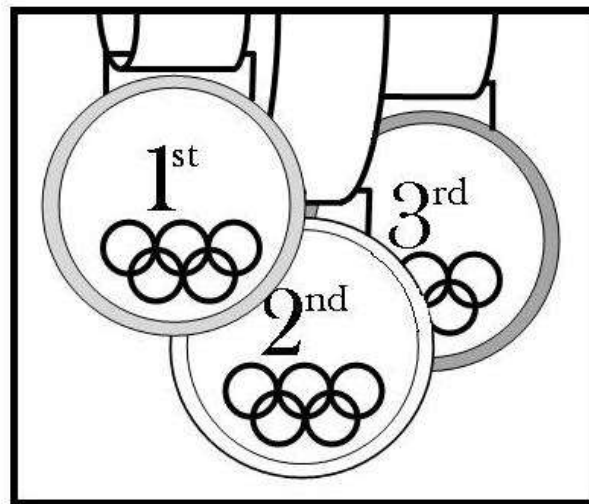


## Winter Olympic Medals

### Mathematics Secondary 3



### Context

Name: \_\_\_\_\_

Group: \_\_\_\_\_

Time: 3 hours

# Winter Olympic Medals

Winter sports are divided into three general categories: Ice sports, Nordic sports, and Alpine sports. The following table provides some information about the number of gold medals that will be distributed during the winter Olympic Games.

**Table 1: Gold Medal Distribution for Winter Games**

Categories	Number of gold medals given by category
<i>Ice sports</i>	150
<i>Nordic sports</i>	$2x - 10$
<i>Alpine sports</i>	$x$
<b>Total</b>	<b><math>10x</math></b>

One gold, one silver and one bronze medal are awarded at **each** event. There are no ties.

You are the assistant to the purchasing director of the Olympic Committee. You have been assigned a budget of \$117 000, including labour costs, to complete the following tasks:

- Choose the final design of the silver and bronze medals. There are two possible solids for the silver and bronze medals. Based on cost, you will choose which solid will be used for the bronze, and which will be used for the silver.
- Calculate the exact cost of purchasing all the medals (gold, silver and bronze) for the games.

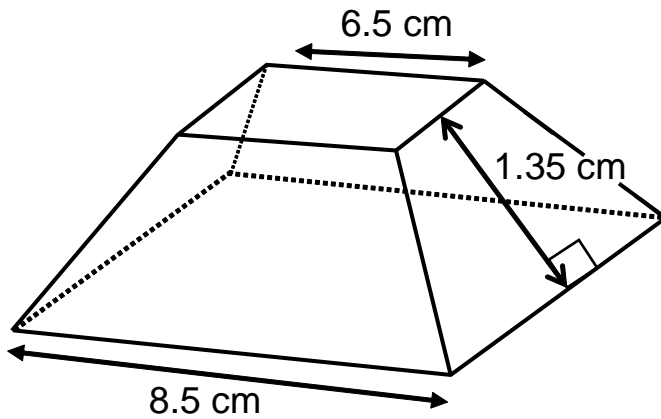
You must then submit a detailed report which will be reviewed by the Olympic Committee. The report must include the type of solids used for each medal and the total cost of production (including labour).



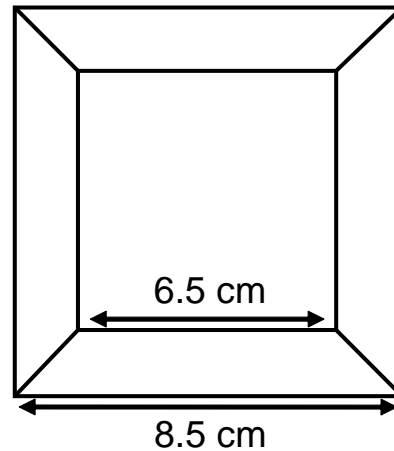
## GOLD MEDALS

The solid chosen for the gold medals is a truncated square-based right pyramid whose dimensions are provided below.

**Three-dimensional (3-D) view**



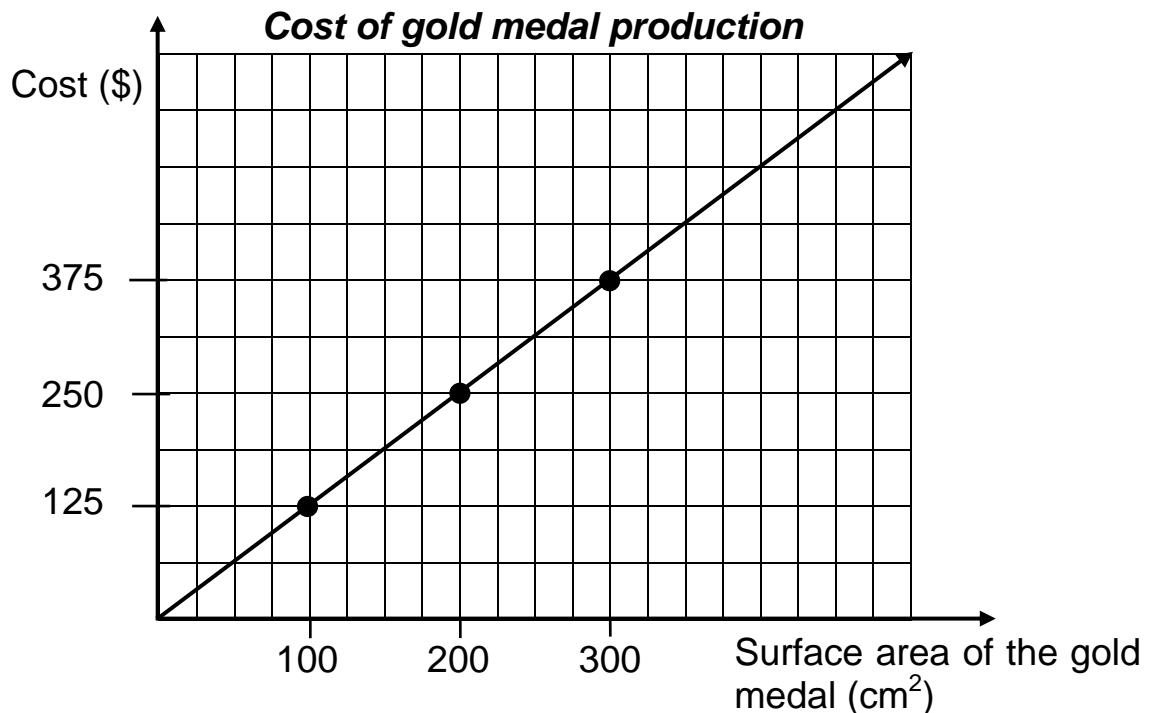
**Top view**



The figures are not to scale.

Because gold is very expensive, the medals will be made of another solid material and then coated in gold on all sides.

The cost of the medals depends on the total surface area that must be coated with gold. The relationship is shown on the Cartesian plane below.



## SILVER AND BRONZE MEDALS

The organizers of the Olympics would like to have unique solids for the silver and bronze medals. There are two **possible** solids, a truncated right circular cone, and a right circular cylinder. You will choose which solid will be used for the bronze, and which will be used for the silver.

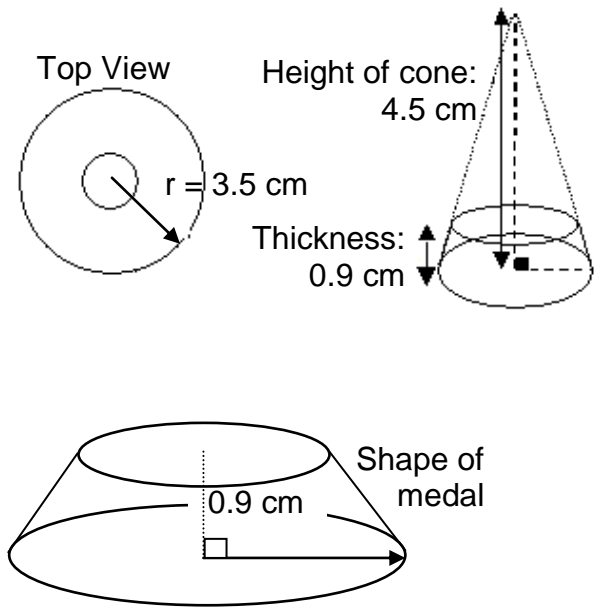
These medals are made entirely of silver or bronze. There are 2 possible solids, listed below, for you to choose from. Diagrams are not to scale.

**Truncated right circular-cone**

Total height of the original cone: 4.5 cm

Thickness of the medal: 0.9 cm

Radius of the base of the original cone: 3.5 cm



Top View

Height of cone: 4.5 cm

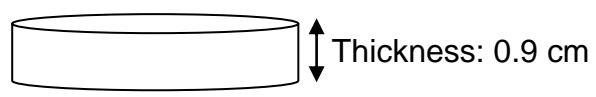
$r = 3.5$  cm

Thickness: 0.9 cm

Shape of medal

0.9 cm

**Right circular-cylinder**



Thickness: 0.9 cm

Thickness of the medal: 0.9 cm

Lateral area of the cylinder is  $16.96 \text{ cm}^2$



## COSTS RELATED TO THE PRODUCTION OF THE SILVER AND BRONZE MEDALS

### Silver Medal

The density ( $\rho$ ) of silver is  $10.5 \text{ g/cm}^3$  and is calculated by using the formula:

$$\rho = \frac{\text{mass}}{\text{volume}}$$

The cost of a silver medal is directly proportional to the mass of the medal and it can be represented by the following equation:

$$C(m) = \frac{2m}{9}$$

where  $C(m)$  represents the cost, and  $m$  represents the mass of silver in grams.

### Bronze Medal

Bronze is a metal alloy of copper and other trace metals. There is a direct relationship between the mass of bronze and its volume. This relation is represented in the table below:

**Table 2: Relationship of the volume of bronze compared to the mass**

Volume of bronze ( $\text{cm}^3$ )	Mass of bronze (g)
5	40
10	80
15	120
20	160

The cost of the bronze medal corresponds to 25% of its mass.



## LABOUR COSTS

Creating these medals is the work of highly skilled craftsmen since all the medals are uniquely engraved with different patterns. A craftsman is paid according to his years of experience as described in the table below. To estimate the hourly wage of the craftsmen you will hire, your boss suggests that you use the mean wage. Also each medal requires a certain amount of time to make.

**Table 3:**  
**Hourly wage of craftsmen**

<b>Hourly wage (\$)</b>	<b>Number of employees</b>
[10, 15[	5
[15, 20[	15
[20, 25[	20
[25, 30[	4
[30, 35[	1
<b>Total</b>	<b>45</b>

**Table 4:**  
**Time required to build and detail one medal**

<b>Solid</b>	<b>Hours of Work</b>
Truncated Pyramid	5 hours
Truncated Cone	4 hours
Cylinder	4.5 hours

