Choosing the Best Heater

Assessment Type	Recommended Grade Level	MYP Criterion Level
Real-life application of mathematics	Grade 7 (MYP2)	MYP 1

MYP Assessment Criteria
Criterion C: Communicating
Criterion D: Applying mathematics in real-life contexts

MYP Command Terms Used
apply, select, state, show, identify, state, describe, explain, use

MYP Global Context
Orientation in space and time

MYP Key Concepts
Aesthetics, Relationships

MYP Related Concepts
Models, Space

MYP Branch of Mathematics
Spatial reasoning

MYP Topics and Skills

- Area of plane figures, including triangles, rectangles, trapezoids, and compound shapes
- Volume of cubes, cuboids, cylinders, and prisms

Prior Knowledge Needed

- Metric conversions
- Calculating area of basic 2D shapes
- Calculating volume of basic 3D shapes

Assessment Description

In this assessment, students are given several diagrams of a bedroom with labeled dimensions of the room and the furniture. Students are then tasked with choosing the best possible heater for the room based on several conditions, such as cost, fit, and space that the heater can heat. The different pieces of furniture in the room are of different shapes, so students need to know how to calculate the areas and volume for each of them.

Materials Needed

Scrap paper, pencil, calculator (highly recommended), ruler (optional)

Task-specific instructions / Recommendations

It is recommended to print this assessment in color for students to have a clear visual to see. This is an assessment that requires a lot of calculation, so it is recommended that students can use a calculator and are given enough time to complete the task.

Assessment Criterion C: *Communicating*

	Achievement Level Descriptor (MYP1)	Task Specific Descriptor
0	The student **does not** reach a standard described by any of the descriptors below.	
1-2	The student is able to: i. use **limited** mathematical language ii. use **limited forms** of mathematical representation to present information iii. communicate through lines of reasoning that are **difficult to understand** iv. *(not demonstrated at this level)*.	The student is able to: i. **use** a minimal amount of mathematical vocabulary ii. **use** one of the following effectively, but with errors: tables, diagrams, calculations, and written explanations iii. **present** arguments that are difficult to understand iv. *(not demonstrated at this level).*
3-4	The student is able to: i. use **some appropriate** mathematical language ii. use **appropriate forms** of mathematical representation to present information **adequately** iii. communicate through lines of reasoning that are **able to be understood**, although these are **not always coherent** iv. **adequately organize** information using a logical structure.	The student is able to: i. **use** some appropriate mathematical vocabulary ii. **use** two of the following effectively, but with minor errors: tables, diagrams, calculations, and written explanations iii. **present** arguments that can generally be understood, however are not always coherent iv. **organize** working out somewhat adequately using some form of logical structure
5-6	The student is able to: i. **usually** use **appropriate** mathematical language ii. **usually** use **appropriate forms** of mathematical representation to present information **correctly** iii. communicate through lines of reasoning that are **usually coherent** iv. **present** work that is **usually organized** using a logical structure.	The student is able to: i. usually **use** appropriate mathematical vocabulary ii. **use** at least three of the following effectively: tables, diagrams, calculations, and written explanations iii. **present** arguments that are usually coherent iv. usually **organize** working out using a logical structure
7-8	The student is able to: i. **consistently** use **appropriate** mathematical language ii. **consistently** use **appropriate forms** of mathematical representation to present information **correctly** iii. communicate **clearly** through **coherent** lines of reasoning iv. present work that is **consistently organized** using a logical structure.	The student is able to: i. consistently **use** appropriate mathematical vocabulary ii. **use** at least four of the following effectively throughout the investigation: tables, diagrams, calculations, and written explanations iii. **present** clear arguments that are consistently coherent iv. consistently **organize** working out using a logical structure

Assessment Criterion D: *Applying mathematics in real-life contexts*

	Achievement Level Descriptor (MYP1)	Task Specific Descriptor
0	The student **does not** reach a standard described by any of the descriptors below.	
1-2	The student is able to: i. identify **some** of the elements of the authentic real-life situation ii. apply mathematical strategies to **find a solution** to the authentic real-life situation, **with limited success** iii. *(not demonstrated at this level)* iv. *(not demonstrated at this level)* v. *(not demonstrated at this level)*.	The student is able to: i. **identify** some of the main elements needed to solve the problem ii. **find** a volume of the empty space in the room that is within 5 cubic meters of the correct answer, but doesn't choose the best heater based on that finding iii. *(not demonstrated at this level)* iv. *(not demonstrated at this level)* v. *(not demonstrated at this level).*
3-4	The student is able to: i. identify the **relevant** elements of the authentic real-life situation ii. apply mathematical strategies to **reach a solution** to the authentic real-life situation iii. *(not demonstrated at this level)* iv. *(not demonstrated at this level)* v. **state, but not always correctly**, whether the solution makes sense in the context of the authentic real-life situation.	The student is able to: i. **identify** all of the main elements needed to solve the problem ii. **find** a volume of the empty space in the room that is within 2 cubic meters of the correct answer, and chooses the best heater based on that finding iii. *(not demonstrated at this level)* iv. *(not demonstrated at this level)* v. **state** briefly, but not always correctly, why the heater chosen is the best.
5-6	The student is able to: i. identify the **relevant** elements of the authentic real-life situation ii. select **adequate** mathematical strategies to model the authentic real-life situation iii. apply the selected mathematical strategies to **reach a valid solution** to the authentic real-life situation iv. **describe** the degree of accuracy of the solution v. **state correctly** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to: i. **identify** all of the main elements needed to solve the problem ii. **select** the correct area and volume formulas for at least 5 objects/furniture in the room iii. **find** the volume of the empty space in the room within 1 cubic meters of the correct answer, and chooses the best heater based on that finding iv. **describe** why he/she believes the volume of the empty space found is accurate v. **state** correctly but briefly, why the heater chosen is the best
7-8	The student is able to: i. identify the **relevant** elements of the authentic real-life situation ii. select **adequate** mathematical strategies to model the authentic real-life situation iii. apply the selected mathematical strategies to **reach a correct solution** to the authentic real-life situation iv. **explain** the degree of accuracy of the solution v. **describe correctly** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to: i. **identify** all of the main elements needed to solve the problem ii. **select** the correct area and volume formulas for all objects/furniture in the room iii. **find** the correct volume of empty space in the room and choose the best heater iv. **explain** why he/she believes the volume of the empty space found is accurate v. **describe** correctly why the heater chosen is the best

Introduction

Johnny's parents recently re-modeled the attic of their house so that Johnny could make it his new bedroom. The attic includes a slanted ceiling that can be seen in the model diagrams of the room that you will see as you start this task.

Johnny needs to buy a heater for his room. However, he realizes that he has limited space in his new room for a heater and has only saved $400 in his piggy bank to spend on one. Johnny would like to spend as little money as possible while making sure that the heater can heat the empty space in his room and be able to place it somewhere unintrusive.

Johnny searches an online store and finds several heaters that he likes and records the essential information into a list as seen in the next page. The information includes the following:

- The size of the heater (based on dimensions given)
- Notes on the direction the heater should face
- The amount of empty volume it can heat
- The cost of the heater

To help figure out which heater would be the best to buy, Johnny used a special software called *Sketchup* to construct a model diagram of the room. He also took measurements of all the different furniture and which can all be found between three different screenshots of the model room that Johnny has printed out. These screenshots can be found on the pages after the list of heaters.

There are certain things Johnny has decided already regarding where he can put the heater:

- It must have a side that touches a wall.
- It cannot be in front of, or on any furniture, doors, or windows.
- Furniture cannot be moved to make space for the heater. Johnny likes the Feng Shui of his room!

Tasks

Johnny has asked you to write a report that tells him what is the best option for a heater, where in the room it should be placed, and why. To do this, you will need to **apply** and **select** problem solving techniques to analyze the list of heaters and diagrams.

***Final Report*:** On the last page there is a space for you to write your final report. In this report, you should make sure you do the following:

- **State** what objects in the room take up space.
  [D: 1-8, i]
- **Show** your working out to find the volume of the empty space is in the room.
  [D: 1-8, ii]
- **Identify** and **state** what you believe to be the best heater for Johnny.
  [D: 1-8, iii]
- **Describe** why you believe that this is the best possible heater for Johnny.
  [D: 1-8, v]
- **Explain** with reasons on how accurate you believe your findings for the volume of empty space in the room is.
  [D: 1-8, iv]

Heaters found for sale online:

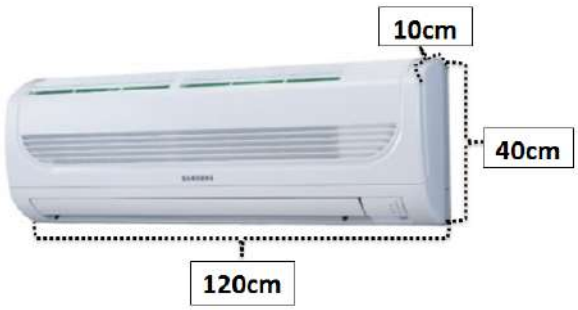
Heater 1:

Notes: Can face any direction: Must stay on its wheels.

Volume that can be heated: 45,000,000cm^3

Price: $140

Heater 2:



Notes: Back side must be mounted at least 1 meter above the floor. Back must be mounted to the wall.

Volume that can be heated: 49,000,000cm^3

Price: $165

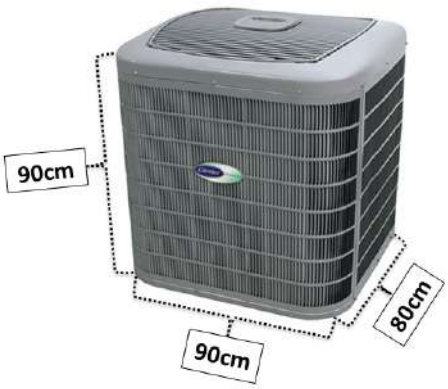
Heater 3:

Notes: Back side must be against the wall. Bottom must touch the floor.

Volume that can be heated: 52,000,000cm^3

Price: $215

Heater 4:

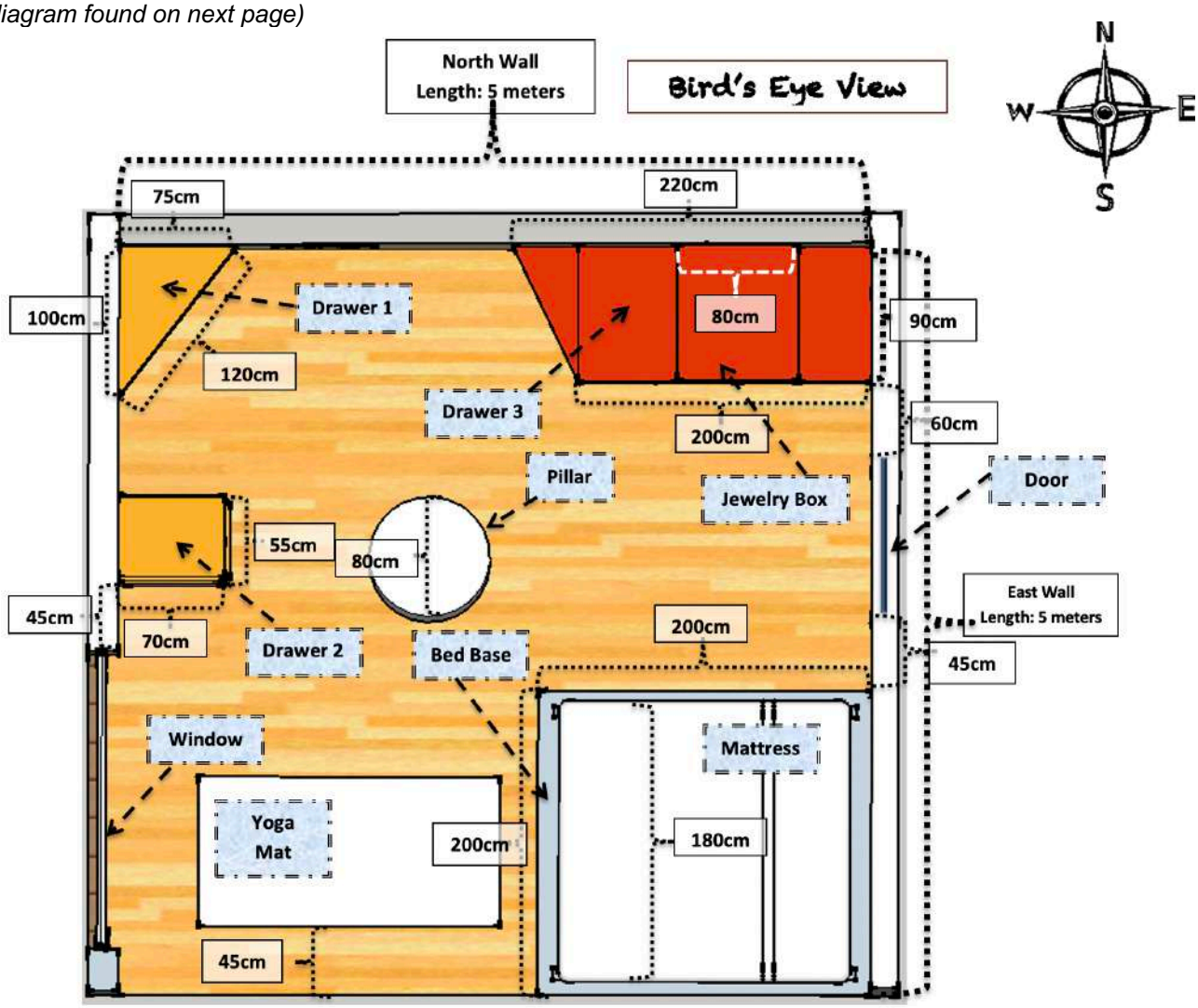


Notes: Bottom must touch the floor. One of the adjacent sides must touch the wall.

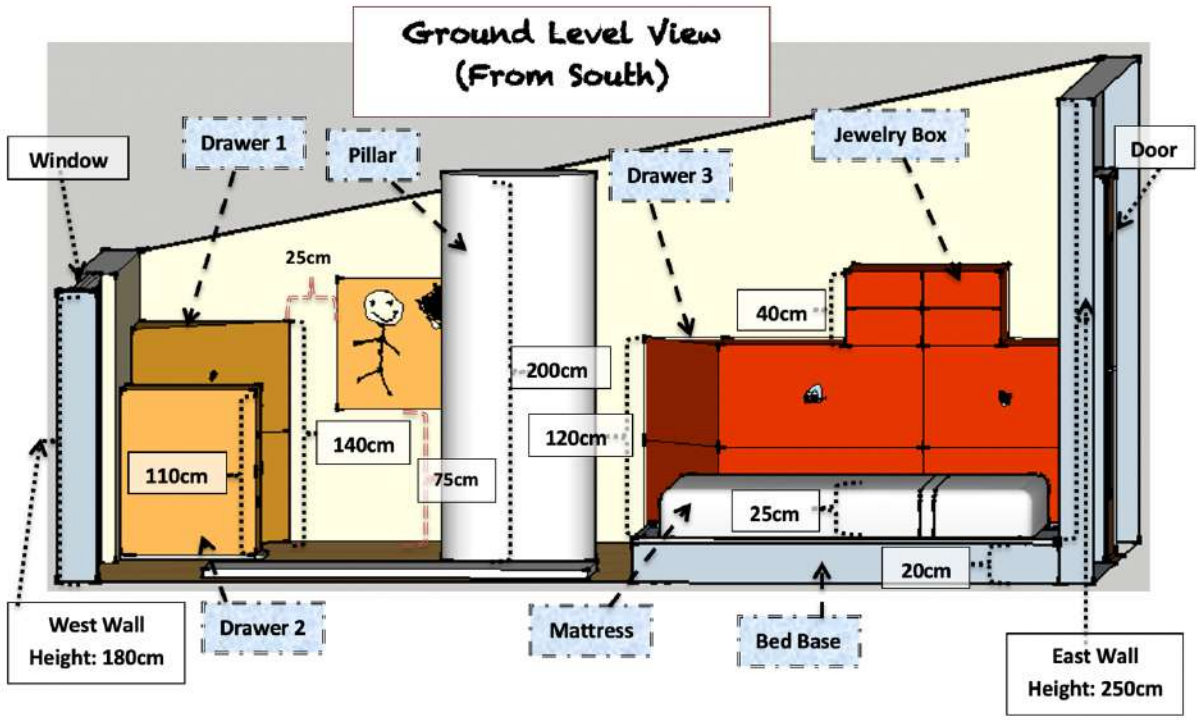
Volume that can be heated: 55,000,000cm^3

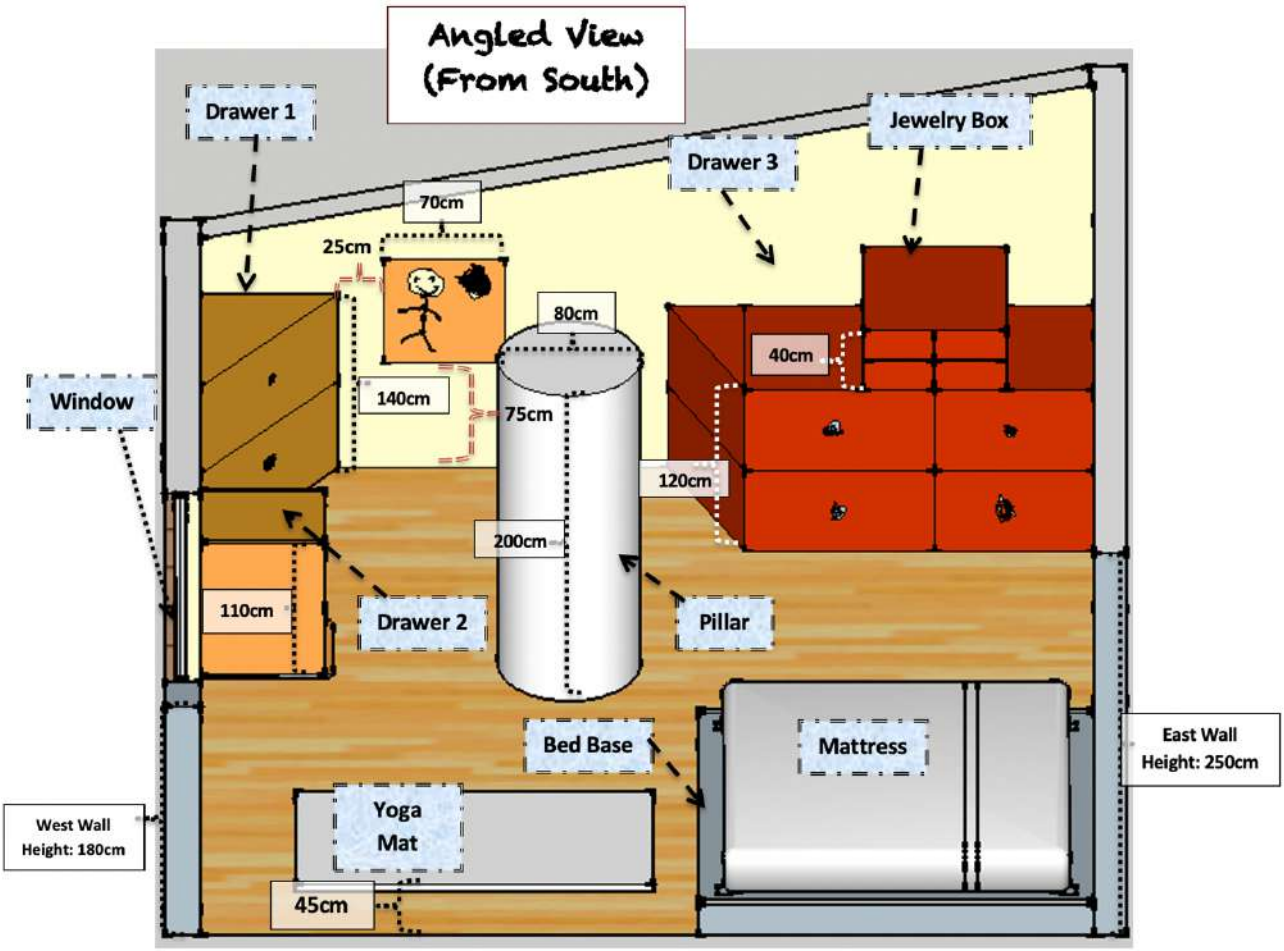
Price: $415

(Third diagram found on next page)



Note that the mattress is square shaped.





Note that the mattress and the painting on the wall are both square shaped.

Final Report: Remember that in your report you should do the following:

- **State** what objects in the room take up space.

[D: 1-8, i]

- **Show** your working out to find the volume of the empty space is in the room.

[D: 1-8, ii]

- **Identify** and **state** what you believe to be the best heater for Johnny.

[D: 1-8, iii]

- **Describe** why you believe that this is the best possible heater for Johnny.

[D: 1-8, v]

- **Explain** with reasons on how accurate you believe your findings for the volume of empty space in the room is.

[D: 1-8, iv]

Communication: you will also need to **show** thorough working out so that your audience can understand your thought process. As you do so make sure to do the following:

- **Use** appropriate mathematical vocabulary that has been discussed throughout the unit.

[C: 1-8, i]

- **Show** your thinking and answers in such a way that is **clear**, **coherent**, and **organized**, that includes multiple forms of representation such as **tables**, **diagrams**, **calculations**, and **supporting explanations**, etc.

[C: 1-8, ii-iv]

*** Before starting your final report, it is advised to do a draft on scrap paper first.***

Objects in the room

- Drawers 1-3
- Jewelry box
- Mattress
- Pillar
- Bed base
- Mattress

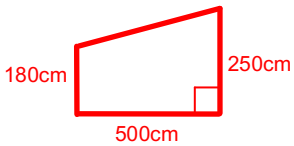
The room is a trapezoidal prism

Trapezoid area

$$= \frac{b_1 + b_2}{2} \times h$$

$$= \frac{180 + 250}{2} \times 500$$

$$= 107{,}500\text{cm}$$



Room Volume:

Trapezoid Area X Room length

$= 450{,}000\text{cm} \times 500\text{cm}$

$= \mathbf{53{,}750{,}000cm^2}$

Drawer 1 is a triangular prism

Area of Triangle:

$$= \frac{b + h}{2}$$

$$= \frac{75\text{cm} \times 100\text{cm}}{2}$$

$$= 3{,}750\text{cm}$$

Volume of prism:

Area of triangle X height of drawer

$= 3{,}750\text{cm} \times 140\text{cm}$

$= \mathbf{525{,}000cm^2}$

Drawer 2 is a rectangular prism

Volume of prism

$= 55\text{cm} \times 70\text{cm} \times 110\text{cm}$

$= \mathbf{423{,}500cm^2}$

Jewelry box is a rectangular prism

Volume of prism

$= 80\text{cm} \times 90\text{cm} \times 40\text{cm}$

$= \mathbf{288{,}000cm^2}$

Drawer 3 is a trapezoidal prism

Area of trapezoid

$$= \frac{b_1 + b_2}{2} \times h$$

$$= \frac{220 + 200}{2} \times 90$$

$$= 18{,}900\text{cm}$$

Volume of prism:

= Area of trapezoid X height of drawer

$= 18{,}900\text{cm} \times 120\text{cm}$

$= \mathbf{2{,}268{,}000cm^2}$

Pillar is a cylinder

Area of circular base

$= \pi r^2$

$= \pi(40)^2$

$= \pi 1600$

$\approx 5024\text{cm}^2$

Volume of Cylinder

=Area of circular base X Height

$= 5024\text{cm} \times 200\text{cm}$

$= \mathbf{1{,}004{,}800cm^2}$

Mattress is a prism

Volume of prism

$= 180\text{cm} \times 180\text{cm} \times 25\text{cm}$

$= \mathbf{810{,}000cm^2}$

Bed base is a rectangular prism

Volume of prism

$= 200\text{cm} \times 220\text{cm} \times 20\text{cm}$

$= \mathbf{880{,}000cm^2}$

Amount of empty space in the room

$= \text{Room Volume} - (\text{Drawer 1} + \text{Drawer 2} + \text{Drawer 3} + \text{Jewelry box} + \text{Mattress} + \text{Bed base} + \text{Pillar})$

$= 53{,}750{,}000 - (525{,}000 + 423{,}500 + 2{,}268{,}000 + 288{,}000 + 810{,}000 + 880{,}000 + 1{,}004{,}800)$

$= 53{,}750{,}000 - 6{,}199{,}300$

$= \mathbf{47{,}550{,}700 cm^2}$

The best heater for Johnny would be **Heater 3**. Heaters 2, 3, and 4 are all acceptable because they can heat the amount of empty space in the room. Out of all these heaters, Heater 3 is also the cheapest. It also can fit comfortably on the wall above the jewelry box or almost anywhere on the south side wall.

The accuracy of this answer is dependent on how well Johnny was able to measure the objects/furniture in his room as it is possible that there may have been some human error. Not to mention there is always a chance that this report itself has some human errors in the calculations it provides. Though as long as any total miscalculations off by a net total of 2,449,300cm^2 $(5{,}000{,}000 - 47{,}550{,}700)$, Heater 2 would still remain the best choice. Also, it should be noted that one value that was calculated was a rounded figured. This would be the volume of the cylinder since the value of π is irrational.

Nevertheless. the rounding of π was to the nearest hundredth so the impact on the total of the calculations is negligible to the greater context of the problem and would have no effect on which heater would be best for Johnny to buy.