

## Activity 1

### Matter and antimatter - Teacher's Guide

➤ Try to get a student to explain the concepts of matter and antimatter to the rest of the class. Otherwise, the teacher will give this basic explanation or read it to students.

Let's take this as a very basic explanation of matter and antimatter in the universe:

*Matter and antimatter particles are always produced as a pair and, if they come in contact, annihilate one another, leaving behind pure energy. Therefore, if matter and antimatter are created and destroyed together, it stands to reason that the universe should contain nothing but leftover energy. Nevertheless, a tiny portion of matter – about one particle per billion – managed to survive. This is what we see today. In the preceding few decades, scientists have learned from particle physics experiments that the laws of nature do not apply equally to matter and antimatter.*

➤ Now ask students the following questions to which the answer is provided here.

Question 1: From what you know about matter and anti-matter, what would happen if you, as a body made out of matter, were suddenly transported to a parallel universe that is anti-matter dominant instead?

There would be an explosion that would take out whichever city you found yourself in. Bigger than that from any atomic weapon built so far.

Question 2: If matter and anti-matter disappear in a flash when they contact each other, how does the universe not implode?

Our universe contains only matter, neglecting a small antimatter component of the cosmic rays originating from different high energy processes which we are able to reproduce (partially) in the accelerators like the LHC. But all these antimatter creation does not change the net amount of matter as particles are produced in association with their antiparticles only. The fact of this matter nature of our universe is related to the matter antimatter symmetry breaking in the very early and hot universe. This symmetry breaking possibility is confirmed to exist in some processes involving production of exotic particles containing heavy quarks.



Question 3: Is there a possibility of another universe made of antimatter? What would it look like?

Most probably yes. Everything would have the opposite charge to the particles in this universe and to people living there, it would be an ordinary matter universe. It would look the same. And we would call the antimatter "matter" and the matter "antimatter". A few asymmetries would be reversed, but no one would notice.

Question 4: Can humans create antimatter?

Humans have created antimatter particles using ultra-high-speed collisions at huge particle accelerators such as the Large Hadron Collider, which is located outside Geneva and operated by CERN (the European Organization for Nuclear Research). But no one has ever produced antimatter without also obtaining the corresponding matter particles.

➤ You can now either project the questions (copy and paste) in the class and in small groups decide the answers trying to justify them by checking online if it is necessary or give them the link to do it on their own at home asking them to justify at least three of their answers. Another possibility

if it is done in the class, depending on the number of students, the teacher could assign each student one of the questions and ask them to find out about the answer. Then put them together in groups in which each student can give explanations about their corresponding questions and answers. There should be a discussion going on afterwards.

<https://forms.gle/hQHY2q197Jotp6Ri7>

Form:

Choose True or False *		
	True	False
Antimatter is used in medicine	<input type="radio"/>	<input type="radio"/>
People are actually studying how to fuel spacecraft with antimatter	<input type="radio"/>	<input type="radio"/>
Humans have created only a tiny amount of antimatter	<input type="radio"/>	<input type="radio"/>
Antimatter has negative mass	<input type="radio"/>	<input type="radio"/>
Antimatter, dark matter and dark energy are all the same things	<input type="radio"/>	<input type="radio"/>
Small amounts of antimatter constantly rain down on the Earth in the form of cosmic rays	<input type="radio"/>	<input type="radio"/>
There is such a thing as an antimatter trap	<input type="radio"/>	<input type="radio"/>
Only Antimatter is capable of annihilation	<input type="radio"/>	<input type="radio"/>

Key:

Choose True or False *		
	True	False
Antimatter is used in medicine	<input checked="" type="radio"/>	<input type="radio"/>
People are actually studying how to fuel spacecraft with antimatter	<input checked="" type="radio"/>	<input type="radio"/>
Humans have created only a tiny amount of antimatter	<input checked="" type="radio"/>	<input type="radio"/>
Antimatter has negative mass	<input type="radio"/>	<input checked="" type="radio"/>
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Only Antimatter is capable of annihilation	<input type="radio"/>	<input checked="" type="radio"/>

To get their answers students can turn to:

<https://www.symmetrymagazine.org/article/april-2015/ten-things-you-might-not-know-about-antimatter>

<https://www.quora.com/What-are-common-misconceptions-about-antimatter>

➤ Pose this question to the whole group:

If everything on the planet was turned into antimatter and you were the only one made of normal matter, what would you do?

Obviously, the answer would be that anybody would cease to exist before they could formulate a thought. "Doing" something would be out of the question.

Discuss for a few minutes about this.

Writing:

*If everything on the planet was turned into antimatter and you were the only one made of normal matter, what would you do? Which do you think would be the advantages of that condition and which the drawbacks?*

Ask students to write a paragraph (about 100 words) either during the class or at home and peer correct it afterwards. Ask them to be creative and use their imagination.