Periscope Design Challenge

YEAR 5
PHYSICAL SCIENCES
DESIGN AND TECHNOLOGIES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Cover image: A First World War Australian Army Trench Periscope owned and used by a Gallipoli veteran. © QM, Peter Waddington.

QUEENSLAND MUSEUM NETWORK

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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EXPLORE – EXPLAIN – ELABORATE – EVALUATE

Periscope Design Challenge

Teacher Resource

In this activity, students design, build and test a periscope with features that allow for the adjustment of height and mirror angle to see beyond a trench and identify approaching threats. Students apply their understanding of the physical sciences and follow the design-thinking framework to investigate relevant aspects of the design challenge.

Periscopes are instruments that are used to view something that is not in a direct line of sight. The earliest periscopes were used to see over the heads of others at religious festivals. During the First World War periscopes were commonly used by the troops to see around them while remaining behind shelter, thus reducing the risk of being shot. The trench periscope is an example of the simplest type of periscope, comprising of mirrors that allow the observer to see objects at a distance. As the name suggests, ***trench periscopes*** allowed the troops to see over the walls of their trench while remaining safe from snipers. The Queensland Museum holds a trench periscope (registration number H14724) in its collection. This object was owned by First World War veteran John McGuirk.

Building a Periscope

Materials

Students can be provided with a variety of materials to construct the periscope. These could include:

- Packing boxes, empty milk cartons, cardboard tubes etc.
- PVC pipes and joiners etc.
- Mirrors
- Skewers
- Pencils or pieces of wooden dowel
- String or twine
- Rubber bands
- Paper clips
- Scissors
- Masking tape
- Ruler

Please note: Total number of materials required to implement the design challenge will depend on the number of student groups completing the task. You may also wish to provide students with only the necessary materials needed to make a periscope (i.e. cardboard, mirrors, pencils or dowel and tape).

Constructing a Trench Wall

To further engage students in the development of their periscope, you may wish to construct a trench wall within the classroom. In replicating the depth of a trench, students are able to test their periscope according to the conditions experienced by soldiers who were stationed in similar locations. They are also able to develop an understanding of how deep trenches were and the effort it would have taken to dig these holes in the ground.

The trench wall could be constructed from PVC pipes and covered with a hessian-like material. Alternatively, freestanding noticeboards, whiteboards, room dividers or an alternative design could be used to make the wall.

Print a copy of the trench panorama and stick this on a wall or other supporting structure behind the trench wall. The trench panorama depicts a wartime scene from the First World War, including the threats students are required to identify during this activity: a tank (Mephisto), bombs and hidden enemy soldiers. Students should be able to see the panorama when looking over the trench wall with their periscopes.

Implementing the Design Challenge

1. Revisit the image of the soldier sleeping in the trench. Ask the students to close their eyes and read the 'Imagine' scenario out loud to the class.

2. Introduce students to the design challenge:
   Design, build and test a periscope that will let you see beyond the trench and identify approaching threats. The height and mirrors of the periscope must be adjustable.

3. Share or negotiate any specific challenge requirements, restrictions or criteria for success with students. These may include:

   - Size of student groups (two students per group)
   - Student roles
   - Materials to complete the challenge
   - Time limit to complete the challenge
   - Identifying the approaching threats

4. Divide students into their groups, ensuring each student knows their individual role, if assigned.

   Provide students with time to conduct research to gather additional ideas and information that will inform the design of their periscope. Students will use this information to write a design proposal and gain approval from their supervisor (the classroom teacher) before constructing. The proposal should include:

   - Information about the development of the periscope
   - Labelled sketch or digital representation of the periscope
   - Justification for design
   - Materials required to build the periscope

5. Following approval from the supervisor, students create their periscopes. Students may like to play a game of eye spy to test how well the periscope works before moving on to the trench wall.

6. Students test their periscope at the trench wall. They record their observations, including how well they can adjust the height and mirrors of their periscope and what happens when they do. You may like to open up a periscope and demonstrate how light travels through the device, before asking students to draw a ray diagram of this occurrence and to explain how the periscope works.

Students also identify where the approaching threats are on the trench map and their approximate location. Students then write a short message that communicates this information to their supervisors. The message written by students will be used in future activities featured within this resource. The map can be used to further explore mathematical concepts with students, including identifying the:

- Coordinate location of specific landmarks;
- Distance between specific landmarks, including shortest and longest routes; and,
- Area of natural and manmade features.

7. Students refine the design and construction of their periscopes before re-testing. During this time, students should share their observations, challenges experienced and discuss what they should change to address or resolve these problems. Students could share this information with the class group before progressing with the design challenge. Following subsequent testing, students should describe how any changes made to the periscope influenced its performance.

   Extension opportunities exist for students who successfully complete the design challenge within the allocated time. These may include:

   - Modifying the periscope so that it is useful in students' everyday lives.
   - Modifying the periscope so that something behind the user can be observed.
   - Adding more mirrors to the periscope, and observing the effects of these changes.
   - Modifying the periscope so that the top can rotate 180 or 360 degrees, and observing the effects of these changes.

8. Students reflect on and evaluate their final design and experiences:

   - What new knowledge/understandings helped you make decisions about your periscope?
   - Are there any further changes you could make to improve your design?
   - What were the main challenges you experienced during the design process? How did you overcome these?
   - What have you learnt about science/design from this activity?
   - How could you apply this knowledge and understanding to your learning in other contexts?
   - What more would we like to know about periscopes?

After completing this activity, you may further investigate the law of reflection with your students. The following hands-on resource, ***Mirror Mirror***, developed by The University of Texas at Austin, McDonald Observatory, provides students with an opportunity to test the law of reflection and explore the relationship between the angle of incidence and the angle of reflection.

Curriculum Links

Science

YEAR 5

Science Understanding

Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

Design and Technologies

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

Design and Technologies: Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

Mathematics

YEAR 5

Measurement and Geometry

Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Using spatial reasoning

Using measurement

ICT Capability

Investigating with ICT

Creating with ICT

Critical and Creative Thinking

Inquiring: Identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Self-management

Social management

Periscope Design Challenge

Student Activity

Imagine:

You are a soldier asleep in a dugout (a protective hole dug into the side of a trench). As you wake up you hear a mechanical sound in the distance. This sound is different to the whistling shells, incessant artillery and machine gun fire heard throughout the day; it is a rumbling and a crunching that you have never heard before and it sounds dangerous. You need to know what is coming towards you so that you can communicate this information to your supervisors... but how? The trench you are positioned in is between two to three metres high. You do have some equipment to stand on to see over the top of the trench, but do not wish to do so for fear of being shot. There are also many different materials and debris scattered at your feet. You have a thought – perhaps these might help you see over the trench without exposing yourself to the enemy.

Task:

Design, build and test a periscope that will let you see beyond the trench and identify approaching threats. The height and mirrors of the periscope must be adjustable.

You must:

- **Investigate:**
  - The development of the periscope.
  - How periscopes were used during the First World War.
- **Design** a periscope that can help you to see beyond the trench and identify approaching threats. The height and mirrors of the periscope must be adjustable.
- **Create** a prototype of your periscope from recyclable materials supplied by your teacher.

- **Test** the prototype's ability to see the approaching threats.
- **Refine** the periscope's design and construction to make it work more effectively.
- **Collaborate** in teams of two. Your teacher may allocate a role to each team member.
- **Evaluate** continuously to design a periscope that meets the brief. You may also be required to evaluate social interactions to effectively work in a team.

Investigate and Design

You must write a proposal to explain the design of the periscope and gain approval from your supervisor (in this case, your teacher) before creating your periscope.

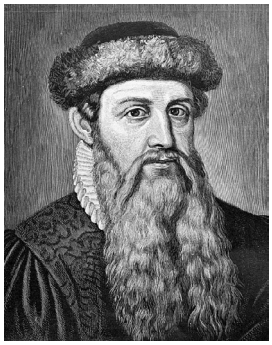
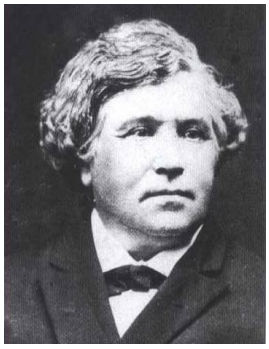
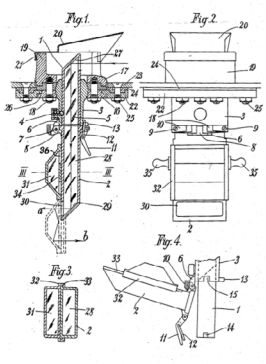
Your proposal should include:

- ☐ Information about the development of the periscope
- ☐ Labelled sketch or digital representation of the periscope
- ☐ Justification for design
- ☐ Materials required to build the periscope

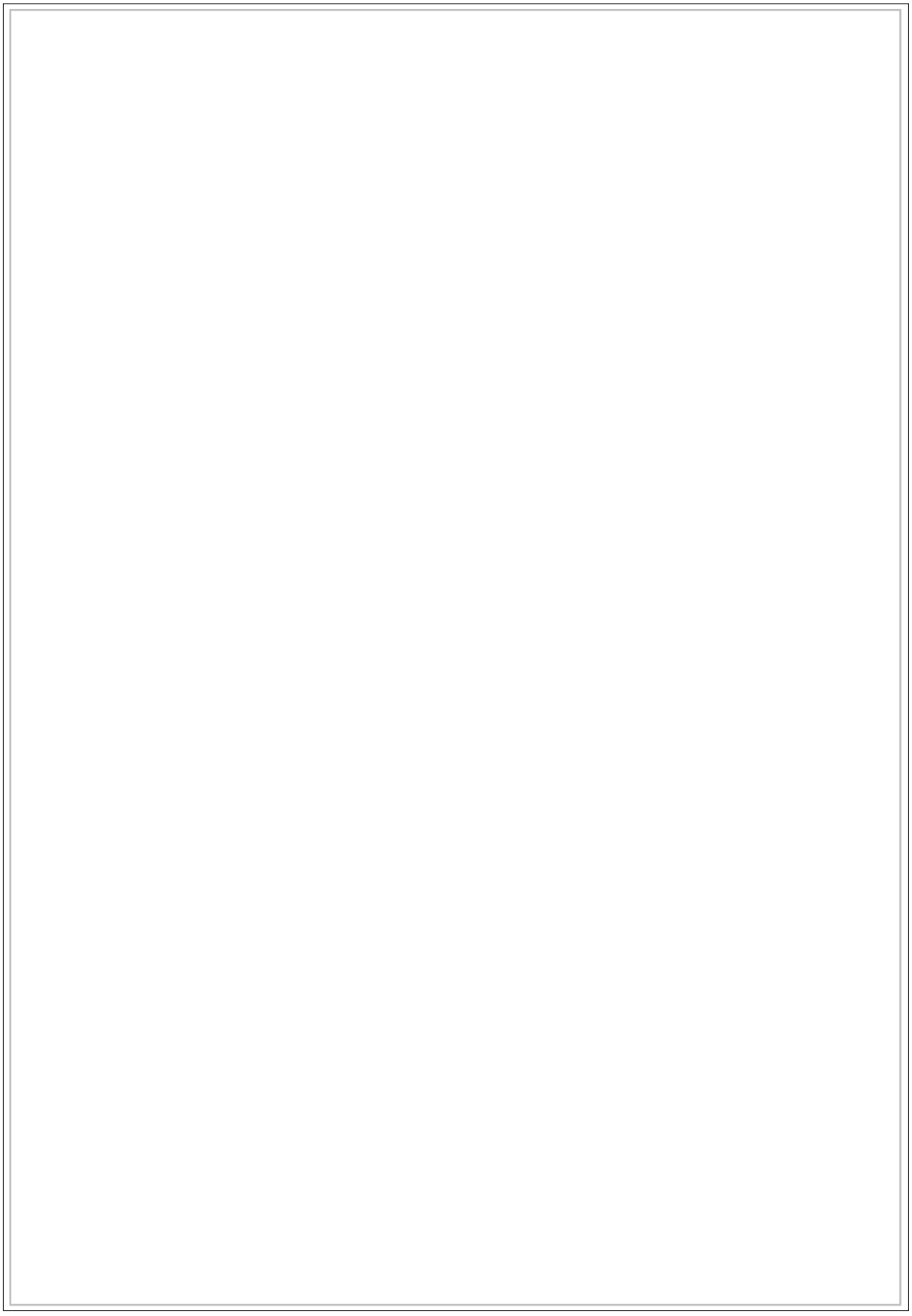
You should also investigate how periscopes were used during the First World War. You can do this by visiting the ***Australian War Memorial*** website and typing 'periscope' into the search bar. Make sure you filter your results by viewing photographs from the First World War. You may choose to base your design on the periscopes viewed during this investigation.

Once your proposed design has been approved, you can create your periscope prototype.

Investigate how the following people contributed to development of the periscope.
Record your findings in the table below.

Name	**Nationality**	**Occupation**	**Contribution** (including year and significance)
Johannes Gutenberg 			
Hippolyte Marié-Davy 			
Rudolf Gundlach 			

Draw a labelled diagram of your periscope. Make sure you identify the materials you will use to make the periscope, and explain and justify its components.



Create

Create your periscope using the materials provided. Record any modifications required as you build the periscope.

Modification	Reason

Test

Make your way over to the trench wall. Move along the trench, using your periscope to see over the top. What do you notice? Record your observations and discuss your results on the following pages.

Refine

Based on your observations, modify the periscope's design to make it work more effectively. Continue to refine and test until the height and mirrors of the periscope can be easily adjusted to identify the approaching threats. You may like to take a photo of the threats seen through your periscope using an electronic device, such as a camera or iPad.

Recording Results

1. Are you able to adjust the height of your periscope? What happens when you do?

2. Describe any changes you will make to improve this aspect of the periscope.

3. Are you able to adjust the periscope's mirrors? What happens when you do?

4. Describe any changes you will make to improve this aspect of the periscope.

5. What can you see when you look through your periscope?

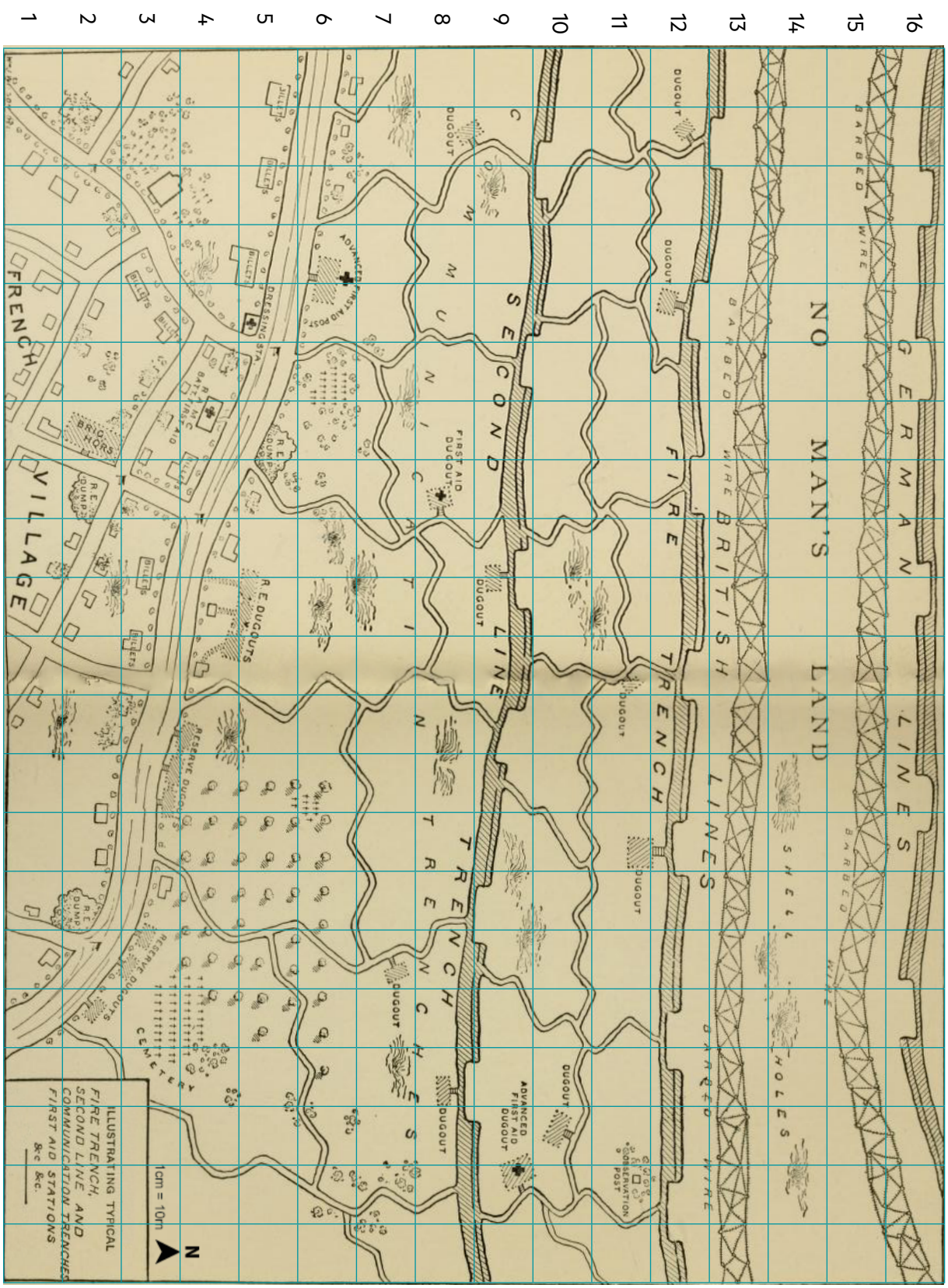
Based on your observations through the periscope and the environment around you, use the trench map on the following page to:

a) Determine where you are on the battlefield and mark this position on the trench map. Justify your reasoning below.

b) Determine the approximate coordinates of the approaching threats. Mark these positions on the trench map.

6. Write a message that communicates your location and information about the approaching threats to your supervisors.

Trench Map


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
A B C D E F G H I J K L M N O P Q R S T U
GERMAN LINES
NO MAN'S LAND
BRITISH LINES
FIRE TRENCH
SECOND LINE
COMMUNICATION TRENCHES
FRENCH VILLAGE
DUGOUT
BARBED WIRE
SHELL HOLES
ADVANCED FIRST AID POST
FIRST AID DUGOUT
ADVANCED FIRST AID DUGOUT
OBSERVATION POST
DRESSING STN.
BILLETS
R.E. DUGOUTS
RESERVE DUGOUTS
R.E. DUMP
BRIG. HQRS
CEMETERY
ILLUSTRATING TYPICAL FIRE TRENCH, SECOND LINE AND COMMUNICATION TRENCHES FIRST AID STATIONS &c. &c.
1cm = 10m
N

Discussing Results

1. Draw a ray diagram to show the path light takes as it travels through the periscope. Your teacher may work with your class to open up a periscope and investigate how light travels through the device.

2. Explain how your periscope works. Consider what you already know about light and make sure you include scientific language in your explanation.

3. Describe the outcome of any changes made to the design of the periscope. Were the changes effective? Why?

4. Modify the periscope so that it is useful in your everyday life. Draw a labelled diagram to show these modifications. Make sure to explain how these changes support the new purpose of the periscope.

Evaluate

Reflect on your actions with your team or class after you have completed the design challenge. You might like to think about the following questions to assist with your reflection:

- What new knowledge/understandings helped you make decisions about your periscope?
- Are there any further changes you could make to improve your design?
- What were the main challenges you experienced during the design process? How did you overcome these?
- What have you learnt about science/design from this activity?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would we like to know about periscopes?

Explore More!

- Modify the periscope so that you can see something behind you.
- What happens if you add more mirrors to the periscope?
  How does this change affect the periscope?
- Modify the periscope so that it can rotate 180 or 360 degrees.
  How does this change affect the periscope?
- Investigate how we use maps for recreation, including geocaching and orienteering. You may like to locate or hide a geocache, or design an orienteering challenge for your class!