

REVISION: ORGANIC CHEMISTRY & MOTION**12 MARCH 2013****Lesson Description**

In this lesson we revise how to:

- Describe the relationship between inter-molecular forces and the physical properties of organic substances
- Identify different types of organic reactions
- Calculate projectile motion problems.

Key Concepts**Inter-molecular Forces**

The intermolecular forces in organic molecules are governed by two major types:

Van der Waals forces are the weakest and are present in all organic substances:

London forces or Temporary dipole are the weakest type of van der Waals forces. These are temporary movements in the electrons around molecules. This causes one side of the molecule to become temporarily positive, and the other negative.

Dipole-dipole attraction is stronger than London forces. When molecules are polar, they have a permanent positive side and a permanent negative side. When molecules are close to one another, the positive end of one will attract the negative of the other.

Hydrogen bonds are very strong and are stronger than both types of van der Waals forces. When a molecule contains hydrogen covalently bonded to oxygen or nitrogen, hydrogen bonds can occur. As a result, the melting and boiling points of these substances will be higher than those held together by Van der Waals forces.

Physical Properties

Melting point: The temperature at which a substance changes from solid to liquid.

Boiling point: The temperature at which a substance changes from liquid to gas (vapour pressure = atmospheric pressure)

Viscosity: The “thickness” of the substance.

Vapour Pressure: The ability of the substance to evaporate from a liquid state.

Demonstration

When ether (a light organic molecule) is placed in an open dish, the liquid very quickly evaporates. This shows that it has a very high vapour pressure. The desire of the molecules to become gas is high. This is because ether has very weak intermolecular forces.

When we compare ether to butan-1-ol, we can see that the vapour pressure is must lower.

These two molecules have the same molecular mass as they are isomers of one another – here is the reason for the difference:

- Butan-1-ol has an OH group (hydroxyl) and this allows for hydrogen bonding. This means that molecules require more energy to become gas. This lowers the vapour pressure and increases the boiling point of the compound.
- Diethyl ether does not have any hydrogen atoms bonded to the oxygen in the structure. This means that it cannot to hydrogen bonding and must rely on van der Waals forces. This means that the molecules are not held together strongly and can escape and become gas easily.

Demonstration

When an unsaturated compound is treated with bromine, the bromine quickly reacts with the unsaturated molecule. The brown colour of the bromine quickly disappears, indicating that the reaction has taken place.

If an unsaturated compound is treated with bromine, the brown colour of the bromine remains. After some time, with the help of UV light, the colour slowly fades.

This is a simple and effective test for the presence of unsaturated compounds.

Question 5

(Adapted from Nov 2010, DOE, P2, Question 5)

5.1 Why is prop-1-ene considered to be a dangerous compound? (1)

Through addition reactions, prop-1-ene can be converted to other compounds, such as alkanes and alcohols.

5.2 Which part of the structure of an alkene allows it to undergo addition reactions? (1)

5.3 In one type of addition reaction, prop-1-ene can be converted to an alcohol.

5.3.1 Use structural formulae to write a balanced equation for the formation of the alcohol during this addition reaction. (4)

5.3.2 Name the type of addition reaction that takes place. (1)

5.3.3 Write down the name or formula of the catalyst used in this reaction. (1)

5.4 Use molecular formulae to write down a balanced chemical equation for the complete combustion of propane. (3)

Prop-1-ene can be produced from an alcohol by an elimination reaction.

- 5.5 Use structural formulae to write a balanced chemical equation for the formation of prop-1-ene from a PRIMARY alcohol. (4)
- 5.6 Name the type of elimination reaction that takes place. (1)

Gravitational Acceleration Calculations ($g = 9,8 \text{ m}\cdot\text{s}^{-2}$)

When an object is dropped, it will accelerate due to the force of gravity. Galileo Galilei famously proved that ALL objects accelerate at the same rate. This means that mass does not change the way that gravity accelerates an object.

This means that an object of 5 kg will accelerate at the same rate as another object of mass 50 g. We can drop both objects and the result will be that they strike the ground at exactly the same time, with the same final velocity.

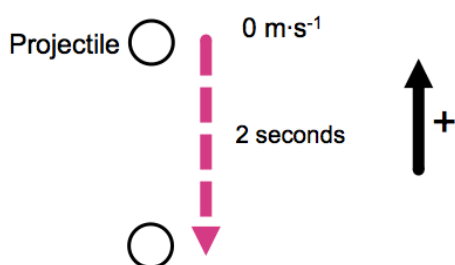
Let's see study how this gravitational acceleration affects objects which are dropped.

If we drop an object from a particular height – this means that gravity is the ONLY force acting on it. It accelerates at $9,8 \text{ m}\cdot\text{s}^{-2}$. We call this value g .

Example 1:

Calculate how fast a ball will be moving if it is allowed to fall for 2 seconds from a stationary point.

Step 1: Diagram and Direction



Notice how the direction that we consider positive is marked with an arrow and a “plus” sign?

Step 2: Tabulate

It's important to know what information was have an don't have. Some of the numbers not directly given to us so we must READ carefully.

$$v_i = 0 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = ?$$

$$\Delta t = 2 \text{ s}$$

$$a = -9.8 \text{ m}\cdot\text{s}^{-2}$$

$$\Delta y = \dots$$

Notice how acceleration due to gravity is down, therefore making it a negative vector? Down mean negative if we follow our own diagram.

Step 3: Equation

We now choose an equation with the information that we HAVE and the information that we NEED.

Tip: we don't need displacement, nor are we asked it – so look for the equation WITHOUT it.

$$v_f = v_i + a\Delta t$$

$$v_f = (0) + (-9.8)(2)$$

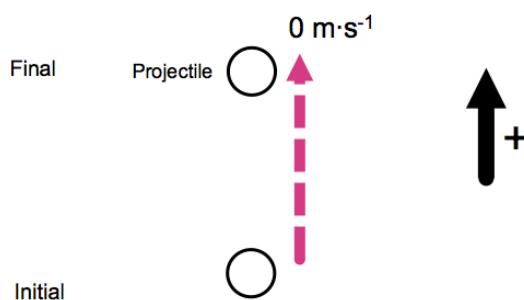
$$v_f = -19.6 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = 19.6 \text{ m}\cdot\text{s}^{-1} \text{ downward}$$

Notice how the negative answer must be re-written so that direction is included. The answer was negative – meaning that the ball was moving downwards after 2 seconds. This is expected. The value also makes sense because it increase in velocity at $9.8 \text{ m}\cdot\text{s}^{-1}$ every second.

Example 2:

Calculate how far up a ball will rise if it is thrown upwards at $19.6 \text{ m}\cdot\text{s}^{-1}$?

Step 1: Diagram and Direction

Notice how the direction that we consider positive is marked with an arrow and a “plus” sign.

Also, notice that when an object reached its maximum height – the VELOCITY becomes zero.

Step 2: Tabulate

It's important to know what information we have and don't have. Some of the numbers not directly given to us so we must READ carefully.

$$v_i = +19,6 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = 0 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta t = \dots$$

$$a = -9,8 \text{ m}\cdot\text{s}^{-2}$$

$$\Delta y = ?$$

Notice how gravitation acceleration is still negative and DOWNWARDS. If acceleration is in the opposite direction to motion the object will slow down. Think about what happens when you throw a ball up: it slows down and stops.

Step 3: Equation

We now choose an equation with the information that we HAVE and the information that we NEED.

Tip: we don't need time nor are we asked it – so look for the equation WITHOUT it.

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(0)^2 = (19,6)^2 + 2(-9,8)\Delta x$$

$$\Delta x = 19,6 \text{ m upward}$$