

STRUCTURE OF THE ATOM ----- ANSWERS

Program 1

1. Democritus is credited with proposing that matter is made up of atoms.
2. Root of atom is the Greek word atomos, which means indivisible.
3. Democritus's theory of matter states that:
 - i) all reality is made up of particles in space
 - ii) all atoms have motion
 - iii) all atoms are indivisible
 - iv) existing things differ because of atoms
 - v) every event results from collisions and can be predicted
4. The church was opposed to the theory of atomism because it explained the human spirit by saying that there were certain 'soul' atoms.
5. There was no change in the theory of atomism for about 2000 years.
6. Alchemists thought that all matter was the same and that differences were due to the arrangement of atoms. These alchemists are credited with shifting work from purely theoretical to observation and experiments.
7.
 - a) William Gilbert - 1540 - 1603
Careful experiments which formed the basis of magnetic science. He found that when you rubbed things together, they could attract matter.
 - b) Niccolo Cabeo
He noticed that particles could repel each other, in a similar manner to Gilbert.
 - c) Benjamin Franklin - 1792
While flying his kite, it was struck by lightning. He named this electricity and thought it was a fluid. An excess of this fluid was said to be positive.
 - d) Charles Augustin de Coulomb - 1785
He found that the force between charges varied inversely as the distance between their centers, and that the true nature of atoms is in the interior
 - e) Antoine Laurent Lavoisier - 1783
The Law of Conservation of Mass - He did reactions of hydrogen and oxygen to form water and found that the mass of the reactants was equal to the mass of the products.
 - f) Joseph Proust
He did a variety of experiments to come up with the Law of Constant Composition.

Program 2

1. Dalton was looking for why water absorbs more of one gas than another.
2. Dalton's atomic theory:
 - i) Matter is made up of tiny indivisible particles called atoms.
 - ii) All atoms of a particular element are identical in mass, size etc.
 - iii) Atoms of different elements have different characteristics.
 - iv) Atoms of different elements combine in small whole number ratios to form compounds; 1:1, 1:2, 3:2 etc. Combined atoms called a molecule.
 - v) In chemical reactions, atoms are not destroyed; they simply join together or separate from each other.
3. Proust's Law of Constant Proportions was explained by Dalton's theory. This led to Dalton's Law of Multiple proportions
4. Faraday believed that electricity was the force that held all compounds together.
5. See attached sheet for overhead of Cathode rays.
6. Crookes determined that whatever was being emitted was coming from the negative terminal (the cathode). These particles moved in straight lines, came from the cathode and had some kind of mechanical force behind them.
7. J.J. Thomson showed that these cathode rays were actually negative particles because an electric field caused the particles to bend towards the positive.
8. The mass to charge ratios was found by balancing the deflection by magnetic and electric fields. It was found to be 1.76×10^{11} coulombs/kg.
9. Showing that the mass to charge ratio was the same for any metal or gas used showed that all atoms had these even smaller particles in them.
10. Millikin showed that all electrons were identical and he determined their charge/mass by using his oil drop experiment.
11. Thomson's model of the atom consisted of a positive dough with negative raisins throughout. The "Plum Pudding Model"
12. Dalton's model was that of a hard, impenetrable sphere, while Thomson thought of the atom as consisting of smaller particles still.
13. At the time Thomson could not find e or m separately because they were too small to measure at that time.

Program 3

1. Henri Becquerel is credited with discovering radioactivity in 1896.
2. A magnetic field can be used to show that radioactive substances give off two particles.
3. Alpha (α , He^{2+}) and Beta (β , e^-) particles are given off by radioactive decay.
4. The alpha particle is fast, massive and positively charged, therefore it is good for probing the atom.
5. Rutherford's gold foil apparatus.
6. Most of the particles traveled straight through with no deflection, some were deflected and other still bounced backwards.
7. Most surprising were the particles that bounced back.
8. The atom was said to be mostly empty space as most particles went through.
9. Using photographic plates, Rutherford found the scattering pattern of the particles. It was quite different than what would have occurred if they acted as billiard balls.
10. Rutherford then calculated a scattering pattern using Coulomb's Law.
11. The concentration of mass in the atom was given the name NUCLEUS.
12. Coulomb's Law of electrostatic repulsions: $F = q_1 q_2 / d^2$
13. Rutherford calculated the distance of closest approach of an alpha particle and thus found the radius of a nucleus.
14. Rutherford's atom had a nucleus with electrons circling it.
15. Rutherford said that electrons stayed near the nucleus because of the attraction between positive and negative charges.
16. Classical physics says that a moving charge produces magnetic energy and must lose energy and slow down. It would then get closer and closer to the nucleus.

Program 4

1. Classical physicists would say that as the electron traveled closer to the nucleus it would lose energy and thus change the frequency of light that it would emit. Plank thought matter emitted energy in discrete bundles.
2. Plank called these bundles of energy QUANTUM.
3. The most energy was found in the orbits farther away from the nucleus.
4. Bohr thought that electrons occupied precise orbits or energy levels, while Rutherford thought that electrons just orbited the nucleus.
5. Hydrogen atom: $r_1 = 5.2 \times 10^{-11}$, $r_2 = 2.08 \times 10^{-10}$, $r_3 = 4.68 \times 10^{-10}$ m.
6. There is no theoretical limit to the number of possible orbits.
7. Hydrogen atom: $v_1 = 2.18 \times 10^6$, $v_2 = 1.09 \times 10^6$, $v_3 = 7.3 \times 10^5$ m/s.
8. Electrons slow down as they move to higher orbitals.
9. Hydrogen atom: $E_1 = 0$, $E_2 = 10.2$, $E_3 = 12.1$ eV.
10. Electrons can gain enough energy to move to a higher level by a collision with a free electron.
11. If there is less than 10.2 eV then there is no interaction.
12. If there is more than 10.2 eV, the electron will jump to the appropriate level.
13. 13.6 eV is required to totally liberate an electron from Hydrogen.
14. Energy is given off in the form of light (photons) when an electron moves from a higher to a lower energy level.