Year 9 Maths Program

Surface area worksheet

Maths Activity 2

Activity 1 - Penstocks

In the picture you can see the Penstock is made up of many repeated segments.

To calculate the total surface area, we find the surface area of one segment and multiply by the number of segments in a penstock.

Question 1

In this example, there are sixteen segments in each penstock. If the segments are fifteen metres long and have a diameter of five and a half metres, then;

1. Draw the net of one segment
2. What is the surface area of one segment?
3. What is the total surface area of one penstock?
4. If one litre of paint covers six square metres of area, how many litres of paint are needed to coat;

- one segment
- one penstock

Show your working here:

Show your working here:

Activity 2 – Heatsinks

Engineers use heat sinks to cool down all kinds of machines, for example; engines, refrigerators and in today's class, transformers. A heat sink transfers the heat to the outside air using cooling fins, which helps it maintain a steady temperature.

More precisely, we could ask how much of the "hot part" (the metal fins) touches the "cold part" (air, water, liquid nitrogen etc)?

In transformers, the hot metal cooling fins are touching the cold air everywhere that it has a surface area! That means if we can increase the surface area, we can get more hot bits to touch the cold bits, and we can cool down the transformer faster.

Try this experiment

This can also be demonstrated by using cubes of ice, one unbroken, once smashed.
The smashed ice will have a greater surface area to volume ratio and will melt quicker.

Reference information to answer below questions

SA: Surface Area

Heat sink A: 3500cm^2 of surface area,

Heat sink B: 5000cm^2 of surface area.

Question 1

A transformer requires a new Heat Sink and the boss has asked you which one to buy.

If both Heat Sinks are made of the same material, which Heatsink is better at cooling down the transformer?

CIRCLE ANSWER

A B

Question 2

Heatsink A is made of copper, costs \$1000 and is 90% efficient. Heatsink B is made of iron, costs \$500 and is 35% efficient.

Which heat sink is cheaper with respect to surface area?

(Hint, what is the price per cm^2?)

Heat sink A = 1000/3500 = 29¢/cm^2

Heat sink B = 500/5000 = 10¢/cm^2

CIRCLE ANSWER

A B

Question 3

Which heat sink is better at cooling?
(Hint : effective surface area = Surface area x Efficiency)

Effective SA A = 3500x90% = 3150 cm^2 effective

Effective SA B = 5000 x 35% = 1750 cm^2 effective

CIRCLE ANSWER

A B

Question 4

Which heat sink is better value? (price per effective SA)

A = \$1000 / 3150cm^2= 31.5¢/cm^2

B = \$500/1750cm^2 = 29¢/cm^2

CIRCLE ANSWER

A B

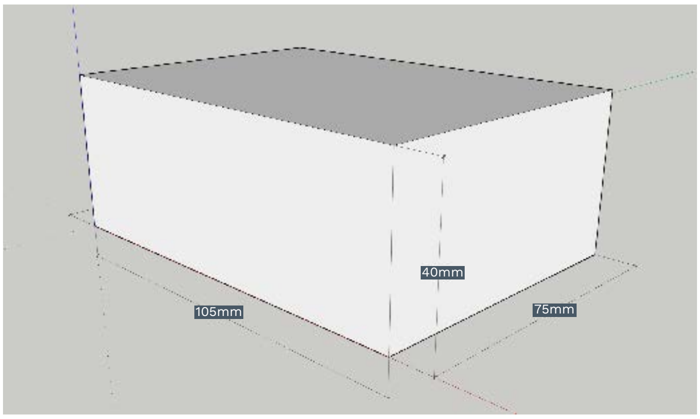
Reflect on your learning

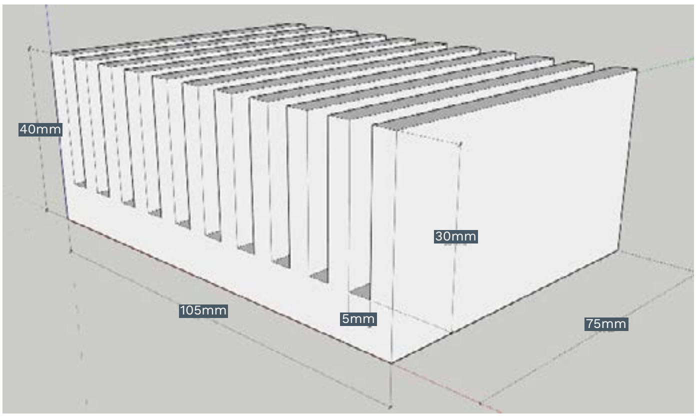
You have just seen how we would actually use SA at Snowy Hydro.

Maths is cool when you can use it to work stuff out and how it relates to the real world with physics.

Activity 3 - Cooling Fins

In this section we will take a look at cooling fins and use the measurements in the two diagrams to explain and understand how to create a greater surface area.





Scenario

If a material is able to cool down at a rate of 2° celsius per square centimetre it is very important to have as much surface area as possible in the smallest space for the heatsink, or our phones would be very big.

1. If it must cool at least 1000° celsius, how much SA is needed?
2. Given a space of 40x105x75mm (solid rectangle picture above), what is the surface area of the solid rectangle? (Hint: draw the net first)
3. Is this adequate for the cooling needed?
4. In the slotted shape shown above, how many repeating shapes are there?
5. What is the surface area of each of these shapes? (Hint: break the shape into different nets)
6. What is the total surface area of the slotted shape?
7. Does this have adequate cooling?

Show your working here:

Activity 4 - Pipelines

Scenario: The inside of the Penstock needs to be coated with a special material to prevent it from rusting and wearing out. This is a very expensive material at $2000 per m². Given the section of drawing below, calculate:

1. Draw the nets of the shapes that make the approximate surface area as drawn in figure 1
2. The total surface area the nets 1, 2 and 3
3. The cost of lining the approximated section of penstock
4. What shapes would you use to calculate the exact surface area of the pipeline? Draw the basic shapes on Figure 2
5. Which method (approximate or exact) would give you the best answer? List the pros and cons of each method

Figure 1 - Approximate Surface Area

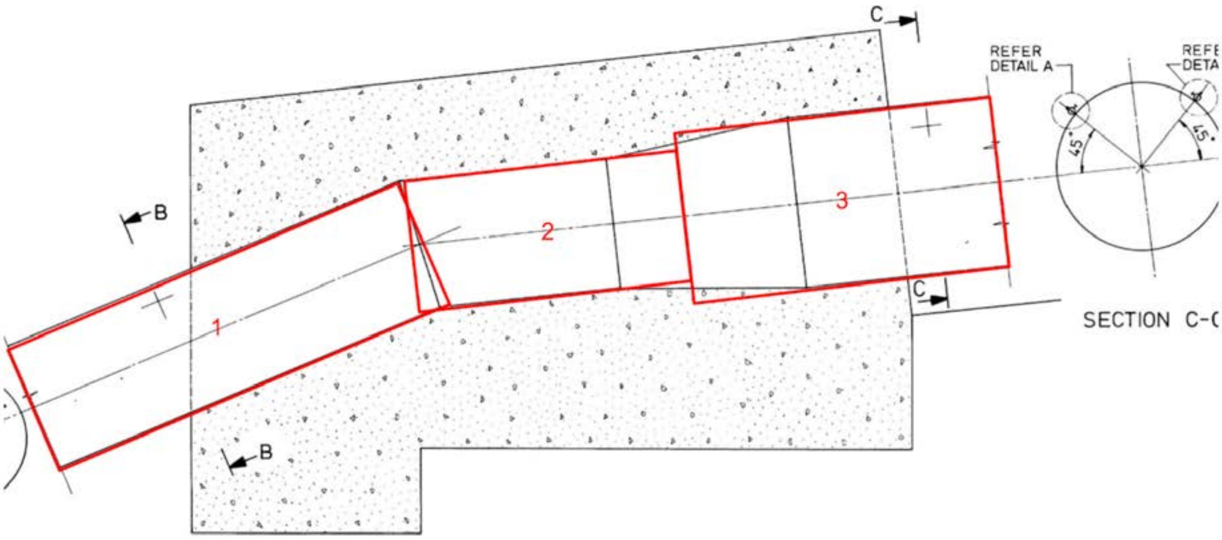
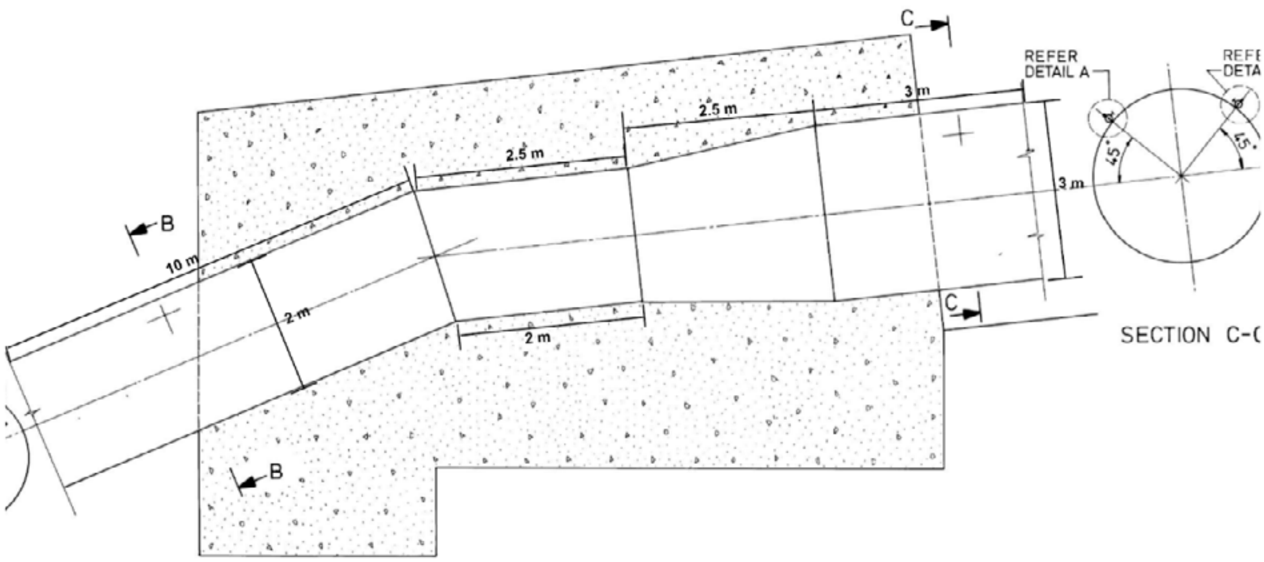


Figure 2 - Draw the exact surface area breakdown on this diagram



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