The Pedestrian Bridge:
Southgate (Melbourne)

Name: _____

The pedestrian bridge over the Yarra River at Southgate (figure 33) was designed by the Melbourne architects, Cocks and Carmichael. The bridge is of bow truss construction and the curve of the arch is a parabola.
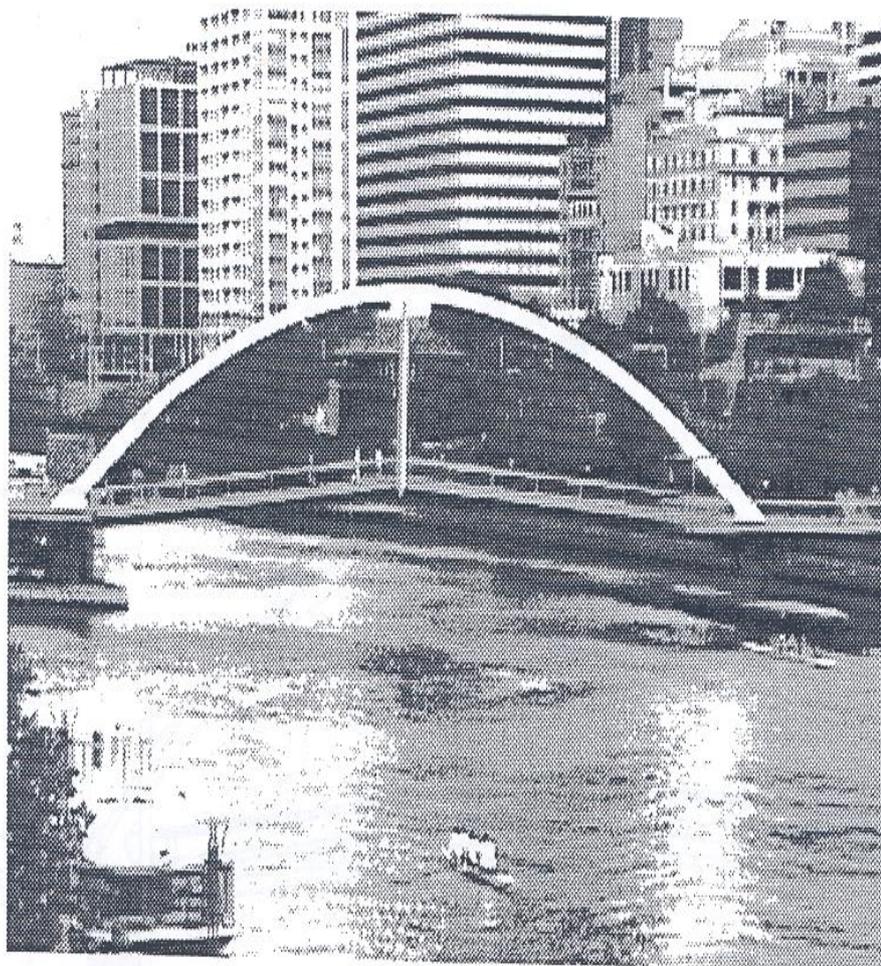

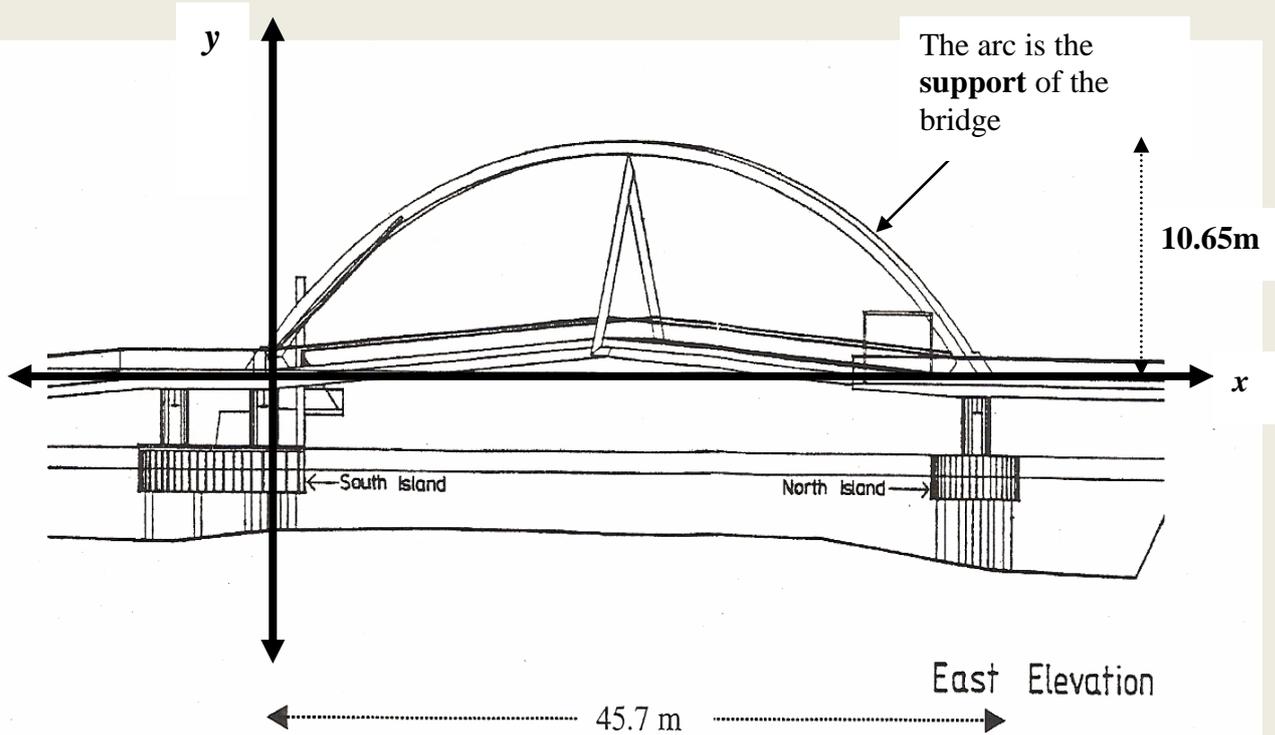*Figure 33.* The footbridge from Princes Bridge.

Figure 34. East elevation of the footbridge (Architects' drawing).

Part A: Investigating the pedestrian bridge
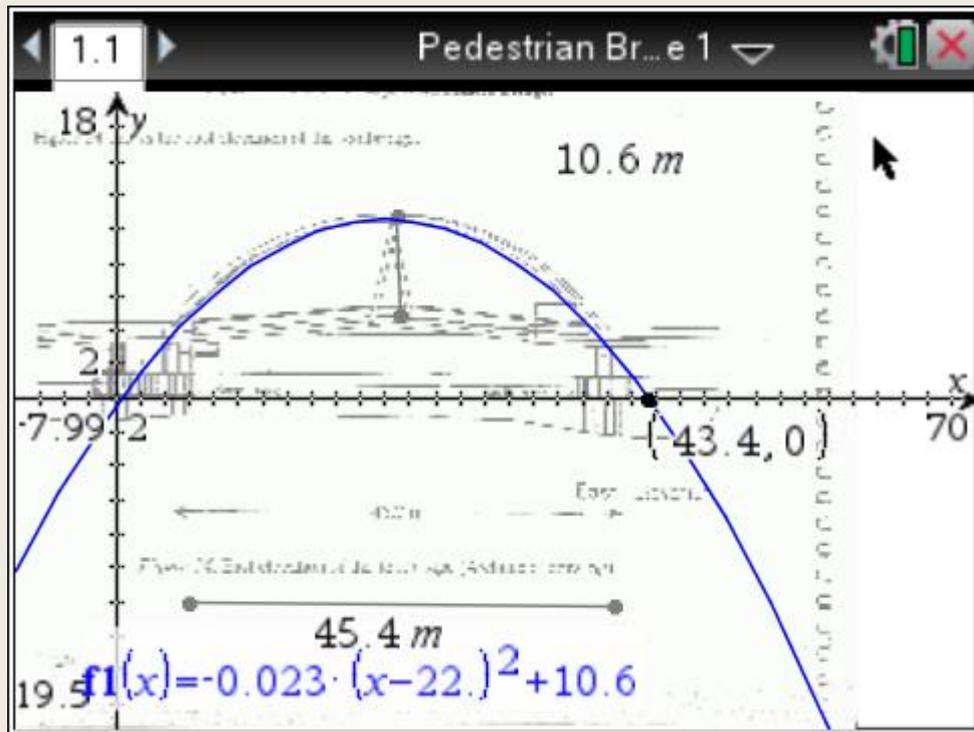
1. Using the architects' drawing in *Figure 34,* and the axes shown, the scale of the drawing is:

    Vertically   1cm: ____m   Horizontally   1cm: ____m

    - *From question 2 onwards use the actual measurements of the bridge, not the scaled values.*

2. The support of the pedestrian bridge is in the shape of a parabola. The parabola is represented by the equation: $y = a(x+h)^2 + k$.

    (i)   Do you expect the value of a to be positive or negative? Explain.

(ii)   What are the values of h and k ?

3.   Using the coordinate axes and dimensions shown on the architects' drawing of the pedestrian bridge (*Figure 34*), determine the value of a. *(3 decimal places)*

4.   What is the equation for the parabolic shape of the bridge with the origin in the position shown?

5.   (a) What **type** of discriminant would you expect to obtain, (e.g. positive, negative or zero). Why?

(b) Work out the discriminant. Does this confirm your prediction?

(c) What does this tell you about the supports of the bridge?

6.   (a) What are the minimum and maximum x values on the graph? (known as the *domain*.)

(b) What are the minimum and maximum y values on the graph? (known as the *range*.)

Part B: Reconstruction of the bridge.

It was decided by the Mayor of Melbourne, Robert Doyle, that the pedestrian bridge should be reconstructed.

The length of the bridge would remain the same, but it would be 2.5m taller.

7.   **Sketch** the new bridge and old bridge below on the same axes showing all the appropriate labels and relevant information.

8.   What are the values of h and k for the reconstructed support?

9.   Find the value of a in the new support, and hence find the new equation. *(The value of a should be to 3 decimal places)*

10.   Describe the differences between the two bridges.

11.   What is the domain and range of the new bridge?

Part C: Your Report

You have been employed by 'The John Holland Group', a large construction company in Melbourne to investigate if the reconstruction is possible. You must prepare a report for Robert Doyle.

You have been given the following information:

- You have been given a budget of: $11 000 to purchase the steel required for the support of the bridge.

- The cost of steel is $215 per metre.

- A triangle method can be used to estimate the cost of steel required in the supports for both the old and new bridge (as in the diagram below).
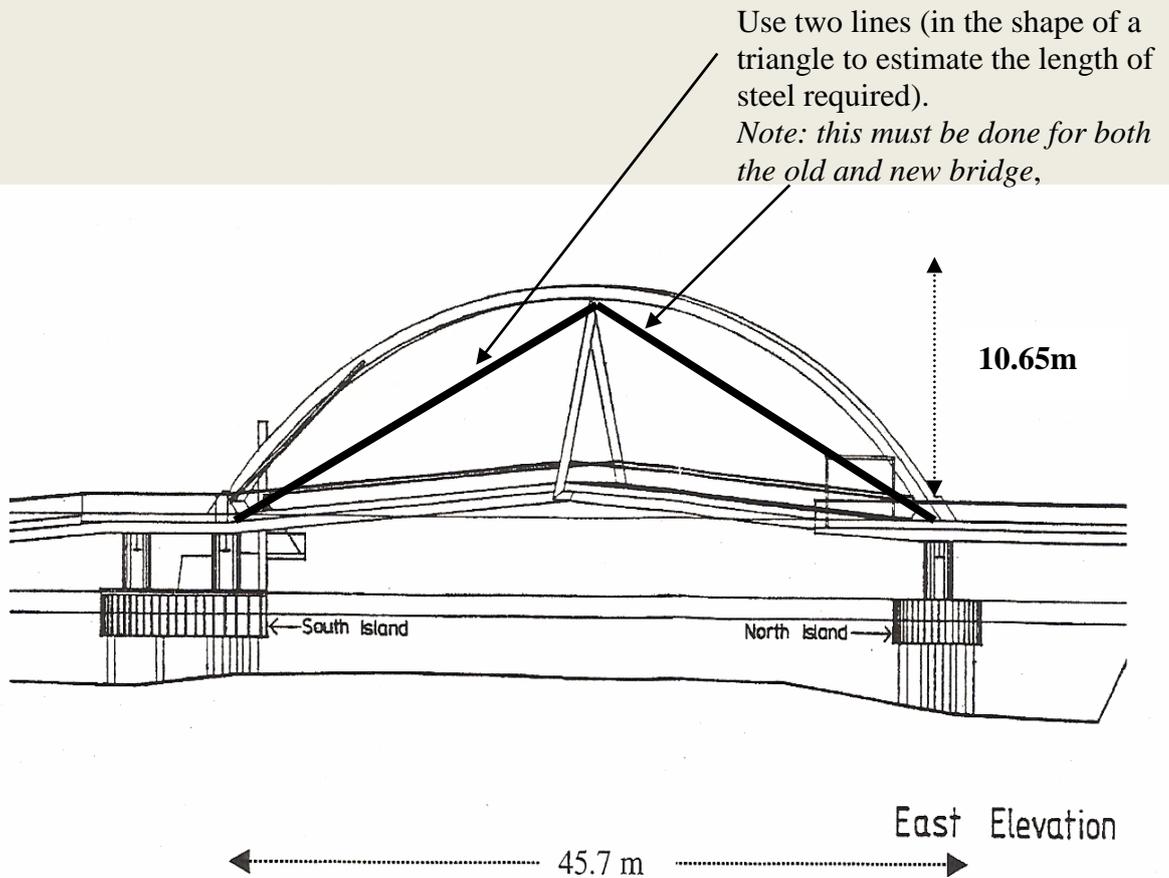
Use two lines (in the shape of a triangle to estimate the length of steel required).
Note: this must be done for both the old and new bridge,

10.65m

←—South Island   North Island—→

East Elevation

45.7 m

Figure 34. East elevation of the footbridge (Architects' drawing).

Your report to Robert Doyle must include the following:

- An estimate (*to the nearest metre)* of the **amount** of steel required in the supports for **both** the old and new bridge (use the triangle method shown on the previous page)

- The **cost** of the steel required in the support for both the old and new bridge *(to the nearest dollar).*

- A statement as to which bridge will require more steel

- A statement as to whether the construction of the new bridge is possible under the current budget? *(You must support your statement with mathematical*

calculations). If not, how much additional money would you need to complete the new bridge? *(to the nearest dollar).*

- A statement as to whether it is appropriate is it to use the triangle method to approximate the cost of steel required.

Your report should be completed on separate paper