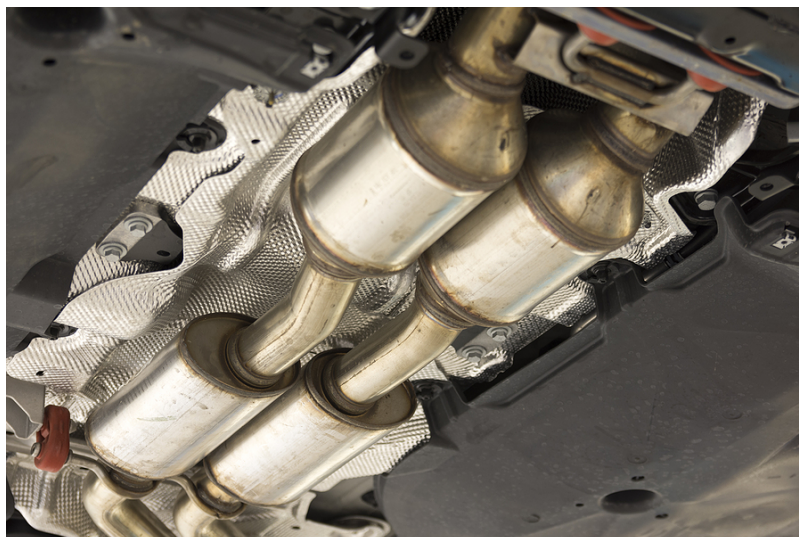


1. Untreated car exhaust waste can contain pollutants such as toxic carbon monoxide gas, cancerous hydrocarbons, and nitrogen oxides which cause smog. In order to address this problem, most cars have catalytic converters installed which convert carbon monoxide into carbon dioxide, hydrocarbons into carbon dioxide and water, and nitrogen oxides to nitrogen gas and oxygen gas.



A sample of car exhaust was analysed before and after a catalytic converter was installed to process the exhaust gas.

The concentration of which of the following gases will have decreased in the exhaust after the catalytic converter is installed?

- A. CO
 - B. CO₂
 - C. H₂O
 - D. N₂
2. A fire is a terrible destructive event, but what is even more damaging is the automatic water irrigation systems. Museum exhibits or electronics in a hardware store will suffer from water even if they are not burned by fire, so a different fire extinguishing system is used in such places:
- 1) People leave the room
 - 2) The room is completely sealed off by the system
 - 3) Pumps fill the room with argon and thereby reduce the concentration of oxygen in the room below the minimal 15% required to sustain burning.

Imagine a fire started in an art hall with a width of 10 m, a length of 15 m, and a height of 4 m. The initial concentration of oxygen in the air is 20%. The fire extinguishing system pumps 100 m³ of argon every minute. The oxygen consumption and carbon dioxide production are insignificant, assuming the fire is detected and stopped right away.



In how many minutes will the system eliminate the fire in this room?

- A. 4
- B. 8
- C. 6
- D. 2

3. Relative atomic mass of any element is based on the mass of its atoms. In the periodic table, carbon atoms are taken as a standard. Mass of 1 carbon atom is equal to $1.993 \times 10^{-26} \text{ kg}$. 1 atomic mass unit is the mass of 1/12 of a carbon-12's atom. Determination of the relative atomic mass of any element is based on the use of the following proportion:

$$\frac{1.993 \times 10^{-26} \text{ kg}}{\text{Mass of 1 atom of the element}} = \frac{12 \text{ amu}}{\text{Relative atomic mass of the element}}$$

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period 1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57-71 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89-103 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo


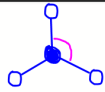
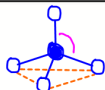

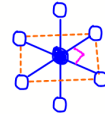
Periodic Table Key

X Synthetic Elements	X Liquids or melt at close	X Solids	X Gases	Alkali Metals	Alkali Earth Metals	Transition Metals	Other Metals	Metalloids	Other Non Metals	Halogens	Noble Gases	Lanthanides & Actinides
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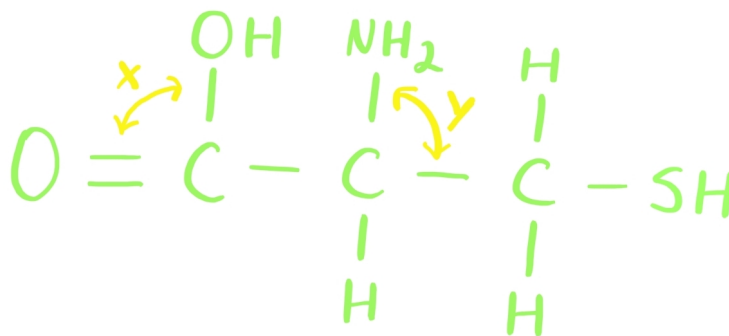
What is the relative atomic mass of the element X that has a mass of 1 atom equal to $6.145 \times 10^{-26} \text{ kg}$?

- A. 4 amu
- B. 37 amu
- C. 50 amu
- D. 61 amu

4. VSEPR theory is a theory of repulsion that describes the geometry of the molecule. According to that theory, molecules take a shape, which has the minimum repulsion between outer shell electrons (bonds). In other words, the bonds try to be as far away from each other as geometrically possible.

Total no. of electron pairs = bond pairs + lone pairs	Basic Shape	Diagram	Bond angle
2	linear		180°
3	trigonal planar		120°
4	tetrahedral		109.5°
5	trigonal bipyramidal		120° 90°
6	octahedral		90°

In VSEPR, single and double bonds are considered equivalent in terms of repulsions. For the cysteine molecule below:



What are approximate bond angles x and y?

- A. $x = 90^\circ$; $y = 90^\circ$
- B. $x = 120^\circ$; $y = 109^\circ$
- C. $x = 120^\circ$; $y = 90^\circ$
- D. $x = 90^\circ$; $y = 109^\circ$

5. Nixtamalization refers to the process of treating maize before it is ground into flour, in order to remove mycotoxins and to increase the nutritional value of the maize. In nixtamalization, maize is cooked and soaked in an alkaline (basic) solution.



In the Americas, where maize has been a staple food for thousands of years, nixtamalization can be traditionally conducted as such: A special type of rock is heated to high temperatures, before being added to water. Maize is soaked and boiled in this water, before it is ground into flour.

What could be the main constituent of this special rock?

- A. $\text{Fe}(\text{OH})_2$
- B. CaSO_4
- C. CaCO_3
- D. Al_2O_3

Answers

- 1. A
- 2. D
- 3. B
- 4. B
- 5. C