C5ISR CENTER STEM@Home

Welcome to STEM@Home!

As we maneuver the challenges of the COVID-19 epidemic, we strive to continue to make STEM accessible to all.

The STEM@Home Newsletter is intended to be a resource to provide engaging and educational activities that can be done with minimal materials and a whole lot of imagination.

In this Issue…

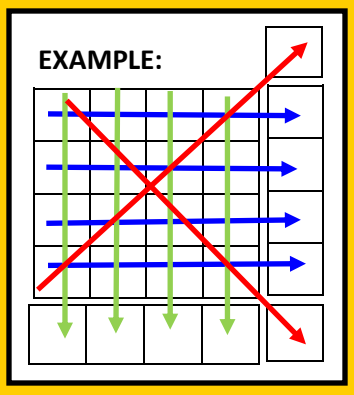
Issue 22

Brain Teaser: Complete the Number Block

Fill in the missing numbers:

- The missing numbers are all integers between 0 and 5.
- Numbers **can** be used more than once in each row and column
- The numbers in each row add up to totals to the right.
- The numbers in each column add up to the totals along the bottom.
- The two long diagonal lines also add up the totals on the end. (See example)

				11
				10
		3	4	15
	2			12
2				13
12	10	12	16	14



Solution on Page 3

SHARE YOUR STEM!

Visit the C5ISR Center on Facebook to post a photo of your child completing one of the STEM@Home Activities.

#C5ISRCenterSTEM

Facebook.com/DEVCOM.C5ISR

Introducing Major Rachel Mullholland

Name:
Major Rachel Mullholland

Job Title:
Offensive Cyber Officer

Length of Time in the U.S. Army: 16 years

Education:

Bachelor of Arts in communications-broadcast news, Washington State University

Washington State Teacher's Certificate, Saint Martin's College

Master of Science in program management, University of Maryland

How does your job support the U.S. Soldier? I began service as a Signal Corps Officer, managing tactical radio and computer networks. After seven years, I applied and was selected to become an acquisition officer. As an acquisition officer, I manage research and development for the next generation of Army equipment. My job supports the U.S. Army Soldier by ensuring we are developing systems with the Soldier in mind. The desired goal is to develop and produce technology a Soldier can use with minimal training and experience. While I do not have the education and expertise that our science and technology engineers have, I've been a Soldier both in the field and on deployments. Having a Soldier trained and educated in U.S. Army acquisitions, like me, provides invaluable insight into what Soldiers need.

What is a typical day or a week like for you? I spend most of my time with my team of engineers. We discuss the current project and what experiments or studies we have to perform to answer the project's mission. We also have to prepare status meetings where we inform our leadership about the progress of our project. These status meetings are incredibly important because this is our time to demonstrate progress and show leadership that our project is capable of supporting the Soldier.

What drew you to the field originally? As an undergrad, I majored in communication-broadcast news. I enrolled in multiple courses on television and radio broadcasting technology, equipment, and infrastructure. This is where I developed my fascination and love for the electromagnetic spectrum (EMS) and signal propagation theory. I was able to apply this knowledge as a Signal officer. When deployed, very few things are more important than being able to communicate with your people and leadership. Our radio and computer network reach other units hundreds of miles in every direction.

Why is STEM important to our national security and our national future? At its core, STEM is about solving problems. There will always be an adversary with new threats. There will also be new technology that will help us meet those threats. Supporting STEM means we have the ability to shape the latest innovations we need to address new threats.

How should students further their interests in a STEM field? I would recommend developing your people and communication skills. Every science and technology engineer I've worked with is incredibly talented in their field. As a person who is not an engineer, I've learned the most from the engineers who have been able to explain complex concepts in a way I could understand. The ability to convey your theories to a wide audience can only benefit your career.

What is the most important STEM-related innovation you've witnessed in your career? During my time in the Army, the most important innovation I've seen the Army moving from using the EMS primarily for tactical radio networks to supporting worldwide communications and controlling weapon systems. Most of the Army's recent innovations have centered entirely on using the EMS to enable both offensive and defensive operations. As technology becomes more capable and complex, the reliance on the EMS will continue to grow.

What is your favorite technology for personal use? My cell phone is my favorite technology for personnel use. Whether it's the ability to make an emergency phone call when my car breaks down 85 miles east of Amarillo, Texas, or playing MergeDragons while I am waiting for an appointment, I cannot live without it!

What is the next great technological frontier? The Army's use of the EMS has exploded over recent years, and the Army will continue to leverage capabilities that use the EMS. While this is exciting in terms of innovation, we must remember the EMS is a finite resource. As science and technology engineers develop technologies that use the EMS, they must maximize capability and minimize bandwidth usage. This consideration will ensure the Soldier out on the front line can use the technology that the science and technology engineers conscientiously developed.

Why is it important for engineers, scientists, and analysts to engage with STEM Outreach? Today's challenges will be addressed by tomorrow's engineer. It is so important that the Army science and technology community encourages new ideas and fosters an environment that supports innovation. We will never have all the answers and we must find the next generation of scientists and engineers who find that quest exciting.

STEM Challenge

Go For The Gold

The Winter Olympic Games is a major international multi-sport event that is held every four years, typically taking place during the month of February.

Materials:

- Popsicle sticks
- Paper, cardstock, or cardboard
- Paper towel roll tubes
- Small plastic cups
- Aluminum foil
- String or rubber bands
- Small paper cups or bowls
- Pipe cleaners
- Straws
- Tape
- Glue
- Plastic spoons
- Other useful items in your home

Ask a grownup for permission to use these items.

About the Winter Olympics

- In the 2018 Winter Olympics, there were 2,833 athletes from 91 different countries around the world.
- The next Winter Olympic Games will be held in Beijing, China, from Feb. 4 to Feb. 20, 2022.
- Athletes compete in 15 different sports at the Winter Olympics:
  - alpine skiing
  - the biathlon event
  - bobsledding
  - cross-country skiing
  - Curling
  - figure skating
  - free-style skating
  - ice hockey
  - luge
  - the Nordic combined event
  - short-track speed skating
  - the skeleton
  - ski jumping
  - snowboarding
  - speed skating

Mission:

The International Olympic Committee of the Winter Olympics is on the lookout for the best-enhanced equipment for each of the sport disciplines that will be played at the 2022 Winter Olympic Games. Hank Pro Athletics Company is hiring you as an engineer to work on designing new and improved sports equipment that could be used by athletes in the upcoming Winter Olympics.

Requirements:

- The sports equipment must be for one of the 15 sport disciplines that are played at the Winter Olympics.
- The equipment must be a new design that will be beneficial in allowing the athletes to perform to best of their ability.

Design Process:

ASK: What is the problem you need to solve? Your company is looking new sports equipment for events held during the Winter Olympic Games.

IMAGINE: Brainstorm and decide on one idea. What sport discipline will you design new equipment for and how will it work?

PLAN: Draw a picture of your design. What will your equipment look like?

CREATE: Use the materials to create a prototype of your new equipment.

IMPROVE: Use materials to test your equipment. How can you improve your equipment?

Questions to ask:

- If you had more choices of materials, what would you use and why?
- How will your equipment be effective in helping athletes perform to the best of their abilities?

Ask an adult to **Share your STEM** on Facebook.

#C5ISRCenterSTEM

Facebook.com/DEVCOM.C5ISR

Solution from P. 1

3	3	0	4	10
5	3	3	4	15
2	2	4	4	12
2	2	5	4	13
12	10	12	16	14
				11

STEM IN THE NEWS

A Longer Lasting Battery

We are already pretty familiar with conventional lithium-ion batteries. They are in the electronics we use every day, like smartphones, laptops, and electric vehicles. While lithium-ion batteries have enabled the use of these and many other technologies, they still face certain challenges in powering electric vehicles over long distances.

A team of researchers and chemists came together from the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, the Pacific Northwest National Laboratory (PNNC), and other DOE-sponsored universities to form the consortium called Battery500. The goal of the Battery500 consortium is to develop smaller, lighter, and less-expensive batteries. Furthermore, they want to build a battery that would not only allow electric vehicles to drive farther while retaining their power but also be better suited for other devices as well. Their hypothesis is that they will be able to increase the battery's energy density to 500 watt-hours per kilogram, which is more than double the energy density of the state-of-the-art batteries we see today. In order to do this, the Battery500 team is working on making rechargeable batteries with lithium-metal anodes.

These lithium-metal rechargeable batteries are different compared to lithium-ion batteries, which use graphite as the anode. The anode in a battery is the negative terminal that releases electrons into the external circuit. Battery500 explains that there are two main advantages to using a lithium metal as the anode. Firstly, their specific capacity is high, and secondly, they provide a higher voltage battery. This combination leads to a greater gravimetric energy density, which is the measure of how much energy a battery contains in proportion to its weight.

A lithium-metal anode has long been recognized for its advantages over a lithium-ion anode. However, the lithium-metal anode did not allow for a battery to be safely recharged through a reversible reaction. This lack of reversibility was ultimately why graphite was used, hence the lithium-ion battery.

The Battery500 consortium has driven new research, made incredible progress over this time, and now projects that they will be able to safely make lithium-metal anodes reversible. The discovery was made by fully understanding a lithium-ion battery's interface between the anode and electrolyte and the internal chemical reactions taking place when a battery is in use.

Including Brookhaven and the PNNC, Battery500 collaborated with the Army Research Laboratory and the University of Maryland, and the organizations published their findings in the scientific journal *Nature Nanotechnology.* Lead author on the study Brookhaven chemist Enyuan Hu states that, "All of this work would not be possible without the ambitions of young scientists, wisdom from senior scientists, and the patience and resilience of the team."

Sources and Resources:

www.energy.gov/eere/articles/battery500-progress-update
www.nature.com/nnano/volumes/16/issues/1
www.bnl.gov/newsroom/news.php?a=117633
batteryuniversity.com/learn/article/bu_1101_glossary

STEM Activity/Challenge

Materials:

- Baking soda
- Water
- Vinegar
- A bowl
- Food coloring (blue, green, yellow, red)
- Squeeze bottles, or use small bowls and a spoon
- Tray or a baking sheet

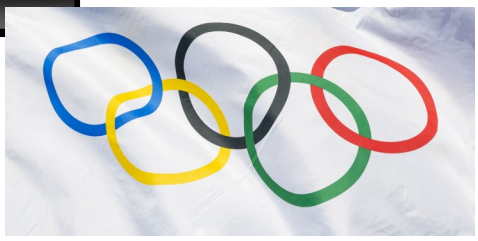
SAFETY NOTICE

Make sure you have an adult's permission and supervision before beginning this activity.

Did you know?

The chemical name of baking soda is NaHCO3, which means it consists of hydrogen, oxygen, sodium, and carbon.

Olympic Rings Experiment



With the Winter Olympics being held in February every four years, what a better to way to spend a day in February than to create your own fizzy Olympic Rings. The Olympic rings have five rings that are interlaced from left to right, with the colors blue, yellow, black, green, and red. The design represents the union of the five continents and the meeting of athletes from around the world at the Olympic Games. Using just a few ingredients from your kitchen, you can create a chemical reaction in the shape of the Olympic Rings.

Directions:

1. Mix the baking soda and a small amount of water together. Add enough water and stir until the mixture has formed a dough-like consistency.
2. Form the baking soda mixture into five circular shapes resembling the Olympic Rings and place them on your tray or baking sheet. Place them in your freezer or outside in the cold for about an hour.
3. Pour about ¼ a cup of vinegar into each of your squeeze bottles or bowls and add food coloring to each one. (To make your food coloring black, mix together blue, green, and red food coloring).
4. Pour your vinegar over the baking soda rings you created earlier.
5. Observe what happens when the vinegar and baking soda react.

Science Explained

When you mix the two common household ingredients of baking soda and vinegar, there are actually two reactions taking place. The first reaction that takes place is an acid-base reaction, with the baking soda being the base and vinegar as the acid. The hydrogen atoms in the vinegar react with the sodium and bicarbonate ions in the baking soda, which results in the two new chemicals carbonic acid and sodium acetate. The second reaction that takes place is a decomposition reaction. The carbonic acid that was formed immediately begins to decompose into water and carbon dioxide gas. Think of the carbon dioxide bubbles in a soda, which is similar to the carbon dioxide that formed when the carbon acid decomposes and rises to the top of the mixture. This is what creates the bubbles and foam you saw in the experiment when you added the vinegar to the baking soda.

COME & GET YOUR STEM ON...

The C5ISR Center Community Outreach Program is dedicated to providing quality STEM programs to students K-12. For more information about our STEM Outreach Programs, visit us on the web:

https://c5isr.ccdc.army.mil/student_programs/

***Due to COVID-19, programs are currently virtual.**

U.S.ARMY

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OUTREACH