

Part A

1. (a) Single carbon atoms react with _____ hydrogen atoms to produce _____.
- (b) Single nitrogen atoms react with _____ hydrogen atoms to produce _____.
- (c) Single oxygen atoms react with _____ hydrogen atoms to produce _____.
- (d) Single fluorine atoms react with _____ hydrogen atom to produce _____.
- (e) Neon atoms _____

2. Draw **electron-configuration diagrams** for the following atoms. (You will need to know each atom's electron configuration; see Question 12 of the Shedding Light on Atoms Episode 6: Electron Shells worksheet.)

Carbon, C

Nitrogen, N

Sulfur, S

Fluorine, F

3. Atoms can bond together either with _____ bonds or with _____ bonds.

Part B

4. Describe how atoms join together with covalent bonds. Use a diagram of a hydrogen gas molecule (H₂) to illustrate your answer.

5. Complete the electron dot diagrams below and fill in the rest of the table.

Electron Dot Diagrams for Four Simple Molecules			
methane, CH ₄	ammonia, NH ₃	water, H ₂ O	hydrogen fluoride, HF

(the first one has been done for you)

Notice in the diagram of CH₄ how each shared pair of electrons occupies both shells!

Draw neatly.

The electron configuration of	carbon is _____	nitrogen is _____	oxygen is _____	fluorine is _____
The number of H atoms that can bond with a single atom of	carbon is _____	nitrogen is _____	oxygen is _____	fluorine is _____

6. Complete the paragraph below using the words in the list. Some words may need to be used **twice**. Some will not be used at all.

covalent Group 18 inner valence (or outer) two four eight hydrogen molecule non-metals metals

A _____ is a group of two or more atoms that are bonded together by _____ bonds.

When atoms bond together in this way, their _____ shells always end up with _____ electrons in them, with the exception of _____ atoms, which end up with _____ electrons in their valence (or outer) shells. Covalent bonds usually only form between the atoms of _____ (hydrogen, carbon, nitrogen etc.). The _____ elements are very unreactive because they already have _____ electrons in their outer shells (or _____ in the case of Helium).

Part C 7. Draw an electron dot diagram of an O₂ molecule and an N₂ molecule. Label the double bond and the triple bond.

oxygen gas, O₂

nitrogen gas, N₂

8. Why are oxygen and nitrogen considered elements if they are made of 2 atoms bonded together? Why is water not considered an element?

9. SINGLE BONDS: In your exercise book, draw **electron dot diagrams** for the following molecules (which all have **single bonds** only). Use **different coloured atoms**! Have a table of **electron configurations** nearby.

(a) phosphine (PH₃)

(b) hydrogen sulfide (H₂S) (draw the S atom first)

(c) hydrochloric acid (HCl) (draw the Cl atom first)

(d) fluorine gas (F₂)

(e) methanol (CH₃OH)

(f) ethane (C₂H₆, but also written CH₃CH₃)

(g) hydrazine (N₂H₄)

(h) silane (SiH₄)

10. DOUBLE and TRIPLE BONDS: In your exercise book, draw electron dot diagrams for the following molecules. The first four have at least one **double bond** while (e) and (f) have one **triple bond** each.

(a) ethene (also called ethylene) (C₂H₄, but also written CH₂CH₂)

(b) diazine (N₂H₂) (Hint HNNH)

(c) carbon dioxide gas (CO₂) (Hint: OCO)

(d) nitroxyl (HNO)

(e) ethyne (also called acetylene) (C₂H₂)

(f) hydrogen cyanide (HCN)

Part D 11. Fill in rest of the table.

	Group 14	Group 15	Group 16	Group 17	Group 18
					helium 2 He
	carbon 6 C	nitrogen 7 N	oxygen 8 O	fluorine 9 F	neon 10 Ne
	silicon 14 Si	phosphorus 15 P	sulfur 16 S	chlorine 17 Cl	argon 18 Ar
Number of Valence (outer-shell) Electrons				7	8 (or 2 for He)
Valency (no. of bonds the atom forms)		3			

12. What is a valence electron?

13. What is an atom's valency?

14. Draw **structural diagrams** (also called **structural formulas**) for NH₃, H₂O, HF, O₂ and N₂. (CH₄ has been done for you.)

CH₄

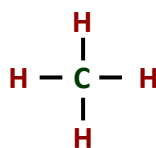
NH₃

H₂O

HF

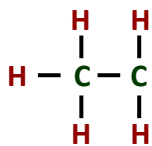
O₂

N₂



15. In your book, draw structural diagrams of all the molecules in Questions 9 and 10. Remember, each shared pair of electrons is represented by one line (which represents the bond).

Part E 16. What is wrong with this structural formula?



17. You have a gas container filled with a mixture of gases. Describe how you could determine the mass of the carbon dioxide in the container.

18. Imagine that you are a scientist in the 1860s and that you have determined the chemical formulas of the following compounds. In your book, **draw structural diagrams** for them, ensuring that each atom has the correct number of bonds. (For example every carbon atom should have 4 bonds. **You may need to refer to the table in Question 11.**)

(Use a pencil!!)

- (a) fluoromethane (CH₃F)
- (b) difluoromethane, CH₂F₂
- (c) tetrafluoromethane, CF₄
- (d) hydrogen peroxide (H₂O₂) (Hint: HOOH)
- (e) hydroxylamine, NH₂OH (HINT: all single bonds)
- (f) triazane, N₃H₅ (HINT: all single bonds)
- (g) triazene, N₃H₃ (HINT: one double bond)
- HINT: No more hints!
- (h) phosphorus trifluoride, PF₃
- (i) ethanol, CH₃CH₂OH
- (j) carbonyl sulphide, OCS

- (k) carbon disulphide, CS₂
- (l) formaldehyde, CH₂O
- (m) sulfur monoxide, SO
- (n) hydrogen cyanide, HCN
- (o) dioxygen difluoride, O₂F₂
- (p) hypochlorous acid, HClO
- (q) isocyanic acid, NCOH
- (r) tetrafluoroethene, C₂F₄
- (s) ethylamine, C₂H₇N
- (t) cyanogen, NCCN (or C₂N₂)
- (u) urea, CO(NH₂)₂
- (v) acetonitrile, CH₃CN

19. Many compounds were found to have the same formula but different structures! Try to draw **two different structures** for each of the following compounds.

(a) C₄H₁₀ (All single bonds: one version is called **butane** and the other is called **methyl propane**)

(b) C₂H₆O (All single bonds: one version is called **ethanol** and the other version is called **dimethyl ether**. To help differentiate, ethanol is often written as CH₃CH₂OH, while dimethyl ether is often written as CH₃OCH₃)

(i) C₄H₁₀

(ii)

(i) C₂H₆O

(ii)

(Note: The study of compounds that have carbon atoms in them is called "organic chemistry". There are literally millions of named compounds that contain carbon atoms. No other element even comes close.)