ST. JEAN DE BREBEUF

MATHEMATICS

CHAPTER 1.6 (PART 1)

ANALYSING OPTIMUM VALUE and SURFACE AREA:

SQUARE BASED PRISMS

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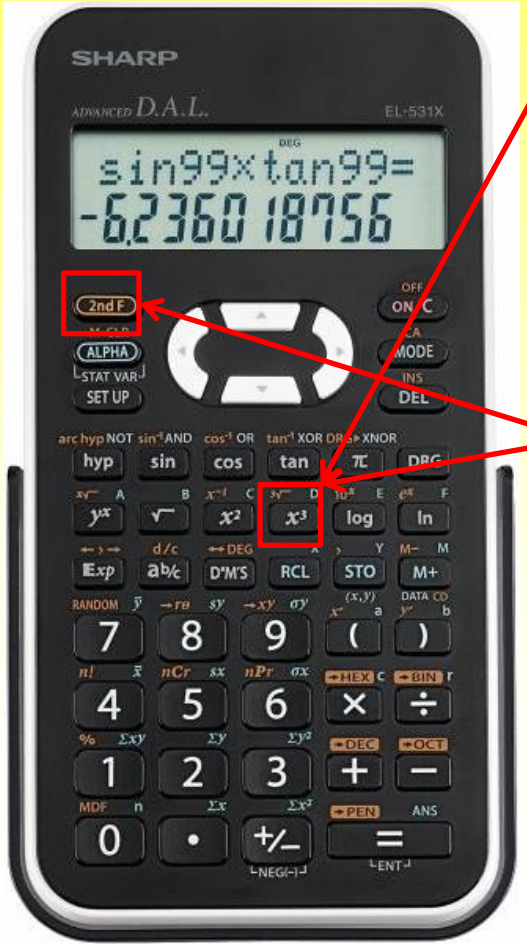
KEY CONCEPTS

USING YOUR CALCULATOR



x^3 button

→Raises a number to the exponent 3

EXAMPLE:

Evaluate **4^3**

→ Press "**4**" → **x^3** → **3** → **=**

2^{nd}F then x^3 button

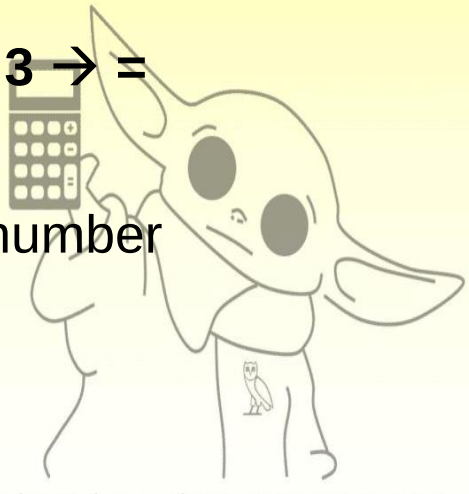
→*Cubed root* function

→Takes the *cubed root* of a number

EXAMPLE:

Evaluate $\sqrt[3]{125}$

→ Press **2ndF** → **x^3** → **125** → =



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ANALYSING OPTIMUM VALUE and SURFACE AREA: SQUARE BASED PRISMS

KEY CONCEPTS

Minimizing surface area for a given volume is important when designing packages and containers to save on materials and reduce heat loss.

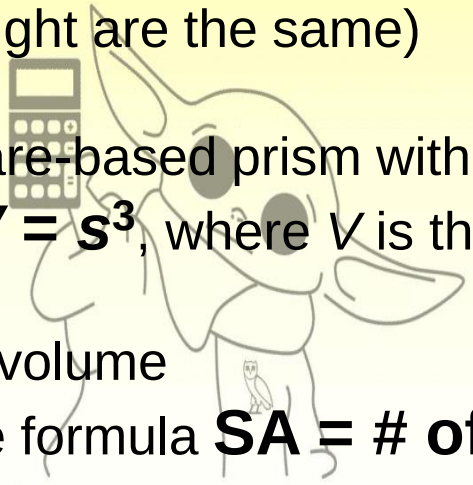
For a square-based prism with a given volume, a base length and a height exist that result in the minimum volume.

For a square-based prism with a given volume, the minimum surface area occurs when the prism is a **cube** (length, width and height are the same)

Given a volume, you can find the dimensions of a square-based prism with minimum surface area by solving for *s* in the formula $V = s^3$, where *V* is the given volume and *s* is the length of a side of the cube.

→ You can solve for *s* by taking the **cubed root** of the volume

→You can then solve for the **surface** area by using the formula **SA = # of faces × s^2**



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EXAMPLE 1

Determining the Minimum Surface Area, Volume Given

(a) A cardboard box has a **volume of 1728 cm^3**. Determine the dimensions of a *square* shaped box that will minimize the amount of cardboard used.

$$V = s^3$$

$$1728 = s^3$$

$$\sqrt[3]{1728} = \sqrt[3]{s^3}$$

$$12 = s$$

* Isolate **s**
→Take the **cubed root** of each side

The box will have a length, width and height of **12 centimetres**.

(b) Using the measurement from (a), **how much** cardboard will be used to make this box?

$$SA = \#of\ faces \times s^2$$

$$= 6 \times (12)^2$$

$$= 864\ cm^2$$

864 square centimetres of cardboard will be required for the box.

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EXAMPLE 2 *Minimizing Heat Loss*

Pong's Palace, famous for its gourmet fried rice, wants to design a *square*-based prism container to transport its hot food during delivery and pick up orders. To keep heat loss at a minimum, the total surface area must be minimized.

Determine the interior measurements of the container with a volume of **3869.893 cm³**.

V

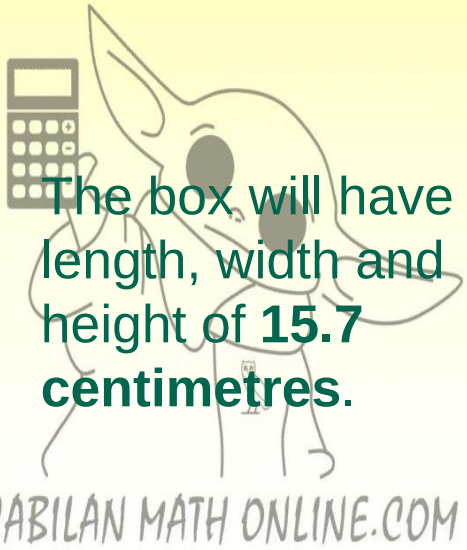
$$V = s^3$$

$$3869.893 = s^3$$

$$\sqrt[3]{3869.893} = \sqrt[3]{s^3}$$

$$15.7 = s$$

* Isolate **s**
→Take the **cubed root** of each side



The box will have a length, width and height of **15.7 centimetres**.

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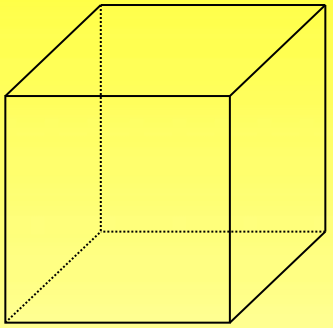

For a square-based prism with a given surface area, a base length and a height exist that result in the maximum volume.

The maximum volume for a given surface area of a square-based prism always occurs when the prism is a **cube**.

The surface area of a cube is given by the formula $\boldsymbol{SA = 6s^2}$, where ***s*** is the **side length of the cube**.

→When you are given the surface area, solve for *s* to find the dimensions of the square-based prism with *maximum* volume.

→The **volume** can then be solved by using the formula $\mathbf{V = s^3}$

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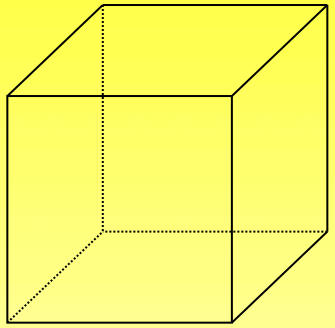
EXAMPLE



(a) Determine the dimensions of a *square*-based prism with a **surface area of 25350 cm²**.

SA

$$SA = 6s^2$$

$$\frac{25350}{6} = \frac{6s^2}{6}$$

*Isolate **s**
→Divide both sides by **6**

$$4225 = s^2$$

$$\sqrt{4225} = \sqrt{s^2}$$

*Square root both sides

$$65cm = s$$

The cube will have a length, width and height of **65 centimetres**.

(b) Calculate the **volume** of the prism.

$$V = s^3$$
$$= (65)^3$$
$$= 274625\ cm^3$$

The cube will have a volume of **274625 cubic centimetres**.

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Homework:

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