Key: Yellow highlight = required component

Rockets!

Subject Area(s) Chemistry

Associated Unit

Lesson Title **Rockets!**

Header

Image 1
Image file: ___?
ADA Description: ___? *(Write as if describing the image to a blind person; do not repeat any caption content.)*
Source/Rights: Copyright © ___?
Caption: ___?

Grade Level 10 (9-10)

Time Required 20 minutes

Summary

Students get a brief introduction to statics and dynamics in order to understand the forces needed to lift rockets off of the ground. Understanding that a thrust force is needed to launch rockets into space, students learn that the energy for thrust is stored as chemical energy in the fuel. Finally, using the law of conservation of energy, it can be concluded that the chemical energy of the fuel is converted into work and heat energy during la rocket launch.

Engineering Connection

Rockets are an engineering marvel. Mechanical and aerospace engineers develop the shape and design of the rocket, chemical engineers develop the fuel, and materials engineers develop materials that are light weight thermally durable for a trip into outer. For this class, and associated activity, students use their knowledge of stoichiometry to create the fuel for a small rocket engine as well as their critical thinking skills to design a rocket that can be successfully launched.

Engineering Category = 1

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords

combustion, conservation of energy, fuel, rocket

Educational Standards (List 2-4)

ITEEA 2000, grades 9-12, 16.J

Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.

J. In order to select, use, and understand energy and power technologies, students should learn that energy cannot be created nor destroyed; however, it can be converted from one form to another.

Texas: Science 2010, grades 9-10, C

Science Concepts. The student recognizes multiple forms of energy and knows the impact of energy transfer and energy conservation in everyday life. The student is expected to demonstrate common forms of potential energy, including gravitational, elastic, and chemical, such as a ball on an inclined plane, springs, and batteries

Pre-Requisite Knowledge

Students should be able to balance chemical equations and use stoichiometry.

Learning Objectives

After this lesson, students should be able to:

- Draw a free-body diagram
- Know Newton's second law of motion
- Understand the effect of forces on motion
- Identify the components needed for a combustion reaction
- Understand the law of conservation of energy

Introduction / Motivation

How do rockets work? Rockets are large and extremely heavy, and therefore require a great deal of energy to get them off of the ground. But where does this energy come from? The chemical energy stored in the fuel of the rocket is transformed into heat and work. Heat energy is released during the combustion of the fuel and work energy evident by the fact that the rocket is able to launch itself off of the ground. This lesson is designed to give students a basic understanding or the physics and chemistry of launching a rocket.

Lesson Background & Concepts for Teachers

Image Insert Image # or Figure # here [use Figure # if referenced in text]

Figure 1

Image file: ___?

ADA Description: ___? *(Write as if describing the image to a blind person; do not repeat any caption content.)*

Source/Rights: Copyright © ___?

Caption: Figure 1. ___?

Vocabulary / Definitions

Word	Definition
Statics	The branch of mechanics that is concerned with the analysis of loads on physical systems in static equilibrium, that is, in a state where the relative positions of subsystems do not vary over time, or where components and structures are at a constant velocity
Dynamics	The branch of mechanics concerned with the motion of bodies under the action of forces
Conservation of Energy	Energy can neither be created nor destroyed, but can change form.

Associated Activities

We Have Liftoff

Lesson Closure

Assessment

Pre-Lesson Assessment
Descriptive Title: ___?

Post-Introduction Assessment
Descriptive Title: ___?

Lesson Summary Assessment
Descriptive Title: ___?

Homework
Descriptive Title: ___?

Lesson Extension Activities

Additional Multimedia Support

References

Attachments

Other

Redirect URL

Contributors

Supporting Program

Acknowledgements

Classroom Testing Information

Statics & Dynamics

- Statics

$$\sum F = 0$$

  - The sum of the forces acting on an object is equal to o

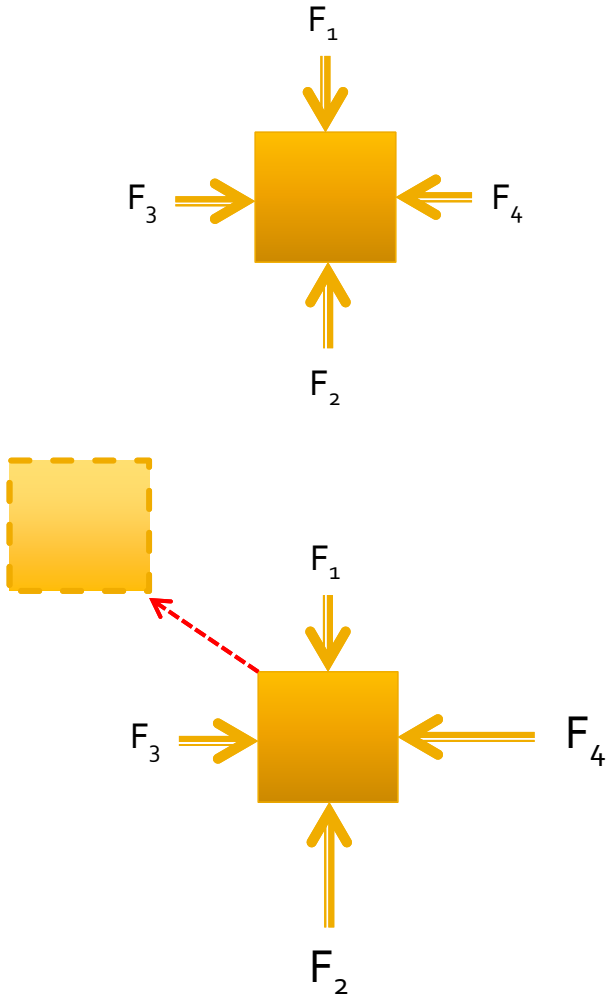
$$F_1 = F_2$$
$$F_3 = F_4$$

- Dynamics

$$\sum F \neq 0$$

$$F_2 > F_1$$
$$F_4 > F_3$$

Free Body Diagrams:



Rocket!

- Newton's Second Law of Motion:

$$F = ma$$

Force Mass Acceleration

  - We know that the forces acting on our rocket are:

$$W = mg$$

Weight

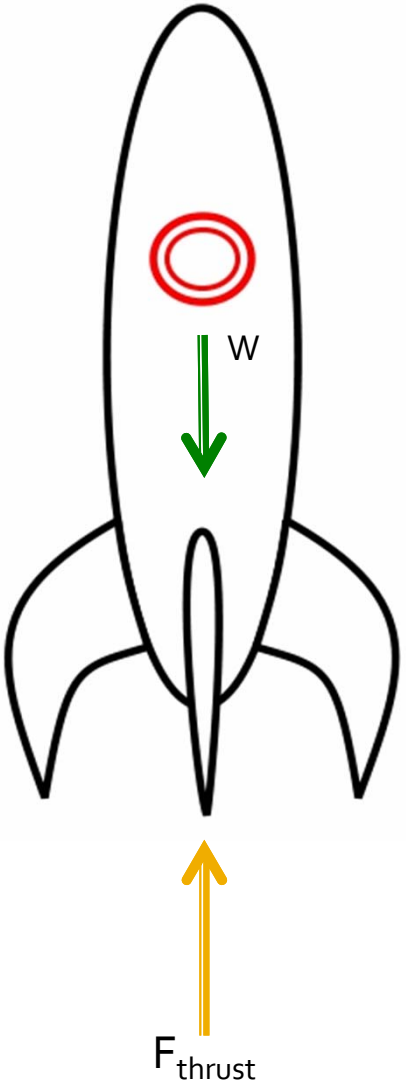
Gravity
(a =9 .8 m/s²)

$$F_{thrust} = uR$$

Exhaust velocity

Rate of mass ejection
(Δ Fuel mass/Δ time)

  - Another force we would normally take into account is the force due to air friction (we will assume it is negligible)



Energy

- 1st Law of Thermodynamics: Energy is conserved; it can neither be created nor destroyed

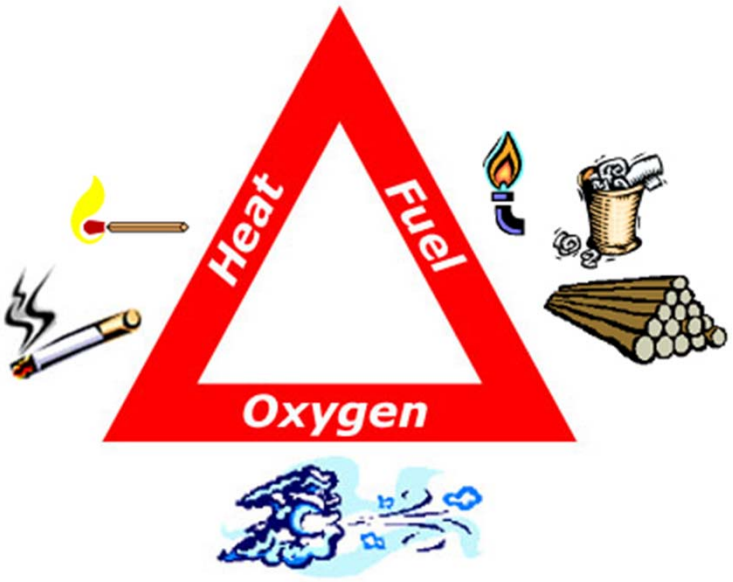
$$\Delta E = \Delta Q + \Delta W$$

Energy Heat Work

  - Any energy that you put into a system must come out of the system as work or heat
  - The energy that we put into the rocket (fuel) is equal to the work (how far it travels) and heat (from combustion and air friction) that come out of the rocket

Fuel

- The energy in the fuel that is not lost to the heat of combustion is converted into work energy to propel the rocket into the air
  - Combustion reactions require fuel, oxygen, & heat
  - The energy of combustion comes from the breaking of molecular bonds of the reactants
  - Fuel for our rockets is a mixture of KNO_3 (found in stump remover) and $C_{12}H_{22}O_{11}$ (table sugar)
- Think about it: How does changing the size of the fuel particles affect the combustion reaction?



$$O_2 + KNO_3 + C_{12}H_{22}O_{11} \rightarrow CO_2 + H_2O + N_2 + K_2CO_3 + KOH$$

In Conclusion

- Recall: $E = Q + W$
- We know:

  E → Chemical energy from our fuel

  Q → Heat energy from combustion

  W → (F_{thrust} x distance traveled)-W_{rocket}
- You are now a Rocket Scientist!