

## Section 3.1: Early Atomic Theories and the Origins of Quantum Theory

### Research This: The Large Hadron Collider, page 141

**A.** String theory is a theory of matter that describes sub-atomic particles as strings. Grand unified theory is an attempt to unite the fundamental forces of nature: electromagnetic force, gravity, weak nuclear force, and strong nuclear force.

**B.** Answers may vary. Sample answer: The LHC and ATLAS projects are worth the enormous amount of money because the information collected will improve our knowledge of sub-atomic particles and will improve our understanding of the components of the universe.

**C.** Answers may vary. Students' answers should allow the audience to learn about the basic concepts that are involved in the LHC and ATLAS research projects.

**D.** Answers may vary. Sample answer: Further investments in these projects and this type of research should be continued because this type of research requires massive collaboration and funding. By funding this type of pure experimentation, scientific knowledge can be advanced in unexpected ways.

### Section 3.1 Questions, page 142

1. (a)(i)  $^{79}\text{Br}$  has 35 protons and 44 neutrons.

(ii)  $^{81}\text{Br}$  has 35 protons and 46 neutrons.

(iii)  $^{239}\text{Pu}$  has 94 protons and 145 neutrons.

(iv)  $^{133}\text{Cs}$  has 55 protons and 78 neutrons.

(v)  $^3\text{H}$  has 1 proton and 2 neutrons.

(vi)  $^{56}\text{Fe}$  has 26 protons and 30 neutrons.

(b)(i) The neutral atom for  $^{79}\text{Br}$  has 35 electrons.

(ii) The neutral atom for  $^{81}\text{Br}$  has 35 electrons.

(iii) The neutral atom for  $^{239}\text{Pu}$  has 94 electrons.

(iv) The neutral atom for  $^{133}\text{Cs}$  has 55 electrons.

(v) The neutral atom for  $^3\text{H}$  has 1 electron.

(vi) The neutral atom for  $^{56}\text{Fe}$  has 26 electrons.

2. (a) The atomic symbol for the isotope with  $Z = 8$ , and 9 electrons is  $^{17}_8\text{O}$ .

(b) The atomic symbol for the isotope of chlorine in which  $A = 37$  is  $^{37}_{17}\text{Cl}$ .

(c) The atomic symbol for the isotope with  $Z = 27$  and  $A = 60$  is  $^{60}_{27}\text{Co}$ .

(d) The atomic symbol for the isotope with 26 protons and 31 neutrons is  $^{57}_{26}\text{Fe}$ .

(e) The atomic symbol for the isotope of I with a mass number of 131 is  $^{131}_{53}\text{I}$ .

(f) The atomic symbol for the isotope with  $Z = 3$  and 4 neutrons is  $^7_3\text{Li}$ .

3. (a)  $\text{Ba}^{2+}$  contains 56 protons and 54 electrons.

(b)  $\text{Zn}^{2+}$  contains 30 protons and 28 electrons.

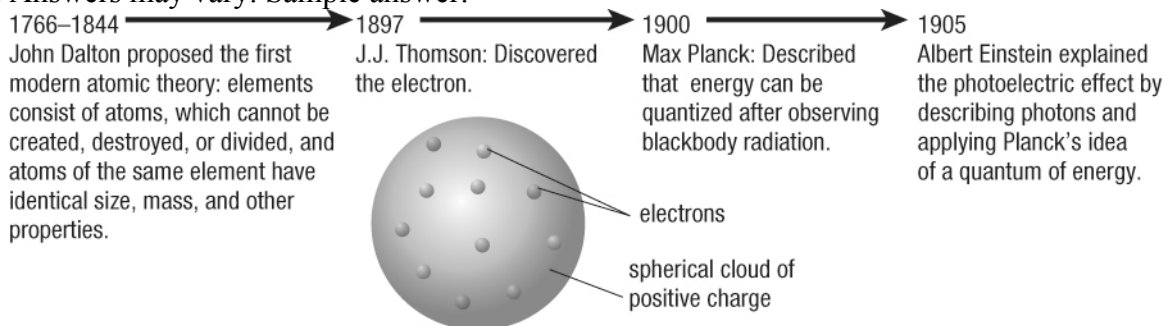
(c)  $\text{N}^{3-}$  contains 7 protons and 10 electrons.

(d)  $\text{Rb}^+$  contains 37 protons and 36 electrons.

(e)  $\text{Co}^{3+}$  contains 27 protons and 24 electrons.

(f)  $\text{Te}^{2-}$  contains 52 protons and 54 electrons.

4. (a) The atomic symbol of an ion with 16 protons, 18 neutrons, and 18 electrons is  ${}^{34}_{16}\text{S}^{2-}$ .  
 (b) The atomic symbol of an ion with 16 protons, 16 neutrons, and 18 electrons is  ${}^{32}_{16}\text{S}^{2-}$ .
5. The photoelectric effect is the emission of electrons from matter when it interacts with high-energy electromagnetic radiation. Electrons absorb some or all of the energy of a photon allowing them to move to higher energy orbitals. In the photoelectric effect, the energy of the electron increases to a high enough level to allow the electron to escape the matter.
6. Answers may vary. Sample answer:



7. **Table 3**

Symbol	Protons	Neutrons	Electrons	Net charge
${}^{238}_{92}\text{U}$	92	146	92	0
${}^{40}_{20}\text{Ca}$	20	20	18	2+
${}^{51}_{23}\text{V}$	23	28	20	3+
${}^{89}_{39}\text{Y}$	39	50	39	0
${}^{79}_{35}\text{Br}$	35	44	36	1-
${}^{59}_{26}\text{Fe}$	26	33	23	3+
${}^{27}_{13}\text{Al}$	13	14	10	3+

8. Answers may vary. Sample answer:  
 09:50 A thin layer of gold foil was mounted in the centre of a detector that wrapped around the foil.  
 11:47 A beam of alpha particles was used to bombard the foil.  
 14:30 The detector was analyzed, producing the following results. Most of the alpha particles passed through the foil and were detected directly behind the foil, in line with the beam. Some alpha particles were deflected in all directions by the foil.
9. (a) Quarks are named up, down, strange, charm, bottom and top.  
 (b) A proton is composed of 2 up quarks and 1 down quark. The up and down quarks carry opposite charges and the net charge of the proton is 1+.  
 (c) Richard E. Taylor provided some of the first supporting evidence for the existence of quarks and received a share of the Nobel Prize.
10. Answers may vary. Sample answer: This information is useful because it allows the reader to see the abundance of different isotopes. Classical periodic tables just gave the average mass of all the isotopes and no details about the abundance of each.