Melbourne Central Precinct Maths Science Trail

Introduction

This trail consists of seven stations, beginning at the corner of Elizabeth and Latrobe Streets, passing through Melbourne Central, then down to Lonsdale Street and finally to the corner of Latrobe and Swanston Streets. We suggest that the data is collected at each station and the final calculations and discussions can then be carried out back at school. We recommend the sequence of the stations provided, however, the trail can be commenced at any station of your choice.

Equipment List

All groups will need:

1. A scientific calculator
2. A sound meter

   Instructions for using sound meter are as follows:

   Use the following settings to gain measurements - "C" weighting (mimics human ear) and slow response. Out of interest, observe the reading when set on fast response.
3. Pen
4. Stop watch
5. Navigational Compass
6. Ruler

Figure 7.1 - Melbourne Central Bubble Bridge over Little Lonsdale Street. Images are conceptual only and reflect plans as at August 2003. Design and retailers depicted in these images are indicative only. Photo courtesy of Melbourne Central Management.

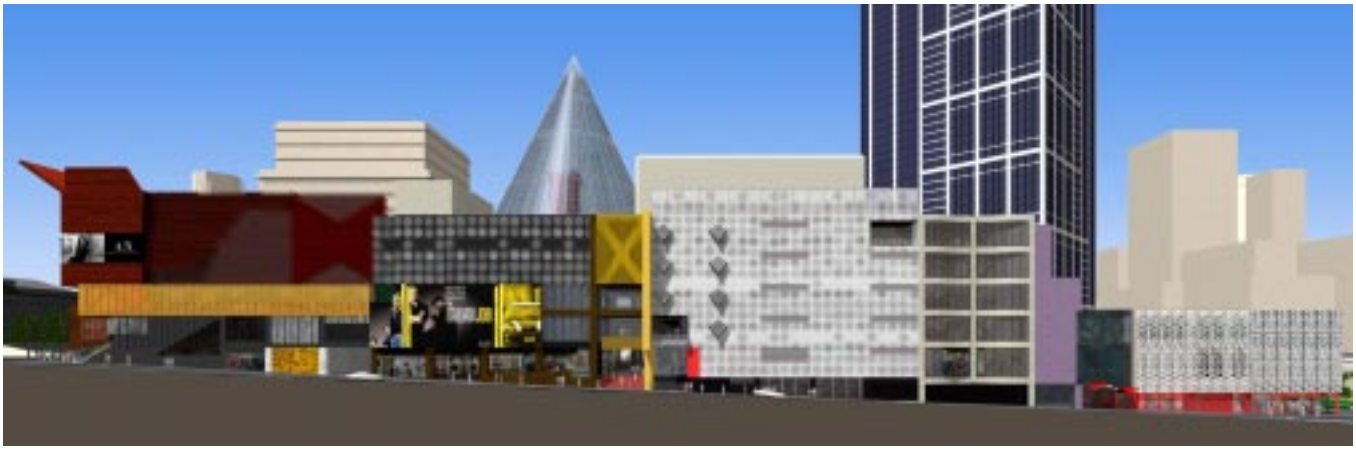


Figure 7.2 - Melbourne Central looking south from Latrobe Street showing the cone covering the Shot Tower. Image based on architectural images and subject to change. Image courtesy of Lend Lease Melbourne Central Management.

Corner of Elizabeth and Latrobe Streets
(Elizabeth Street entrance of Melbourne Central Train Station)

STATION ONE

1. Find this structure (see Fig. 7.3).

2. What are the different shapes that you can see in this scaffolding structure at the Elizabeth Street entrance of Melbourne Central Train Station?

Comment on the different two dimensional and three dimensional shapes. Do a sketch of them.
What shapes do you see? Please use the correct geometric names.

Figure 7.3. Scaffolding above Melbourne Central train station entrance.

Notes **Drawing**

Figure 7.4 Image courtesy of Lend Lease Melbourne Central Management.

Follow the signs to Melbourne Central Shops.
Enter the centre and make your way up the escalators to the open area at the foot of the brick shot-tower.

STATION TWO

This important landmark of Melbourne was preserved and enclosed in a conic glass atrium. The shot tower was built in 1889, and was a factory for making lead shot. The factory operated until 1961*.

Ammunition, both military and sporting, is made from lead. The spherical shot for shotgun use is made by pouring molten lead and arsenic through sieves at the top of a tower. The molten alloy, while dropping forms a true sphere before solidifying near the bottom of its fall. The shot is collected in water. (Encyclopaedia Britannica, 1981,10, p. 729)

Figure 7.5

1. Given the composition of the lead shot, what environmental hazards would the clean up team have to deal with during the construction of Melbourne Central?

_____

_____

_____

_____

2. Calculation of the speed of the shot at the bottom of the tower.

In order to simplify practical problems, assumptions often need to be made. This problem is no exception.

Estimate the height of the shot tower_____ metres

Check this on the architect's drawing of the shot tower (figure 6.31), using the scale provided.

What is the name of the force that causes the lead shot to fall? _____

** Acknowledgement:*
Vincent. J. (1999). Shrine to University: a geometry journey along St.Kilda Road and Swanston Street. MAV 2nd edition 2003

The speed of the shot after travelling a distance *d* metres from rest, can be calculated using the following formula:

$$v^2 = 2ad$$

where $a = 10\text{m/s}^2$, acceleration due to gravity and *d* is the height of the shot tower, in metres, calculated from the architect's drawing.

Find *v*, the speed of the shot.

The value calculated above, is the theoretical speed for the lead shot. In reality, the lead shot would encounter other forces that would influence its speed as it falls through the air column. What are the other forces?

Draw a simple diagram to illustrate these forces acting on the shot. Represent the shot as a sphere

What effect would these forces have on the speed of the falling object?

Convert the speed to km/hr, using the following conversion factors.

Conversion factors:
1000 metres in one kilometre; 60 seconds in one minute; 60 minutes in one hour.

Compare this speed to the speed of

- a car travelling on a freeway
- walking dog
- running to the ice cream shop
- a tram

Rank these speeds in ascending order.

3 a) What geometric name best describes the transparent structure surrounding the Tower?

_____
_____

3 b) List three possible purposes of this structure.

_____
_____
_____

3 c) What is the meaning of transparent?

_____
_____
_____

3 d) What is the most likely material used in the transparent panels?

_____
_____
_____

3 e) What properties does this material need to have to achieve its purpose(s)?

_____
_____
_____
_____

3 f) What other material could be used as a substitute?

_____
_____

3 g) What material would be found in the framework of the structure and give one reason why?

_____
_____
_____
_____

On the ground level walk to the Little Lonsdale Street exit. Turn left at the New Zealand ice cream shop and walk towards the Little Lonsdale Street exit. You will pass the Body Shop. Go out through the sliding door. Turn right into Lt. Lonsdale Street and walk down until you reach Elizabeth Street. Turn left into Elizabeth St. and walk the length of the block. St. Francis' Church will be on your left.

STATION THREE

This station is outside St. Francis' Church, Elizabeth Street, near the corner of Lonsdale Street.

Observe the gates and fence (Figure 7.6).

1. What materials are the gates made from?

_____
_____
_____
_____

2. Can you see any evidence of corrosion? What is the common name for this type of corrosion?

_____
_____

3. In your travels today where else have you seen evidence of this process? Give one precise location.

_____
_____

4. List two environmental factors that cause corrosion?

_____
_____

5. Find a similar stone pillar to the one shown in Figure 7.7. Identify any plant life that may be growing on the stone and record its common name.

_____
_____
_____
_____

List one thing about the environment that encourages this growth?

_____

Figure 7.6.

Figure 7.7

6. Seek shade under a tree. Observe the canopy of leaves. Sketch a leaf. What geometric shape could be used to represent the surface area of the leaf?

7. Why do you think that the leaf needs such a large surface area in relation to its volume?

_____

_____

8. Do you think that these trees will lose their leaves in Autumn? Yes/No

9. What is the general term that we give to plants that lose their leaves in Autumn?

_____

In a city environment such as this, what would be the benefits of having trees of this type growing? List as many benefits as you can.

_____

_____

_____

_____

Walk to the corner of Elizabeth and Lonsdale Streets.

STATION FOUR

At the corner of Elizabeth Street and Lonsdale Street listen to the noise around you.

1. When a tram passes, stop and listen to the sounds being produced. Describe the sound. Make comment on the pitch and loudness of the sound as it approaches you and as it passes you.

_____

_____

2. Record the sound level when there are no trams passing, and then when there are trams. What difference is there in sound levels? Show all working.

_____

_____

_____

_____

_____

Walk up Lonsdale Street towards Swanston Street.

STATION FIVE

At the intersection of Lonsdale Street and Swanston Street take note of the time of day.

Time of day_____ am/pm

Note the intersection of Swanston and Lonsdale Streets.

1. Measure the time of the green light cycle along Swanston Street. Do this three times and average your result.

Trial Number	Seconds
1	
2	
3	
Average	

2. Count the number of vehicles that travel along Swanston Street through the intersection in a North-South direction. Do this three times, and average your results. Do the same thing for vehicles travelling in a South-North direction.

	North - South direction		South - North direction
Trial Number	**Number of vehicles**	**Trial Number**	**Number of vehicles**
1		1	
2		2	
3		3	
Average		Average	

3. Calculate the total number of vehicles that pass through this intersection, along Swanston Street, each second.

_____

_____

4. Now do the same thing for the traffic travelling along Lonsdale Street in both directions. (ie: East-West, and West–East directions)

Measure the green light cycle for Lonsdale Street.

Trial Number	Seconds
1	
2	
3	
Average	

	East - West direction		West - East direction
Trial Number	**Number of vehicles**	**Trial Number**	**Number of vehicles**
1		1	
2		2	
3		3	
Average		Average	

5. Now calculate the total number of vehicles that pass through this intersection along Lonsdale Street, each second.

_____

_____

6. Make a comment on the cycle of the lights in relation to the traffic flow at the time. In your opinion have the cycle of the lights been set to adequately cater for the traffic flow?

_____

_____

7. Measure the sound levels at this intersection.

_____

_____

Walk up Swanston Street to Latrobe Street.
Station Six is near the corner of Latrobe and Swanston Streets.

STATION SIX

Go to the food court at Melbourne Central on the corner of Swanston Street and Latrobe Street. You deserve to give yourselves a treat. Buy a soft serve ice cream.

1. Find a seat and while you are enjoying your ice cream work out the volume of ice cream in the cone, by approximating the ice cream to be a cylinder and a cone.

The volume of a cylinder is $V = \pi \times (\text{radius})^2 \times \text{height}$

The volume of a cone is $V = {}^1/_3 \times \pi \times (\text{radius})^2 \times \text{height}$

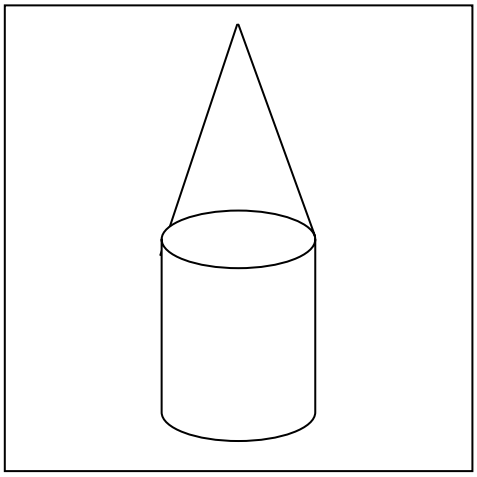


Figure 7.8

Estimate the following:

Radius of the cylinder = ……. cm

Radius of the base of cone = ……. cm

Height of cylinder = ……. cm

Height of cone = ……. cm

Volume of cone = ……. cm^3

Volume of cylinder = ……. cm^3

Total volume of icecream = ……. cm^3

2, If it takes three seconds to pour the icecream into the cone, what is the rate that the icecream fills the cone? (cm^3/sec)

_____

_____

After you have finished your ice cream, go to the corner of Latrobe and Swanston Streets, outside the State Library. This is Station Seven.

STATION SEVEN

From the corner of Latrobe and Swanston Streets, look up Latrobe Street towards Russell Street. On the corner of Latrobe and Russell Streets there is a building with a green roof. This is the Magistrates Court.

Shown is a picture of a famous New York City landmark. She is composed of the same metal as the dome on top of the Magistrates' Court. This metal, when freshly polished, is orange brown in colour, but when exposed to air it slowly corrodes and becomes green. It is also found in the alloy bronze. What is it?

_____

_____

State at least one location where you have seen evidence of this metal structure in other buildings?

_____

_____

At the intersection of Latrobe and Swanston Streets record the sound level.

Sound level = _____decibels

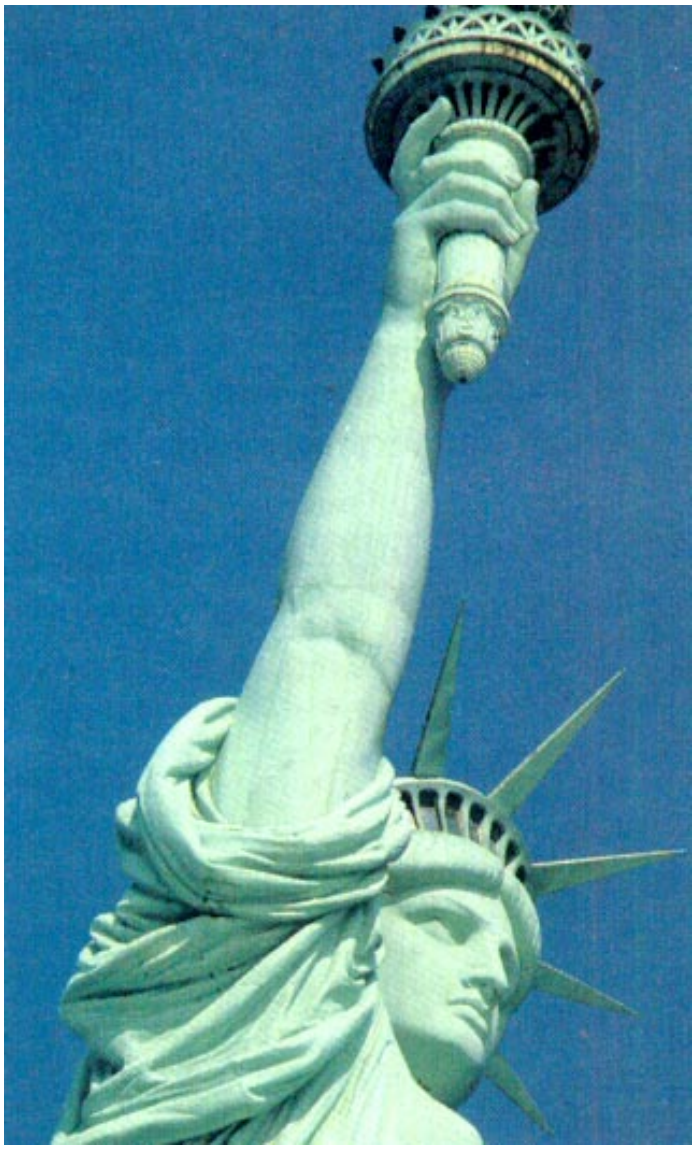


Figure 7.9. *Chang, R. (1994). Chemistry, McGraw-Hill. Page 789*

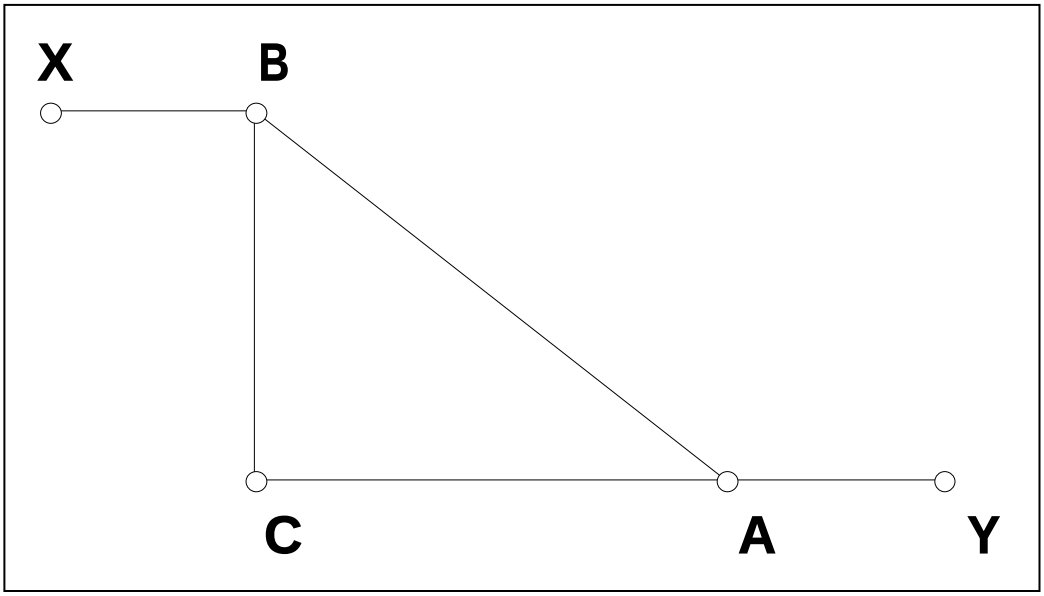
Compare this to the sound level at the intersection of Lonsdale and Elizabeth Streets, as well as the intersection of Swanston and Lonsdale Streets. Which is the noisiest intersection?

_____

_____

CALCULATING THE AVERAGE SPEED OF STEP CLIMBING.

For this exercise, use the steps outside the State Library leading down to Swanston Street. If raining, find alternative stairs within Melbourne Central. For safety reasons, avoid using busy staircases.

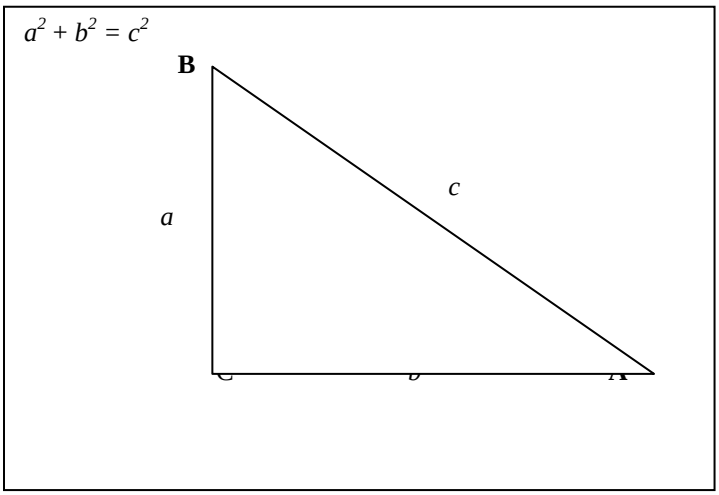


A is at the base of the flight of steps and B is at the top of the flight of steps.

Average speed = $\frac{d}{t}$, where *d* is the distance travelled and *t* is the time taken. The distance travelled by the person climbing the flight of steps is $\overline{BA}$.

WORKING SPACE
It is advisable to use a diagram.

To find the length $\overline{BA}$, the theorem of Pythagoras can be used.



Estimate the vertical height of the staircase, *a*. Using your ruler, measure the height of one of the steps. Using the total number of steps in the staircase, calculate the vertical height.

a = $\overline{BC}$ =_____metres

Estimate the horizontal distance through which the staircase runs, *b*. Using a similar method as above, calculate the horizontal distance.

$B = \overline{CA}$ =_____ metres

Using Pythagoras Theorem, calculate the length of the staircase *c*.

By Pythagoras theorem: $c^2 = a^2 + b^2$

so $c = \overline{BA}$ = _____metres.

Time *t:*
Calculate the time it takes for a person to climb the flight of steps. Do this three times and average the result.

Trial Number	Time (seconds)
1	
2	
3	
Average	

Average speed of the stair climber is $\frac{\overline{BA}}{t}$.

Average speed of the stair climber is approximately equal to _____metres per sec.

To get to Station One you will need to walk down Latrobe Street towards Elizabeth Street. Station One is on the corner of Latrobe and Elizabeth Streets, outside Melbourne Central Station.
If you have already completed Station One then you have completed the trail.

Thanks to Carol Patterson from Haileybury College and Alexandra Abela of Penleigh & Essendon Grammar School, both formerly of St. Margaret's School, Berwick (at which the trail was first implemented) for allowing their educational materials to be reproduced.