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INTRODUCTION

The *Survival* series uses real-life survival situations to connect theories and approaches from maths, technology and science. Students from Years 7–9 will undertake research and conduct experiments relevant to a brief, using combinations of maths and design methods to provide solutions to the design problems. The series is centred around project-based learning, and covers Level 6 VELS in Design, Creativity and Technology, Maths, Science, Interpersonal Development and Personal Learning (http://vels.vcaa.vic.edu.au/vels/level6.html#).

Students will use the Engineering Design Process (EDP) for each Design Challenge: defining, researching, brainstorming, choosing the best solution, building, testing, communicating and redesigning.

Preparation or "research" for each task involves students interpreting and analysing data from tables and graphs, answering questions and making predictions. These tasks require students to use maths processes such as: algebra, problem solving, proportional reasoning, classifying events as dependent or independent, representing data in graphical forms, and being able to interpret and analyse this data.

While undertaking *Survival* challenges, students will generate a range of possible solutions for each task before selecting the preferred option and explaining how it provides the best solution to the problem. They will make critical decisions on materials and techniques, and will develop a suitable design, taking into account function and performance, costs and energy requirements. Students will also test their solutions, critically analyse their effectiveness, and redesign them as needed.

In *Survival: Climbing Mount Everest*, students are required to complete three challenges relating to survival on the mountain: designing a coat to keep them warm and protect them from hypothermia, designing a bridge that will enable them to safely cross a crevasse, and designing a device that will transport altitude-sick students from the top to the bottom of the mountain.

To solve each of these problems, students will need to do a combination of the following: interpret line graphs; conduct controlled experiments, record and display data in a table; draw and relate graphs that have two variables; apply the engineering design process; use physical and maths models; and much more.

Many of the tasks in the *Survival* series require students to work in teams, building team negotiation and delegation skills. Following each task, students are also required to assess how well their team worked, and how well they worked individually within the team.

This book provides rubrics for each step of the Engineering Design Process, as well as Student Self-Assessment Rubrics and student work samples.

1. DEFINE THE PROBLEM: GEARING UP!

OBJECTIVE: Students will read and understand the criteria and constraints of the design challenge.

CLASS Together, read the engineering criteria and constraints.

ASK THE CLASS:

- What types of insulators have you seen used in real life?
  Possible Answer(s): jackets, blankets, walls
- What materials make up these insulators?
  Possible Answer(s): down feathers, fibreglass, wool
- What characteristics of the material make it an effective insulator?
  Possible Answer(s): thick, fluffy, multi-layered
- Of the four materials you will use in your coat design, which one do you think will be the best insulator? Which one will be the worst? Why?
  Possible Answer(s): Answers will vary.
- Why do you think the criterion is that the temperature must remain above 18˚C?
  Possible Answer(s): 18˚C is the standard room temperature at which most humans are comfortable.

INTERESTING INFO: Maths Problem
Base camp instructors are providing climbers with extra clothing because of freezing temperatures on the mountain. The only problem is, your backpack can't exceed 25 kilograms or reaching the summit would become seemingly impossible. Right now, your backpack is 23.8 kilograms. Looking at the table below, which article(s) of clothing will keep you the warmest without exceeding 25 kilograms? Defend your choice.
Possible Answer(s): Basically, any combination that totals less than 1.2 kilograms: 1 thermal jacket, 1 parka and 1 T-shirt; 1 fleece jacket and 1 crew shirt; 4 crew shirts

CLOTHING	WEIGHT	SUITABLE TEMPERATURE RANGES
Fleece jacket	0.62 kg	5°C–15°C
Parka	0.80 kg	–10°C–0°C
Thermal jacket	0.93 kg	–20°C– –5°C
Long-sleeve crew shirt	0.24 kg	20°C–25°C
T-shirt	0.20 kg	25°C and up

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RESEARCH

2. RESEARCH THE PROBLEM: GEARING UP!

RESEARCH PHASE 1: WHAT DO WE KNOW? *(CONTINUED)*

Work with a partner and use Table 1.1 and Graph 1.1 to answer the questions below.

1. How much does the temperature under the cotton clothing change during the first 5 seconds (time = 0 seconds to time = 5 seconds)? _____ ℃

2. How much does the temperature under the cotton clothing change during the last 5 seconds reported on the graph (time = 55 seconds to time = 60 seconds)? _____ ℃

3. Compare your answers in questions 1 and 2. Explain what is happening to the temperature as time goes on.

   _____

   _____

4. a. Using the graph, what do you think the temperature under the cotton clothing will be at 65 seconds? _____ ℃

   b. How did you come up with this prediction?

   _____

   _____

5. a. Imagine that we left the mannequin in the –25 ℃ laboratory room for an entire hour (60 minutes or 3600 seconds). Predict the temperature under the mannequin's cotton clothing at the end of the hour. _____ ℃

   b. How did you come up with this prediction?

   _____

   _____

6. A good insulator will be able to keep the temperature of a thermometer in ice above 18 ℃ for 30 seconds. Is the cotton T-shirt a good insulator? Explain why or why not.

   _____

   _____

7. Sketch a line directly on Graph 1.1 showing how the temperature might change if the mannequin was wearing a good insulator. There is more than one correct answer.

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TEST

6. TEST YOUR SOLUTION: GEARING UP!

Use the rubric provided by your teacher to assess your work on the next few pages.

THICKNESS TEST

Your coat may be no more than 2 centimetres thick. Using a ruler, measure the thickness of all of the layers of your coat put together. Is the thickness no more than 2 centimetres?

☐ yes ☐ no

INSULATOR TEST

Student Jobs: Assign each member of your team to one of the four jobs listed below.

Heater: _____ **Timer:** _____

Cooler: _____ **Recorder:** _____

Step 1: Heater—Clasp your hands around the thermometer stem. Keep your hands there until the temperature is 30°C or higher.

Step 2: Cooler—Fold the layers of material around the thermometer stem once. The material should lie flat (no extra folding or overlapping). Make sure that the thermometer stem, including the tip, is surrounded by the material. Watch the thermometer display. When the thermometer reads 25°C, immediately place the folded material and thermometer in between two icepacks or sandwich bags of ice and say, "Start timing!"

Step 3: Timer—When you hear the **Cooler** say "Start timing!" immediately click "start" on your stopwatch. Shout "Time!" after exactly 30 seconds.

Step 4: Cooler—Watch the thermometer. When the **Timer** shouts "Time!" read the thermometer's temperature aloud. **Recorder**—Record temperature here: _____ °C

After 30 seconds in ice, was the thermometer's temperature above 18°C? ☐ yes ☐ no

LOW COST

Record the total cost of your coat here: _____