium hydroxide is added?		What volume of carbon dioxide, in cm^3, would be produced when 0.0125 g calcium carbonate decomposes? $CaCO_3 \rightarrow CaO + CO_2$	
What is the pH of pure water?		What is the mass in kilograms of 500 moles of water?	
How many moles of chlorine are needed to react with 184 grams of sodium according to this equation? $2Na + Cl_2 \rightarrow 2NaCl$		How many hydrogen atoms are there in the formula for the compound ammonium sulfate?	
How many moles of oxygen are needed to react with one mole of glucose ($C_6H_{12}O_6$) in a complete combustion reaction (hint – this is the same as the respiration equation!)		What is the number of neutrons in a potassium atom minus the number of protons in a phosphorous atom?	
What is the percentage by mass of oxygen in a compound with the formula $C_{27}H_{28}O_3$?		What is the total number of electrons in a magnesium ion, Mg^{2+}?	

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12 Days of Chemistry (Level 1)

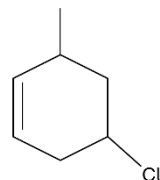## Answers

How many protons are there in a sodium atom?	11	How many moles of oxygen gas are there in 48 dm^3?	2
A student has four test tubes, each containing one of the following metal ions: Ca^{2+}, Na^+, Cu^{2+} and K^+. How many of the solutions produce a white precipitate when sodium hydroxide is added?	1	What volume of carbon dioxide, in cm^3, would be produced when 0.0125 g calcium carbonate decomposes? $CaCO_3 \rightarrow CaO + CO_2$	3
What is the pH of pure water?	7	What is the mass in kilograms of 500 moles of water?	9
How many moles of chlorine are needed to react with 184 grams of sodium according to this equation? $2Na + Cl_2 \rightarrow 2NaCl$	4	How many hydrogen atoms are there in the formula for the compound ammonium sulfate?	8
How many moles of oxygen are needed to react with one mole of glucose ($C_6H_{12}O_6$) in a complete combustion reaction (hint – this is the same as the respiration equation!)	6	What is the number of neutrons in a potassium atom minus the number of protons in a phosphorous atom?	5
What is the percentage by mass of oxygen in a compound with the formula $C_{27}H_{28}O_3$?	12	What is the total number of electrons in a magnesium ion, Mg^{2+}?	10

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12 Days of Chemistry (Level 2)

Each of the boxes in the table below has a chemistry question. The answers to the question are whole number values between 1-12. Can you match each box to the right number? If you can – can you write a new '12 Days of Chemistry' song?
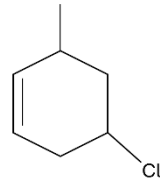
Guidance:

- *You may refer to a periodic table and any other values you think might be useful.*
- *If you use relative atomic masses, round the values to whole numbers.*
- *Under room temperature and pressure, one mole of gas occupies 24 dm^3.*

How many moles of oxygen are needed to fully combust 88 grams of propane?		How many electrons occupy **all** the p orbitals in an aluminium atom?	
What is the isotopic mass of the atom used as the standard to measure the relative atomic masses of all other elements?		What is the volume, in dm^3, occupied by 14 grams of propene at room temperature and pressure?	
How many unpaired electrons are there in a Cr^{2+} ion?		How many grams of calcium carbonate react with 20cm^3 1.0 moldm^{-3} hydrochloric acid?	
How many **structural isomers** of alkenes are there with the molecular formula C_4H_8?		A sample of hydrated calcium chloride ($CaCl_2.nH_2O$) was heated until all the water was removed. If a 4.38 g sample reached a final mass of 2.22 g, what is the value of n in the formula?	
How many protons are there in the atoms of the most electronegative element (and most reactive non-metal)?		0.5 moles of an organic compound reacts fully with 160 grams of bromine. How many C=C bonds are there in one molecule of the compound?	
What is the difference (in degrees) between the H-O-H bond angle in water and the H-C-H bond angle in methane?		What is the total number of hydrogen atoms in the molecular formula of the compound shown?	

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12 Days of Chemistry (Level 2)

Answers

How many moles of oxygen are needed to fully combust 88 grams of propane?	10	How many electrons occupy **all** the p orbitals in an aluminium atom?	7
What is the isotopic mass of the atom used as the standard to measure the relative atomic masses of all other elements?	12	What is the volume, in dm^3, occupied by 14 grams of propene at room temperature and pressure?	8
How many unpaired electrons are there in a Cr^{2+} ion?	4	How many grams of calcium carbonate react with $20cm^3$ 1.0 $moldm^{-3}$ hydrochloric acid?	1
How many **structural isomers** of alkenes are there with the molecular formula C_4H_8?	3	A sample of hydrated calcium chloride ($CaCl_2.nH_2O$) was heated until all the water was removed. If a 4.38 g sample reached a final mass of 2.22 g, what is the value of n in the formula?	6
How many protons are there in the atoms of the most electronegative element (and most reactive non-metal)?	9	0.5 moles of an organic compound reacts fully with 160 grams of bromine. How many C=C bonds are there in one molecule of the compound?	2
What is the difference (in degrees) between the H-O-H bond angle in water and the H-C-H bond angle in methane?	5	What is the total number of hydrogen atoms in the molecular formula of the compound shown?	11

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12 Days of Chemistry (Level 3)

Each of the boxes in the table below has a chemistry question. The answers to the question are whole number values between 1-12. Can you match each box to the right number? If you can – can you write a new '12 Days of Chemistry' song?

Guidance:

- *You may refer to a periodic table and any other values you think might be useful.*
- *If you use relative atomic masses, round the values to whole numbers.*
- *Under room temperature and pressure, one mole of gas occupies 24 dm^3.*

How many carbon atoms are there in a molecule of ethyl 2-methylpropanoate?		What is the pH of a 0.05 $moldm^{-3}$ solution of sulfuric acid?	
11.44 g $Na_2CO_3.nH_2O$ was dissolved and made up into 250 cm^3 of solution. 20 cm^3 of this solution required 12.8 cm^3 0.50 $moldm^{-3}$ HCl to neutralise. Determine the value of n in the formula.		How many peaks are there in the ^{1}H-NMR spectrum of 2,3-dimethyloctane?	
Calculate the rate constant, k, given the following information: Rate equation = k $[X][Y]^2$ Rate = 0.032 $moldm^{-3}s^{-1}$ when [X] = 0.1 $moldm^{-3}$ and [Y] = 0.2 $moldm^{-3}$		How many alcohols are there with the molecular formula $C_4H_{10}O$ which will react with acidified potassium dichromate?	
Fe^{2+} ions react with MnO_4^- ions to produce Fe^{3+} and Mn^{2+}. How many Fe^{2+} ions react with one MnO_4^- ion?		What is the oxidation state of iodine in KIO_4?	
What is the pH of the final mixture after 25 cm^3 0.16 $moldm^{-3}$ HCl is mixed with 25 cm^3 0.18 $moldm^{-3}$ NaOH?		0.060 g of an element contains 9.033 x 10^{21} atoms. How many **protons** are there in one atom of the element?	
A sample of carbon dioxide occupies 6.233 dm^3 at 27°C and 100 kPa. How many grams of carbon dioxide are in the sample?		For the following reaction: $A_2 + B_2 \rightleftharpoons 2AB$ Equal moles of A_2 and B_2 were mixed and allowed to reach equilibrium. At equilibrium, half of the A_2 had reacted. Determine the value for K_c.	

12 Days of Chemistry (Level 3)

Answers

How many carbon atoms are there in a molecule of ethyl 2-methylpropanoate?	6	What is the pH of a 0.05 moldm^{-3} solution of sulfuric acid?	1
11.44 g $Na_2CO_3.nH_2O$ was dissolved and made up into 250 cm^3 of solution. 20 cm^3 of this solution required 12.8 cm^3 0.50 moldm^{-3} HCl to neutralise. Determine the value of n in the formula.	10	How many peaks are there in the ^1H-NMR spectrum of 2,3,-dimethyloctane?	9
Calculate the rate constant, k, given the following information: Rate equation = k [X][Y]^2 Rate = 0.032 moldm^{-3}s^{-1} when [X] = 0.1 moldm^{-3} and [Y] = 0.2 moldm^{-3}	8	How many alcohols are there with the molecular formula $C_4H_{10}O$ which will react with acidified potassium dichromate?	3
Fe^{2+} ions react with MnO_4^- ions to produce Fe^{3+} and Mn^{2+}. How many Fe^{2+} ions react with one MnO_4^- ion?	5	What is the oxidation state of iodine in KIO_4?	7
What is the pH of the final mixture after 25 cm^3 0.16 moldm^{-3} HCl is mixed with 25 cm^3 0.18 moldm^{-3} NaOH?	12	0.060 g of an element contains 9.033 x 10^{21} atoms. How many **protons** are there in one atom of the element?	2
A sample of carbon dioxide occupies 6.233 dm^3 at 27°C and 100 kPa. How many grams of carbon dioxide are in the sample?	11	For the following reaction: $A_2 + B_2 \rightleftharpoons 2AB$ Equal moles of A_2 and B_2 were mixed and allowed to reach equilibrium. At equilibrium, half of the A_2 had reacted. Determine the value for K_c.	4