Factors Affecting Reaction Rates[1]

Information for students

For two or more substances to enter into a chemical reaction, there must be a direct collision between the reactants' atoms or molecules. If there is sufficient energy, bonds between the reactants' atoms break and are rearranged to form new products. Several factors affect the rate at which this takes place.

In this activity, you will conduct two experiments to illustrate how temperature and concentration affect the rate of the reaction between vinegar (CH_3COOH), and baking soda ($NaHCO_3$). The chemical equation for this reaction is the following:

$$CH_3COOH_{(aq)} + NaHCO_{3\,(s)} \rightarrow CO_{2\,(g)} + H_2O_{(l)} + NaC_2H_3O_{2\,(aq)}$$

Note: Please keep in mind the safety precautions you would normally follow in your science classroom when performing any experiments.

Experiment 1: Control reaction (for comparison)

Click on the following link for an example of how you can carry out this experiment: https://www.youtube.com/watch?v=uVzzHoE6Edg&feature=youtu.be

- Use a funnel to put two tablespoons of baking soda in a balloon.
- Clean the funnel well with running water, then dry it.
- Use the funnel to put about 100 mL (about ½ cup) of white vinegar in the bottle.
- Stretch the neck of the balloon over the top of the bottle. Be careful not to spill the baking soda while you do this.
- Tip the balloon upwards to drop the baking soda into the vinegar.
- Record your results and observations.

Experiment 2: How does temperature affect reaction rate?

- Conduct an experiment to investigate the relationship between temperature and rate of reaction. To do this, use some or all of the materials listed below and the procedure for experiment 1.
- Record your results and observations.
- Write a conclusion for your findings to help you answer the question.

Experiment 3: How does concentration affect reaction rate?

- Design an experiment to investigate the relationship between concentration of reactants and rate of reaction. To do this, use some or all of the materials listed below and the procedure for experiment 1. **Hint:** dilute the vinegar to change the concentration of a reactant.
- Record your results and observations.
- Write a conclusion for your findings to help you answer the question.

[1] Activity adapted from: "Baking Soda and Vinegar Balloon," Education.com, accessed April 28, 2020, https://www.education.com/science-fair/article/baking-soda-and-vinegar-balloon/ and "How to Blow Up a Balloon With Baking Soda and Vinegar," wikihow.com, accessed April 28, 2020.

Materials required

- Empty plastic bottle
- White vinegar
- Baking soda
- Bowl
- Ice water
- 3 or more balloons
- Small funnel
- Tablespoon
- Thermometer (optional)
- Timer (optional)
- Paper, writing materials

Information for parents

- Provide your child with a safe workspace and materials that could be used for this activity.
- Make sure that your child is manipulating the material safely.
- Ask your child questions to further develop their thinking skills. For example, ask them to explain the steps they are taking and why they are taking them, or to explain their answers to the experiments' questions.

Moving is hard work

Image : https://www.sunsetremovalsnewcastle.com.au/

Information for students

- Moving heavy objects can be difficult.
- Inclined planes can make it easier.
- The formula for work is $\boldsymbol{W = F\,x\,d}$

Where:

W = work done (in joules)

F = force applied parallel to the displacement (in Newtons)

d = distance travelled (in metres)

- Trigonometric Ratios

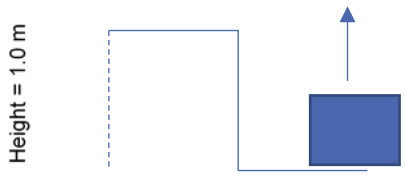
$$\boldsymbol{Sin\,\theta = \frac{opposite}{hypotenuse}} \quad \boldsymbol{Cos\,\theta = \frac{adjacent}{hypotenuse}} \quad \boldsymbol{Tan\,\theta = \frac{opposite}{adjacent}}$$

Alex says it takes the same amount of work (energy) to lift a fridge straight up as it does to push the same fridge up an inclined plane. However, pushing a fridge up an inclined plane is much easier to do. Can you explain why?

Use a free body diagram to model lifting the fridge straight up and another to model the movers pushing the fridge up the inclined plane. Describe the relationship between force, distance travelled and work. Finally, which of those three (force, distance travelled or work) makes it easier to lift heavy objects?

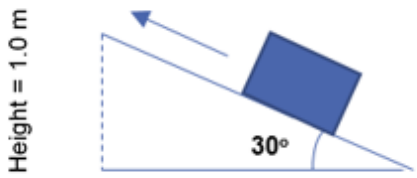
The mass of the fridge is 120 kg.

Lifting the fridge straight up



Pushing the fridge up the inclined plane

The length of the inclined plane is 2.0 m. The angle of inclination is 30º. Assume there is no friction.



Predict what will happen if you change

- the angle
- the length of the inclined plane

Alex then said that the threads of a screw are like an inclined plane wrapped around a cylinder. Describe the relationship between force, distance travelled, and work/energy when using this simple machine.

Image: https://www.needpix.com/photo/1191944/screw-nail-hardware-metal-parts-parts-free-pictures-free-photos-free-images-royalty-free

Materials required

- Calculator

Information for parents

- Carefully explore lifting objects straight up and then pulling these objects using a ramp (an inclined plane) with your child. Inclined planes make transporting heavy objects much easier.
- The concept of applied force is introduced in Secondary 4, but some students may need to review the components of force on an inclined plane. This video reviews forces on an inclined plane: https://www.khanacademy.org/science/ap-physics-1/ap-forces-newtons-laws/inclined-planes-ap/v/inclined-plane-force-components