Name(s)

# The Particle Adventure Internet Activity

Directions:

 1) Proceed to: **http://particleadventure.org**

1. Once at the site, click on ***Standard Model (GO!)***
2. You should find yourself on the ***What is Fundamental? Eternal Questions*** page. Look at the nice picture of the famous sculpture. If you don’t remember the name of this work of art and/or the sculptor who created it, now would be a good time to click on ***(Answer)*** below the picture.
3. Click on the **>** icon at the top right of the page to advance to the next page, ***What is Fundamental? The Search for the Fundamental***. Answer the questions below, then advance to the next page, and so on. Read each page, and then answer the corresponding questions in this packet. Have fun.

**What is Fundamental?** The Search for the Fundamental

1. In order for a particle to be considered fundamental, what must be true about it?

 (Proceed to next page >)

**What is Fundamental?** The Atom

1. No questions here. Just read and proceed (hey, that rhymes…)

**What is Fundamental?** Is the Atom Fundamental?

1. Why is the term “atom” a misnomer?

**What is Fundamental?** Is the Nucleus Fundamental?

1. Well, is it?

**What is Fundamental?** Are Protons and Neutrons Fundamental?

 1. What two fundamental particles are made of quarks?

 and

1. Do quarks appear to have volume?
2. Are quarks considered to be fundamental?

**What is Fundamental?** The Modern Atomic Model

1. Draw a sketch of the modern model of the atom:
2. Is this sketch a scale representation of the atom?
3. What % of the atom is empty space?

**What is Fundamental?** The Scale of the Atom

 1. How many times smaller than the atom is the nucleus?

1. What is the maximum size (in meters) of electrons and quarks?

 m

1. Is it possible that electrons and quarks could be made up of smaller particles?

**What is Fundamental?** What are We Looking For?

1. Approximately how many particles have been discovered so

far?

 2. Are most of these particles fundamental?

3. What do scientists use to name particles?

**What is Fundamental?** The Standard Model

1. According to the Standard Model, what accounts for all of the subatomic particles and the interactions between them?

2. What is the most famous lepton?

3. Is the Standard Model a perfect theory?

4. What important force cannot be explained by the Standard Model?

**What is Fundamental?** Standard Model Quiz

1. Check out the trivia quiz question and answer. What subatomic particle was discovered on the 1930’s?

**What is the World Made of?** Quarks and Leptons

 1. So, what is the world and everything else made of?

**What is the World Made of?** Matter and Antimatter

 1. In what way is a particle different from its antiparticle?

 2. What is the antiparticle to the proton called?

 3. What is the charge on this particle?

 4. What happens when a particle and its antiparticle meet?

**What is the World Made of?** What is Antimatter?

This webpage shows a bubble chamber photograph. Fast-moving subatomic particles passing through the gas in the chamber leave trails of tiny droplets behind.

1. Which direction do positive particles curl in the bubble chambers magnetic field?

How about negative particles?

1. Do photons leave a trail in the bubble chamber?
2. How do we know that the two particles that left the highlighted trails are antiparticles?

**What is the World Made of?** What is Antimatter?

1. How many different kinds of quarks are there?

How many antiquarks?

1. What is the unusual characteristic of quarks?
2. List the name of each of the six quarks and its corresponding

charge:

 Name Charge

1. What turned out to be the most elusive quark, and when was it

finally discovered?

**What is the World Made of?** Naming Quarks

1. From what literary work is the word quark taken?

2. What are the names given to the two lightest quarks?

3. When was the charm quark discovered?

1. When **and** where was the bottom quark discovered?

5. Which is the most massive quark?

**What is the World Made of?** Hadrons, Baryons, Mesons

1. Are quarks ever found alone?
2. What are composite particles made from quarks called? **\_\_\_\_\_\_\_\_\_**
3. Do these composite particles have net fractional charges (like

individual quarks) or net integer charges?

1. What are baryons made from?
2. What combination of quarks makes a proton?

1. What combination of quarks makes a neutron?

1. What are mesons made from?

1. Are most mesons stable or unstable?

## **What is the World Made of?**  Leptons

1. Write a short profile for each of the different Leptons. Be sure to include a discussion of charge and mass:

 Electron -

 Muon -

 Tau -

 Neutrino -

2. Are leptons always found combined with other leptons (as quarks are) or do they exist as solitary particles?

1. What is the name given to the antiparticle to the electron?

## **What is the World Made of?** Lepton Decays

 1. Which two leptons decay rapidly into lighter particles?

1. Which leptons are stable?

## **What is the World Made of?** Lepton Type Conservation (Skip)

**What is the World Made of?** Lepton Decay Quiz (Skip)

## **What is the World Made of?** Neutrinos

1. What do neutrinos almost never do with other particles?
2. What is the reason given for this?
3. In the example given, what is the law that requires that there be another particle produced on the decay of a radioactive nucleus?
4. Do neutrinos have a lot of mass for subatomic particles?
5. Are there a lot of them in the universe?

## **What is the World Made of?** Quiz on What Particles are Made of

 Try the quiz. See how you do.

## **What is the World Made of?** The Generations of Matter

 1. How are generations organized?

2. Which generation(s) of matter is the visible matter in the universe made of?

3. What are three particles that make up the visible universe?

1. Why aren’t other particles included in visible matter?

## **What is the World Made of?** Matter Summary

1. So what’s everything made of?

1. What are particles made up of quarks called?

**What Holds it Together?** The Four Interactions

 1. What are the four interactions?

 2. What’s the difference between a force and an interaction?

**What Holds it Together?** How Does Matter Interact?

1. What is a force at the fundamental level?

**What Holds it Together?** The Unseen Effect

1. Check out the basketball guys on the ice. What do particles exchange when they interact?

2. What types of forces aren’t explained well by the basketball guys on ice analogy?

1. Can any matter particle be affected by any force carrier particle?
2. What is the electromagnetic force carrier?
3. What particles cannot absorb this force carrier?
4. Why can’t they?

**What Holds it Together?** Electromagnetism

 1. What two everyday forces are attributed to electromagnetism?

1. What is the mass of a photon?
2. How fast do photons travel in:
	1. meters/second?
	2. miles/second?

**What Holds it Together?** Residual E-M Force

 1. What does the residual E-M force allow atoms to do?

**What Holds it Together?** What about the Nucleus?

 1. What’s the burning question about the nucleus?

**What Holds it Together?** Strong

 1. What **two** types of charge do quarks have?

1. What is the strong force carrier particle called?
2. Why aren’t we directly aware of the strong force in everyday life?

**What Holds it Together?** Color Charge

1. What happens to the color force field between quarks as they get further apart?

**What Holds it Together?** Quark Confinement

1. What are baryons?
2. What are mesons?
3. Why can’t quarks exist individually?

**What Holds it Together?** Weak

1. What are weak interactions responsible for?

 2. List the weak force carriers particles and indicate whether they

 are charged or neutral.

3. What other force has been unified with the weak force, and what is this unified interaction called?

**What Holds it Together?** Electroweak

1. At what distance does the weak force become comparable to the electromagnetic force?

**What Holds it Together?** Gravity

1. What will scientists call the gravity force carrier particle when it is discovered?

2. Why does the Standard Model work fine without explaining gravity?

**What Holds it Together?** Interaction Summary

 1. Fill in the chart:

 Gravity Weak Electromagnetic Strong

 (electroweak)

 carried

 by

 acts on

 2. Which fundamental interaction(s) is(are) responsible for:

a. friction?

1. nuclear bonding?
2. interactions on neutrinos?