Supplemental Activities Packet

This packet contains classroom activity suggestions and worksheets to reinforce concepts from the Playbook® story and to go beyond the story into the content areas of Language Arts, Math, Science, Social Studies, Art, Health, etc., as well as Character Development.

Activities range in age appropriateness and skill level so that teachers can choose activities that best suit their particular students. An Answer Key is provided on the last page.

To download and print extra copies of this packet, visit www.playbooks.com/supplements.
Calculating Planets

How Long is Each Planet’s Year Compared to Earth’s? In this section you will learn how to determine the length of each planet’s year relative to a year on Earth. You need to know the planet’s speed relative to Earth’s and the planet’s distance from the sun relative to Earth’s. The diagram below shows the two numbers you need to know to find out how long each planet takes to revolve around the sun. Use this formula!

\[ \text{Radius of Orbit (r) / Orbital Speed (s) = Length of Year (y)} \]
(all relative to that of Earth)

Example: Mercury

<table>
<thead>
<tr>
<th>Radius of Orbit</th>
<th>Orbital Speed</th>
<th>Length of Year</th>
</tr>
</thead>
</table>
| 0.387           | 1.607         | \[ \frac{0.387}{1.607} = y \]

\[ y = 0.2408 \]

Mercury’s year is 0.2408 of an Earth year.

How Big is Each Planet Compared to Earth?

To find out how much bigger or smaller in circumference a planet is relative to the size of our Earth, use the following calculation.

Divide the planet’s distance around (miles) by Earth’s distance around (miles) and convert the number into a percentage.

Example: Mercury 9,523 / 24,874 = 0.382  \[ 0.382 = \text{about 38\%} \text{ Mercury is about 38\% the size of Earth.} \]

Directions: Calculate the length of each planet’s (or dwarf planet’s) year in Earth years using the guidelines above and the chart below. Write your answers in the Length of Year column of the chart. Then calculate the size of each planet relative to Earth by percentage and write your answers in the Size column. Show your work for all calculations on a separate sheet of paper. Move to the next activity sheet, “Racing Around the Sun,” and record all your answers there as well, as indicated.

Bonus Activity: For the planets whose days are longer than an Earth day, you may find it helpful to convert hours (displayed in the chart below) to Earth days. On a separate sheet of paper, calculate each planet’s day length in Earth days. Record your answers on the “Racing Around the Sun” activity in days instead of hours when the length of day is longer than one Earth day.

<table>
<thead>
<tr>
<th>Planet</th>
<th>Radius of Orbit (relative to Earth’s)</th>
<th>Orbital Speed (relative to Earth’s)</th>
<th>Length of Year (Earth days or Earth years)</th>
<th>Length of Day (Earth hours)</th>
<th>Number of Moons</th>
<th>Distance From Sun (miles)</th>
<th>Distance Around (miles)</th>
<th>Size (relative to Earth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.387</td>
<td>1.607</td>
<td>88 days</td>
<td>1407.6</td>
<td>0</td>
<td>35,984,030</td>
<td>9,523</td>
<td>38%</td>
</tr>
<tr>
<td>Venus</td>
<td>0.723</td>
<td>1.174</td>
<td></td>
<td></td>
<td></td>
<td>67,239,750</td>
<td>23,629</td>
<td></td>
</tr>
<tr>
<td>Earth</td>
<td>1.0</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td>92,958,591</td>
<td>24,874</td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>1.524</td>
<td>0.802</td>
<td></td>
<td>24.7</td>
<td>2</td>
<td>141,638,663</td>
<td>13,259</td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td>5.203</td>
<td>0.434</td>
<td></td>
<td></td>
<td></td>
<td>483,780,029</td>
<td>272,953</td>
<td></td>
</tr>
<tr>
<td>Saturn</td>
<td>9.539</td>
<td>0.332</td>
<td></td>
<td></td>
<td></td>
<td>890,728,497</td>
<td>212,253</td>
<td></td>
</tr>
<tr>
<td>Uranus</td>
<td>19.18</td>
<td>0.228</td>
<td></td>
<td>17.2</td>
<td>27</td>
<td>1,787,534,383</td>
<td>99,790</td>
<td></td>
</tr>
<tr>
<td>Neptune</td>
<td>30.06</td>
<td>0.182</td>
<td></td>
<td>16.1</td>
<td>13</td>
<td>2,798,386,666</td>
<td>96,686</td>
<td></td>
</tr>
<tr>
<td>Pluto</td>
<td>39.52</td>
<td>0.159</td>
<td></td>
<td>153.3</td>
<td>3</td>
<td>3,650,034,176</td>
<td>4,502</td>
<td></td>
</tr>
</tbody>
</table>
Why do Planets Move Around the Sun?
Gravity is the force that attracts objects together and keeps the planets pulled around the sun. Gravity is also what keeps you standing on the surface of Earth instead of floating off into space. Gravity controls the way all objects move in space. As you discovered in the story, all planets do not have equal gravity which caused some problems when Pluto tried to take on all of Jupiter’s moons! Pluto was too small, so his gravity was not enough to keep all those large moons in orbit. The sun has the greatest gravity of all which is why the planets are drawn to it.

Most objects in our solar system move predictably in two distinct ways: rotation and revolution. Rotation is when an object spins around it’s own axis, like a spinning top, and revolution is when an object moves around a larger object in an orbit. Note: Earth rotates along a line that is tilted rather than vertical.

In the story, you learned that each planet has a different length day and year, and sometimes a planet’s day can be longer than its year! This is because a day is determined by the length of time it takes for a planet to rotate (or spin) one time, and its year is determined by how long it takes to revolve around the sun. These lengths of time can be very different based on speed of motion and distance traveled.

PART A: What happens to us when the Earth rotates and revolves?
Use the information you learned above and critical thinking to answer the questions below.
1. Why does the sun rise and set every day?
2. Why is it summer in the southern hemisphere when it is winter in the northern hemisphere and vice verse?

PART B: So who wins the race?
Use your answers from “Calculating Planets” to fill in the missing information about each planet as shown with the example of Mercury.
1. Write each planet’s name on the top line above its image.
2. Fill the lines underneath the planets with the number of Earth days or years equal to one year on that planet. Also include on the lines the “place” the planet finishes in the race around the sun.
3. Write the length of each planet’s day in hours on the line indicated.
4. Write the number of moons each planet has in the box connected to it.
5. Write the planet’s size relative to Earth in the star connected to each planet.

PART C: Discussion Questions
1. It’s interesting to note that the distance the planet is from the sun is highly responsible for the length of time it takes to orbit around the sun. Does that also tell us how fast each planet moves along its orbit?
2. Who wins the race based on length of year?
3. Who wins the race based on length of day (fastest spinner)?
4. Which planet has the most moons? Why do you think this is?

PART D: Write your own acrostic—to help you remember the order of the planets based on distance from the sun. Below is a sample acrostic using the first letter of each planet’s name.
Earth inside and out! Part 1 - Beneath Earth’s surface

In Planet Parade, you learned how important different characteristics of each planet are to the way they function in the solar system. You know some of Earth’s important characteristics, like the water found on its surface, and the oxygen in its atmosphere. Now let’s look at some of Earth’s properties that aren’t as easily observed—what’s deep beneath our feet! Earth is made up of several main layers, as well as some smaller ones nearest the surface.

Lithosphere: This is the outermost and thinnest layer of Earth. It contains the crust, which is the cool solid rocky surface, and the upper mantle, which is warmer and denser but still solid rock, and is much cooler than the deeper layers.

Mantle: This is the largest layer, making up roughly 80% of Earth’s volume. It is very hot and mostly made of molten (liquid) rock. The mantle is the source of lava brought to the surface by volcanic eruptions.

Outer Core: The outer core is hotter still, and consists of dense liquid metal made up of mostly iron and nickel.

Inner Core: The inner core is a very dense, solid ball of iron and nickel, the hottest layer of Earth. You might wonder why the inner core is solid instead of liquid if it is hotter than the outer core. This is because pressure changes the temperature at which a material will melt, and the pressure is so high in the center of the earth that the core cannot melt.

PART A: Based on the descriptions above, label each of the main layers of Earth on the lines to the left of the arrows indicating each layer. Then, use the Internet to research how many kilometers deep each layer reaches and write it on the arrow line pointing to each layer.

What About Gas Planets?
Earth’s neighbors in the first half of the solar system, closest to the sun, look very much like Earth inside. They have variations of rocky crusts, molten mantles, and metal cores. The gas giants, like Jupiter and Saturn, are quite different!

PART B: On the lines below, compare and contrast rocky planets and gas planets, starting with the differences between the materials they are typically made of and how those might affect visitors to the planet.

____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

**EARTH INSIDE AND OUT! PART 2 - TOWARDS SPACE!**

In *Planet Parade* you learned about the atmospheres of some of the planets in our solar system. Almost every planet has an atmosphere, but some are thinner than others and none are exactly alike! Earth’s atmosphere is a very important part of what allows us to live here.

Earth’s atmosphere reaches *372 miles from the surface* and is *78% nitrogen, 21% oxygen, and 1% other gases*. However, the amount of each gas present varies by distance from the surface of Earth. *Water vapor* is a significant component and can make up to 4% of the air’s volume. The atmosphere is made up of different layers which each have different properties.

**PART A:** The diagram below shows each layer of the atmosphere in order and general (but not exact) relative height, along with some main characteristics. At your school’s library or at home, use the Internet to find how many kilometers high each layer reaches and write it on the line provided.

![Atmospheric Layers Diagram](image)

1. **Troposphere** - This is the layer we live in! Weather activity takes place here. The air gets colder the higher you soar within this layer. The troposphere is the densest layer, containing 75% of all “air” in the atmosphere.

2. **Stratosphere** - This layer is slightly warmer than the top of the troposphere, it rises from -52 degrees Celsius to -3 degrees Celsius. The Ozone Layer, made of a kind of oxygen which absorbs ultraviolet rays from the sun and protects life on Earth, is found near the top of the stratosphere. The stratosphere contains less water vapor and other gases than the troposphere.

3. **Mesosphere** - Here, temperature is colder than the stratosphere, reaching as low as -93 degrees Celsius.

4. **Thermosphere** - The temperature is very hot in this last outer layer of the atmosphere, up to 1,272 degrees! However, the air is very thin which means that if you were in this layer, it would actually feel cold! The probability that any of the particles of gas carrying the heat would hit your body so you could feel them would be very low.

**Atmospheric Mysteries**

**PART B:** Discuss some or all of the following questions as a class and see if you can figure out the answers! If your instructor directs you to, you may also use the Internet at home or your school’s library to research the questions. Number your answers and write them on a separate sheet of paper using complete sentences.

1. Why does the moon have so many more craters than Earth?
2. What are greenhouse gases and how do they affect Earth’s atmosphere? Remember to look at both the positive and the negative effects.
3. Why is Earth warmer than the moon?
4. Do you think Earth’s atmosphere was the same as it is today when the planet was first formed? If not, how was it different?
1. _____ a circular hole on the surface of a planet caused by a meteorite hitting the planet, or by a volcano
2. _____ a planet in our solar system which is made mainly of gas and liquid instead of solid materials, including Jupiter, Saturn, Uranus, and Neptune
3. _____ an area of our solar system between the paths of Mars and Jupiter where many asteroids are located; may have previously been planet that exploded
4. _____ a large group of stars held together by gravity and separate from other groups of stars; there may also be planets present
5. _____ any star that is orbited by planets; the star at the center of our solar system
6. _____ the path followed by planets around a sun or by moons around a planet; or to move around a sun or planet in a curved path
7. _____ the gas surrounding a planet; on earth, the air, containing oxygen and other components
8. _____ a round object that orbits the sun but is not required to clear other objects away from it’s area
9. _____ the center of a planet, made of materials recognizably different from the outer layers; or the center of a star, where a nuclear reaction is taking place
10. _____ a smaller natural object which orbits a planet

**NEW HORIZONS**

New Horizons is the name of the space probe that is currently on its way to Pluto! It was launched on January 19, 2006 and is expected to reach Pluto in June, 2015. The probe is about the size of a piano and is equipped with seven scientific instruments to measure characteristics such as gas composition, surface composition, temperature, and more, as well as a high-resolution telescope for collecting the best quality images.

**Directions:** Write a research essay about the New Horizons space probe. You may find this website helpful and fascinating: [http://www.pluto.jhuapl.edu](http://www.pluto.jhuapl.edu). Include the following in your essay, as well as any other details you think are important:

How is the probe specially designed for effective results?
How has the probe progressed since launch? What is its current position?
Why do scientists want to explore Pluto with a probe? What do they hope to find out?
Where will the probe go after it reaches Pluto?

Have fun learning about this exciting mission to explore Pluto for the first time, and make sure to check out the FAQ section of the website above for some crazy facts about what visiting Pluto might be like!
**Earth Inside and Out — Part 1**

**PART A:**

- inner core
- outer core
- mantle
- lithosphere

**PART B:** (Sample Answer)

While rocky planets have a solid surface, the atmosphere and stormy winds of gas planets gradually transition to thicker, fluid material that makes up a large portion of the planet. The only solid portion in most cases may be the core which is very small compared to the bulk of the planet. Gas planets are also many times larger than rocky planets and therefore have stronger gravitational pull. Theoretical visitors to gas planets would not be able to land on them because there is no surface. The gas storms would also be incompatible with life.

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**Calculating Planets**

<table>
<thead>
<tr>
<th>Planet</th>
<th>Length of Year (Earth days or Earth years)</th>
<th>Size (relative to Earth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>88 days</td>
<td>38%</td>
</tr>
<tr>
<td>Venus</td>
<td>225 days</td>
<td>95%</td>
</tr>
<tr>
<td>Earth</td>
<td>365 days</td>
<td>100%</td>
</tr>
<tr>
<td>Mars</td>
<td>687 days</td>
<td>53%</td>
</tr>
<tr>
<td>Jupiter</td>
<td>12 years</td>
<td>1100%</td>
</tr>
<tr>
<td>Saturn</td>
<td>29 years</td>
<td>850%</td>
</tr>
<tr>
<td>Uranus</td>
<td>84 years</td>
<td>400%</td>
</tr>
<tr>
<td>Neptune</td>
<td>165 years</td>
<td>390%</td>
</tr>
</tbody>
</table>

**Bonus Activity:**

**Planet Day Lengths in Earth Days**

<table>
<thead>
<tr>
<th>Planet</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>59</td>
</tr>
<tr>
<td>Venus</td>
<td>243</td>
</tr>
<tr>
<td>Pluto</td>
<td>6</td>
</tr>
</tbody>
</table>

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**Space Dictionary**


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**Racing Around the Sun — All About Orbits**

**PART A:**

1. The sun rises and sets because different parts of Earth face the sun as the Earth rotates or spins, causing night and day.
2. The seasons are opposite on each hemisphere because Earth is tilted on its axis, so as it revolves around the sun, one half of the Earth is slightly closer to the sun while the other half is slightly farther away from the sun. The distances switch as the Earth moves around the sun.

**PART B:**

Answers provided in chart on “Calculating Planets” activity sheet and “Calculating Planets” Answer Key.

**PART C:**

1. Not necessarily; speed and distance from sun work together to determine who gets around the sun in the least time, however, the planets’ speeds happen to be in the same order as their distances from the sun, so the slowest mover is the farthest and also takes the longest to revolve.
2. Mercury
3. Jupiter
4. Jupiter. This may be because Jupiter is so large and therefore has more gravitational pull to attract all those moons and keep them in orbit.
Steps to Innovation

Directions: You learned in the story that the engineering process requires certain steps to be done in a certain order. On the numbered lines below, unscramble the following words so that they are in the correct order for an engineer to follow. Then, explain what is involved in each step in the lower section. Give examples using your imagination, as if you were designing your own invention.

<table>
<thead>
<tr>
<th>Change it</th>
<th>1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retest it</td>
<td>2.</td>
</tr>
<tr>
<td>Research it</td>
<td>3.</td>
</tr>
<tr>
<td>Success</td>
<td>4.</td>
</tr>
<tr>
<td>Plan it</td>
<td>5.</td>
</tr>
<tr>
<td>Test it</td>
<td>6.</td>
</tr>
<tr>
<td>Picture it</td>
<td>7.</td>
</tr>
<tr>
<td>Build it</td>
<td>8.</td>
</tr>
</tbody>
</table>

_____________________________________________________________________
_____________________________________________________________________
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________________________
Name
Energize The Future!

**Directions:** Use the Internet to perform your own research about alternative energy sources. Fill out the diagram below with characteristics (both negative and positive) of water, wind, and solar energy. In the overlapping sections, write characteristics that apply to both/all of the energy sources.
There are a number of prominent, widely utilized solar power plants around the world. Below are some key facts about some of the most well known.

**Sarnia Photovoltaic Power Plant**
- Sarnia, Ontario, Canada
- Located on 950 acres
- Produces 120,000 MWh (Megawatt hours) per year
- Largest photovoltaic power plant in the world
- Capable of providing power for about 12,800 homes
- Produces no waste, and solar panels will be recycled after they wear out

**Olmedilla Photovoltaic Power Plant**
- Olmedilla de Alarcon, Spain
- Located on 266 acres
- Produces 85,000 MWh per year
- Cost $530 million to build

**Solarpark Lieberose**
- Turnow Prellack, Germany
- Located on 402 acres of land
- Produces 53,000 MWh per year
- Contains 700,000 solar modules

**Recently Approved - Solana**
- Phoenix, AZ
- Will have a capacity of 250 MW
- Concentrated solar plant
- Will contain 2,700 parabolic trough collectors
- Will cover 1920 acres

**Recently Approved - Imperial Valley**
- Imperial Valley - CA
- Will be located on 6,440 acres
- Will have a capacity of 750 MW

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**Steps to Building a Solar Power Plant**

1. Finding and Selecting a Site
2. Preliminary Financial Analysis
3. Leasing or Buying Land
4. Engineering Design and Selection of Technological Features
5. Obtaining Permits
6. Power Purchase Agreement
7. Selection of Solar Installer
8. Financing the Project
9. Testing and Connection to Power Grid
10. Maintenance

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Source: [http://energyfuture.wikidot.com/solar-resources](http://energyfuture.wikidot.com/solar-resources)
**Make a Blueprint**

**Directions:** A blueprint is a drawing made to scale by engineers to show details of a larger object to be constructed. Blueprints contain measurements showing the actual dimensions of the intended objects. A sample of a blueprint is shown below to assist you.

In the space provided, draw a blueprint of a proposed solar power plant for Batsford in the Playbook® story, *Engineer It Out!* You may need to use a separate sheet of paper and make several separate drawings to convey all aspects of the plant, including outer building structures and inner functional mechanisms. *(Your drawing does not need to be completely scientifically exact; the purpose of the assignment is to explore blueprints and solar power structures.)*

Choose the type of solar power structure you think would work best for Batsford’s situation and use it in your blueprint. Below are six different types which you can read about here:

- Photovoltaic Panels
- Parabolic Troughs
- Solar Dish
- Fresnel Reflector
- Solar Power Tower
- Solar Chimney

Use the Internet to research the information you need to create a simple blueprint. Here is one graphic showing the features of Photovoltaic Panels which you may find useful: [http://solar.coolerplanet.com/extras/images/articles/SolarEnergySystemsFull.jpg](http://solar.coolerplanet.com/extras/images/articles/SolarEnergySystemsFull.jpg).

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**Science**

**Engineering**
Get This “Re-SEARCH” Going!

Directions: Find and circle the following words from the story. Some are vertical; some are horizontal, and some are diagonal.

F W N U S U C C E S S S S E
U N C L E N E D X T O P N
L A D C H R I S O W L D E
V S P I R T S I D E A E T
S O U R C E U C U M R J G
D R E T E S T L R O P P Y
P H P C N B A T S F O R D
R T R E S E A R C H W I W
I U O L M O Y B A S E V I
V G B E N G I N E E R A N
A L L C A R L A N X K T D

Word Box

engineer       solar       power
Batsford       electric    research
idea           plan        success
retest         Carla       private
Chris          Uncle Ned   problem
base           dam         source
energy         wind        sun
Vocabulary Challenge

Directions: Write the letters of the words from the box below next to the correct definitions.

1. _______ to interrupt or cause disorder
2. _______ a supply or resource
3. _______ endlessly; for eternity
4. _______ not reusable; possible to consume
5. _______ changed from one form on thing to another
6. _______ a question
7. _______ other option
8. _______ a performance or feat
9. _______ impaired or defective
10. _______ to reach or acquire
11. _______ leveled
12. _______ not continuous; stopping and starting

A. unsound  B. stunt  C. alternate  D. disrupt
E. expendable  F. intermittent  G. reserve  H. obtain
I. graded  J. inquiry  K. perpetuity  L. converted
The links below include teacher/instructor resources for bridge building activities and the engineering principles behind bridge design and construction.

- **Building Big from PBS:** Covers types of bridges, bridge facts, forces involved in bridge function, links to additional bridge-related activities, and more. [http://www.pbs.org/wgbh/buildingbig/bridge/index.html](http://www.pbs.org/wgbh/buildingbig/bridge/index.html)

- **Build a Paper Bridge:** Activity plan for students to build a bridge out of paper. [http://www.learnnc.org/lp/pages/3050](http://www.learnnc.org/lp/pages/3050)

- **Build a Popsicle Stick Bridge:** Includes instructions for building, testing, and many photo examples of different types of popsicle stick bridges. [http://www.garrettsbridges.com/popsicle-stick-bridges/](http://www.garrettsbridges.com/popsicle-stick-bridges/)

- **Virtual Bridge Site Evaluation:** Interactive web game lets students select which bridge would best fit certain locations and circumstances. [http://www.pbs.org/wgbh/nova/tech/build-bridge-p1.html](http://www.pbs.org/wgbh/nova/tech/build-bridge-p1.html)

- **Math Behind Bridge Building:** Includes information on the math principles behind bridge construction. [http://passyworldofmathematics.com/sydney-harbour-bridge-mathematics/](http://passyworldofmathematics.com/sydney-harbour-bridge-mathematics/)
**Catapult Math**

**Directions:** The structure and function of a catapult demonstrates key mathematical concepts including the quadratic equation and rules about the dimensions and angles of a triangle. While these ancient inventions were first used without advanced mathematical knowledge, relying instead on basic trial and error, engineers today can optimize performance of these tools and better understand the reasons why some designs work better than others using the laws of math and physics. Solve the problems below using the numbers given.

**The Quadratic Equation:** \( f(t) = at^2 + bt + c \)

The quadratic equation can be used to graph a parabola. The Equation of Motion is an example of its practical applications and can describe the path of a projectile launched by a catapult. Applied in this way, \( y(t) \) equals the height of the projectile, \( x(t) \) equals the horizontal distance of the projectile, and \( t \) equals the time elapsed since launch, where \( a \) is acceleration, \( b \) is initial velocity and \( c \) is initial position.

**For questions 1-5, use the following information:** A particular catapult launches a projectile that follows a path described by the equations…

\[
\begin{align*}
  y(t) &= -(1/4)t^2 + 2t + 5 \\
  x(t) &= -(1/10)t^2 + 2t + 0
\end{align*}
\]

1. Complete the following table showing the number of seconds elapsed since the projectile’s release.

<table>
<thead>
<tr>
<th>t</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

2. How high does the catapult’s arm suspend the projectile at the time of launch? ____________________________

3. Based on the chart, approximately how high is the catapult capable of launching the object? ____________________

4. Based on the chart, how long does it take the projectile to reach its highest point? __________________

5. How far is the catapult capable of launching the object? __________________

6. The triangle on the right (top) represents the angle and height of the arm of a catapult when it releases a projectile. Find the length of the arm.

7. Using the triangle on the right, (bottom) find the angle of the arm of a catapult at the time of launch.

8. The ideal initial angle of launch for a projectile is 45°. What does this mean in terms of results? What happens if the angle is less than 45°? What happens if it is more than 45°?

_________________________________________________________________________________
_________________________________________________________________________________

9. Why do you think this is?
_________________________________________________________________________________
_________________________________________________________________________________

10. **Bonus question:** Explain what the following equation represents. \( R = v_0^2 \sin(2\theta)/g \)

Name____________________________

Mathematics/Science

Algebra/Physics
Being an Engineer

Directions: Explore the vast potential and range of choices for an engineering career. Read the information below and explore the web links provided.

Engineering is one of the most promising fields for new graduates today. Entry-level positions typically require a bachelor’s degree and starting salaries are some of the highest of new college graduates.

There are more than 25 areas of specialization in the engineering field! For example:

- Aerospace Engineering - design aircraft
- Architectural Engineering - design buildings and other structures
- Bioengineering - use biology and engineering to advance biomedical field
- Chemical Engineering - work with pharmaceuticals, food processing, polymers, and other chemicals
- Civil Engineering - leaders in technology
- Computer Engineering - work with hardware and software systems
- Electrical Engineering - design electronic inventions and equipment
- Environmental Engineering - work to solve issues of pollution, recycling, waste control, and public health
- Mechanical Engineering - use knowledge of energy, materials, and mechanics to design wide variety of devices

Read about the opportunities in these fields and more with the following resource:

http://www.tryengineering.org/explore-engineering/engineering-majors

Preparation for a Career in Engineering: Students interested in engineering can start working toward that goal in junior high and high school by choosing courses that will be useful to their education. Some of these include but are not limited to….

- Algebra II
- Biology
- Calculus
- Chemistry
- Physics
- Foreign Language

Resources for Pursuing a Career in Engineering: The following links provide information on the engineering field and how to plan for a career.

http://www.careerpath.com/jobs-in/engineering/?industry=engineering&cbRecursionCnt=1
http://www.tryengineering.org/explore-engineering
Engineer it Out

Answer Key

For Teacher Use Only

Steps to Innovation

1. Picture it
2. Research it
3. Plan it
4. Build it
5. Test it
6. Change it
7. Retest it
8. Success

Catapult Math

1.

<table>
<thead>
<tr>
<th>t (s)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>x (s)</td>
<td>0</td>
<td>1.9</td>
<td>3.6</td>
<td>5.1</td>
<td>6.4</td>
<td>7.5</td>
<td>8.4</td>
<td>9.1</td>
<td>9.6</td>
<td>9.9</td>
<td>10</td>
</tr>
<tr>
<td>y (m)</td>
<td>5</td>
<td>6.75</td>
<td>8</td>
<td>8.75</td>
<td>9</td>
<td>8.75</td>
<td>8</td>
<td>6.75</td>
<td>5</td>
<td>2.75</td>
<td>0</td>
</tr>
</tbody>
</table>

2. The projectile is at a height of 5 units at the time of release.
3. The highest point is when the projectile is 9 units high.
4. It takes 4 seconds for the projectile to reach its highest point.
5. It can launch the object 10 units.
6. \( \sqrt{89} \) or about 9.4
7. 65 degrees
8. It maximizes the distance that the object will travel before hitting the ground. If the release angle is less than 90°, the object will not fly as high and will hit the ground closer. If the release angle is larger than 90°, the object will fly higher but hit the ground closer.
9. The distance a projectile travels is determined by two factors—the initial speed in the \( x \) direction and the time spent in the air. While a larger release angle results in a faster launch speed, the distance a launched object will travel is limited by the short time it spends in the air. A smaller release angle results in a longer time in the air, but a slower speed. A 45° release angle does not result in the fastest or the longest time in the air, but it travels the farthest because it does reasonably well in both categories.
10. \( v_0 \) is the launch speed, \( \theta \) is the launch angle, and \( g \) is the gravitational acceleration. So this equation allows us to calculate how far an object can be launched at a certain angle at a certain speed.

Vocabulary Challenge

1. D
2. G
3. K
4. E
5. L
6. J
7. C
8. B
9. A
10. H
11. I
12. F

Get This

Re-SEARCH Going!

Energize the Future

Answers will vary.

To download and print extra copies of this page, visit www.readerstheater.com/supplements
Remember PEMDAS!

**Part A:** Simplify the following expressions using the Order of Operations.

1. \((44 - 4) ÷ 5 + 4^2\)  
2. \((46 - 16) ÷ 3 + 5^2\)

3. \(2 x (4 + 3) + 4^2\)  
4. \((9 ÷ 3 + 2^3) - 10\)

5. \((49 - 3^2) ÷ (3 + 7)\)  
6. \(5 x (6 - 3) - 4^3\)

**Part B:** Solve the equations.

7. \((6 + 2)^2 + (y ÷ 4) = 69\)  
8. \((66 - z^3) ÷ (8 - 6) = 25\)

9. \((24 ÷ h) + (2 x 4) = 16\)  
10. \(24 ÷ (h + 2) x 4 = 16\)
**Vocabulary Challenge**

**Directions:** Match the words from the Word Bank with their definitions below.

<table>
<thead>
<tr>
<th>A. operation</th>
<th>B. shudder</th>
<th>C. mope</th>
<th>D. vendor</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. frazzled</td>
<td>F. sluggish</td>
<td>G. equipped</td>
<td>H. parentheses</td>
</tr>
<tr>
<td>I. exponent</td>
<td>J. illuminate</td>
<td>K. calculate</td>
<td>L. scheme</td>
</tr>
</tbody>
</table>

1. ____________ a pair of signs used to mark off a section of text or a mathematical expression
2. ____________ to tremble with a sudden movement
3. ____________ slow
4. ____________ to brighten, clarify, or add knowledge
5. ____________ a number or symbol placed above and to the right of another number or symbol to indicate the mathematical power of that number or symbol
6. ____________ worn out
7. ____________ prepared
8. ____________ to sulk
9. ____________ plan
10. ____________ to figure out
11. ____________ a person or company that sells something
12. ____________ an act or process
Part A: Answer the following questions about the story, Please Excuse My Dear Aunt Sally.

1. What is funny about some of the characters’ names in this story?

________________________________________________________________________________

2. Explain in your own words the metaphor of the businesses preparing for the festival being compared to the Order of Operations.

_______________________________________________________________________________________
_______________________________________________________________________________________

3. Why do you think Dylan is always apologizing for his Aunt Sally? If she was your aunt, would you feel the need to do this, too?

_______________________________________________________________________________________
_______________________________________________________________________________________

4. Do you feel the businesses Aunt Sally asked to help with the festival did a good job doing their parts? Why or why not?

_______________________________________________________________________________________
_______________________________________________________________________________________

5. Can you creatively come up with an “equation” using letters and/or numbers, representing the characters and their parts in planning the festival, showing how each part needed to be done in a certain order? Have fun with this and don’t worry if it doesn’t make perfect sense.

_______________________________________________________________________________________

Part B: In the Playbook® story, Please Excuse My Dear Aunt Sally, Dylan thinks he knows almost everything about math. He doesn’t understand how he managed to do so poorly on his test. Have you ever thought you understood or knew something, but something didn’t quite make sense, or you couldn’t figure out what you were missing? This could have to do with school, a social situation, or anything! Write a short essay on the lines below explaining the situation and how you eventually solved the “mystery.”

_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
_______________________________________________________________________________________
In the Playbook® story, *Please Excuse My Dear Aunt Sally*, one of the festival costs was 100 balloons! In this activity, you will learn about some of the science behind balloons.

**Part A:** Below are some interesting facts about the chemistry behind balloons.
- Why do balloons float in the air? *They are filled with helium (He), which is lighter than the air we breathe.*
- How does the material balloons are made of allow them to function the way we intend? *They are made of rubber which is very flexible, so it stretches, allowing the balloon to be blown up. A “balloon made out of paper wouldn’t inflate into the round shape we want!*

1. Fill in the following information about the element, Helium, using the Internet or your science book.
   - Atomic Number: 
   - Atomic Weight: 
   - Melting Point: 
   - Boiling Point: 
   - Density: 
   - Phase at Room Temperature: 
   - Element Classification: 
   - Period Number: 
   - Group Number: 
   - Group Name: 

2. What is the approximate composition of the air we breathe? Include the different elements and percentages of each.  

**Part B:** You can complete this balloon experiment in your classroom!

**Materials:**
- Balloons (not inflated)
- Acetic acid (vinegar)
- Sodium bicarbonate (baking soda)
- Beakers
- Plastic soda bottles
- Funnels

**Procedure:** Pour 80 mL of acetic acid into the plastic bottle using the beaker. With the funnel, fill the balloon with 2 tablespoons of sodium bicarbonate. Place the opening of the balloon over the neck of the bottle and turn it upside down, emptying the sodium bicarbonate into the bottle.

**Results:**
1. Describe what happens.
2. Explain why this experiment works.
Directions: In the Playbook® story, *Please Excuse My Dear Aunt Sally*, Dylan and Aunt Sally need to make sure the town stays under budget for its festival. In this activity, pretend you are in charge of budgeting for a community concert. Read the specifications below and fill in potential costs for each component in order to stay within your budget.

**Total Budget**: $6,000

**Items and Services Required:**
- 2 Stages  
  Cost of Each: ___________
- 3 Speakers and 4 Microphones  
  Cost of Each: ___________
- Venue  
  Cost: ___________
- Publicity (10 posters, 1 newspaper advertisement)  
  Cost of Each: ___________
- Band  
  Cost: ___________
- Food and drinks for refreshment stand  
  Cost of Each: ___________

*(add any other components you think of on extra lines)*

- ______________________________  
  Cost: ___________
- ______________________________  
  Cost: ___________
- ______________________________  
  Cost: ___________

Now write a mathematical expression showing how each individual cost adds up to the total cost. Use parentheses and show each mathematical operation. Then write the total cost to confirm you have stayed under or at your budget.

________________________________________________________________________________

Next, pretend you have sold 221 tickets to the event at $10 each. Add this information to your expression, and then figure out the balance after combining your event expenditures and the income from ticket sales.

________________________________________________________________________________

In the Playbook® story, the town saved money because several people donated supplies and services. Can you think of any ways to reduce your costs for your event?

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________
Please Excuse My Dear Aunt Sally
Answer Key
For Teacher Use Only

Working on a Budget

Student budget breakdowns and resulting expressions will vary.

Remember PEMDAS!

1. 24
2. 35
3. 30
4. 1
5. 4
6. -49
7. 20
8. 4
9. 3
10. 4

Vocabulary Challenge

1. H
2. B
3. F
4. J
5. I
6. E
7. G
8. C
9. L
10. K
11. D
12. A

Balloon Science

Part A:

1. Atomic Number: 2
   Atomic Weight: 4.002602
   Melting Point: 0.95 K (-272.2°C or -458.0°F)
   Boiling Point: 4.22 K (-268.93°C or -452.07°F)
   Density: 0.0001785 grams per cubic centimeter
   Phase at Room Temperature: Gas
   Element Classification: Non-metal
   Period Number: 1  Group Number: 18  Group Name: Noble Gas

2. 78% nitrogen, 21% oxygen, 1% other including carbon dioxide and argon

Part B:

1. The balloon inflates.
2. The vinegar and the baking soda react when it mixes and forms carbonic acid. Carbonic acid immediately breaks down into water and carbon dioxide. The carbon dioxide released inflates the balloon.

Wacky Ways, Crazy Day

1. Parker Exley = Parentheses and Exponents, Mrs. Divine = Multiplication and Division, and Adam Subs = Addition and Subtraction
2. Answers will vary.
3. Answers will vary.
4. Answers will vary.
5. Answers will vary.