

(1)

a. Consider the carbon dioxide molecule, CO_2 , and the carbonate ion, CO_3^{2-} .

i. Draw the complete Lewis electron-dot structure for each species.

ii. Account for the fact that the carbon-oxygen bond length in CO_3^{2-} is greater than the carbon-oxygen bond length in CO_2 .b. Consider the molecules CF_4 and SF_4 .

i. Draw the complete Lewis electron-dot structure for each molecule.

ii. In terms of molecular geometry, account for the fact that the CF_4 molecule is nonpolar, whereas the SF_4 molecule is polar.(2) a. The longest wavelength of light with enough energy to break the Cl-Cl bond in $\text{Cl}_2(g)$ is 495nm.i. Calculate the frequency, in s^{-1} , of the light.

ii. Calculate the energy, in J, of a photon of the light.

iii. Calculate the minimum energy, in kJ mol^{-1} , of the Cl-Cl bond.

b. A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the sixth energy level ($n = 6$) to the second energy level ($n = 2$).

i. Indicate whether the H atom emits energy or whether it absorbs energy during the transition. Justify your answer.

ii. Calculate the wavelength, in nm, of the radiation associated with the spectral line.

iii. Account for the observation that the amount of energy associated with the same electronic transition ($n = 6$ to $n = 2$) in the He^+ ion is greater than that associated with the corresponding transition in the H atom.

(3) Account for each of the following in terms of principles of atomic structure, including the number, properties, and arrangements of subatomic particles.

(a) The second ionization energy of sodium is about three times greater than the second ionization energy of magnesium.

(b) The difference between the atomic radii of Na and K is relatively large compared to the difference between the atomic radii of Rb and Cs.

(c) A sample of solid nickel chloride is attracted into a magnetic field, whereas a sample of solid zinc chloride is not.

(d) Phosphorus forms the fluorides PF_3 and PF_5 , whereas nitrogen forms only NF_3 .

(4) Explain each of the following in terms of atomic and molecular structures and/or intermolecular forces.

(a) Solid K conducts an electric current, whereas solid KNO_3 does not.

(b) SbCl_3 has a measurable dipole moment, whereas SbCl_5 does not.

(c) The normal boiling point of CCl_4 is 77°C , whereas that of CBr_4 is 190°C .

(d) NaI(s) is very soluble in water whereas $\text{I}_2(\text{s})$ has a solubility of only 0.03 gram per 100 grams of water.

(5) Use simple structure and bonding models to account for each of the following.

(a) The bond length between the two carbon atoms is shorter in C_2H_4 than in C_2H_6 .

(b) The H - N - H bond angle is 107.5° in NH_3 .

(c) The bond lengths in SO_3 are all identical and are shorter than a sulfur-oxygen single bond.

(d) The I_3^- ion is linear.