# Chp 5 IB SL Maths

**1a.** *[4 marks]*

Consider the function  .

Sketch the graph of *f* , for  .

 **1b.** *[1 mark]*

This function can also be written as  .

Write down the value of *p* .

 **1c.** *[4 marks]*

The graph of *g* is obtained by reflecting the graph of *f* in the *x*-axis, followed by a translation of  .

Show that  .

 **1d.** *[3 marks]*

The graph of *g* is obtained by reflecting the graph of *f* in the *x*-axis, followed by a translation of  .

The graphs of *f* and *g* intersect at two points.

Write down the *x*-coordinates of these two points.

 **1e.** *[3 marks]*

The graph of  is obtained by reflecting the graph of  in the *x*-axis, followed by a translation of  .

Let *R* be the region enclosed by the graphs of *f* and *g* .

Find the area of *R* .

 **2a.** *[2 marks]*

The diagram below shows the graph of a function  , for  .



Sketch the graph of  on the grid below.



 **2b.** *[4 marks]*

The graph of *f* is transformed to obtain the graph of *g* . The graph of *g* is shown below.



The function *g* can be written in the form  . Write down the value of *a* and of *b* .

 **3a.** *[3 marks]*

The diagram below shows the graph of a function  , for  .



Let  . Sketch the graph of  on the grid below.



 **3b.** *[3 marks]*

Let . The point  on the graph of  is transformed to the point P on the graph of  . Find the coordinates of P.

 **4a.** *[2 marks]*

Let  and  .

The graph of *g* can be obtained from the graph of *f* using two transformations.

Give a full geometric description of each of the two transformations.

 **4b.** *[4 marks]*

The graph of *g* is translated by the vector  to give the graph of *h*.

The point  on the graph of *f* is translated to the point P on the graph of *h*.

 Find the coordinates of P.

 **5a.** *[2 marks]*

Let  ,  ,  .The graph of *f* is shown below.



The region between  and  is shaded.

Show that  .

 **5b.** *[7 marks]*

Given that  , find the coordinates of all points of inflexion.

 **5c.** *[7 marks]*

It is given that .

(i) Find the area of the shaded region, giving your answer in the form  .

(ii) Find the value of  .

 **6a.** *[2 marks]*

Let  . The graph of *f* is translated 1 unit to the right and 2 units down. The graph of *g* is the image of the graph of *f* after this translation.

Write down the coordinates of the vertex of the graph of *g* .

 **6b.** *[2 marks]*

Express *g* in the form  .

 **6c.** *[2 marks]*

The graph of *h* is the reflection of the graph of *g* in the *x*-axis.

Write down the coordinates of the vertex of the graph of *h* .

 **7a.** *[6 marks]*

Let  and  be functions such that  .

(a) The graph of  is mapped to the graph of  under the following transformations:

vertical stretch by a factor of  , followed by a translation .

Write down the value of

 (i)  ;

 (ii)  ;

 (iii)  .

(b) Let  . The point A(, ) on the graph of  is mapped to the point  on the graph of  . Find  .

 **7b.** *[3 marks]*

The graph of  is mapped to the graph of  under the following transformations:

vertical stretch by a factor of  , followed by a translation .

Write down the value of

 (i)  ;

 (ii)  ;

 (iii)  .

 **7c.** *[3 marks]*

Let  . The point A(, ) on the graph of  is mapped to the point  on the graph of  . Find  .

 **8a.** *[2 marks]*

Let  .

Show that  .

 **8b.** *[8 marks]*

For the graph of *f*

(i) write down the coordinates of the vertex;

(ii) write down the **equation** of the axis of symmetry;

(iii) write down the *y*-intercept;

 (iv) find both *x*-intercepts.

 **8c.** *[2 marks]*

**Hence** sketch the graph of *f* .

 **8d.** *[3 marks]*

Let  . The graph of *f* may be obtained from the graph of *g* by the two transformations:

a stretch of scale factor *t* in the *y*-direction

followed by a translation of  .

 Find  and the value of *t*.

 **9a.** *[2 marks]*

Part of the graph of a function *f* is shown in the diagram below.



On the same diagram sketch the graph of  .

 **9b.** *[4 marks]*

Let  .

(i) Find  .

(ii) Describe fully the transformation that maps the graph of *f* to the graph of *g*.

 **10a.** *[2 marks]*

Consider the graph of  shown below.



On the **same** grid sketch the graph of  .

 **10b.** *[2 marks]*

The following four diagrams show **images** of *f* under different transformations.



Complete the following table.



 **10c.** *[2 marks]*

Give a full geometric description of the transformation that gives the image in Diagram A.

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# Chp 5 IB SL Maths

**1a.** *[4 marks]*

Consider the function  .

## Markscheme

***A1A1A1A1 N4***

**Note:** The shape **must** be an approximately correct upwards parabola.

**Only** if the shape is approximately correct, award the following:

***A1*** for vertex  , ***A1*** for *x*-intercepts between 0 and 1, and 3 and 4, ***A1*** for correct *y*-intercept , ***A1*** for correct domain .

Scale not required on the axes, but approximate positions need to be clear.

 ***[4 marks]***

 **1b.** *[1 mark]*

## Markscheme

***A1 N1***

***[1 mark]***

 **1c.** *[4 marks]*

## Markscheme

correct vertical reflection, correct vertical translation ***(A1)(A1)***

e.g.  ,  ,  ,  , 

transformations in correct order ***(A1)***

e.g.  , 

simplification which clearly leads to given answer ***A1***

e.g.  , 

***AG N0***

**Note**: If working shown, award ***A1A1A0A0*** if transformations correct, but done in reverse order, e.g. .

***[4 marks]***

 **1d.** *[3 marks]*

## Markscheme

valid approach  ***(M1)***

e.g. sketch, 

 , 

 (exact),  ; ***A1A1 N3***

***[3 marks]***

 **1e.** *[3 marks]*

## Markscheme

attempt to substitute limits or functions into area formula (accept absence of  ) ***(M1)***

e.g.  ,  , 

approach involving subtraction of integrals/areas (accept absence of  )  ***(M1)***

e.g.  , 



***A1 N3***

***[3 marks]***

 **2a.** *[2 marks]*

The diagram below shows the graph of a function  , for  .



## Markscheme

***A2 N2***

***[2 marks]***

 **2b.** *[4 marks]*

## Markscheme

***A2A2 N4***

**Note**: Award ***A1*** for  , ***A1*** for  .

***[4 marks]***

 **3a.** *[3 marks]*

The diagram below shows the graph of a function  , for  .



## Markscheme

 ***A2 N2***

***[2 marks]***

 **3b.** *[3 marks]*

## Markscheme

evidence of appropriate approach  ***(M1)***

e.g. reference to any horizontal shift and/or stretch factor,  , 

P is  (accept  , ) ***A1A1 N3***

***[3 marks]***

 **4a.** *[2 marks]*

Let  and  .

## Markscheme

in any order

translated 1 unit to the right ***A1 N1***

stretched vertically by factor 2 ***A1 N1***

***[2 marks]***

 **4b.** *[4 marks]*

## Markscheme

**METHOD 1**

finding coordinates of image on *g* ***(A1)(A1)***

e.g.  ,  ,  , 

P is (3, 0) ***A1A1 N4***

**METHOD 2**

***(A1)(A1)***

P is ***A1A1 N4***

 **5a.** *[2 marks]*

Let  ,  ,  .The graph of *f* is shown below.



The region between  and  is shaded.

## Markscheme

**METHOD 1**

evidence of substituting  for ***(M1)***

***A1***

***AG N0***

**METHOD 2**

 is reflection of  in *x* axis

and  is reflection of  in *y* axis ***(M1)***

sketch showing these are the same ***A1***

***AG N0***

***[2 marks]***

 **5b.** *[7 marks]*

## Markscheme

evidence of appropriate approach ***(M1)***

e.g. 

to set the numerator equal to 0 ***(A1)***

e.g.  ; 

(0, 0) ,  ,  (accept  ,  etc) ***A1A1A1A1A1 N5***

 ***[7 marks]***

 **5c.** *[7 marks]*

## Markscheme

(i) correct expression ***A2***

e.g.  ,  , 

area = ***A1A1 N2***

(ii) **METHOD 1**

recognizing the shift that does not change the area ***(M1)***

e.g.  , 

recognizing that the factor of 2 doubles the area ***(M1)***

e.g. 

 (i.e. **their** answer to (c)(i))  ***A1 N3***

 **METHOD 2**

changing variable

let  , so 

***(M1)***

substituting correct limits

e.g.  ,  , ***(M1)***

***A1 N3***

 ***[7 marks]***

 **6a.** *[2 marks]*

Let  . The graph of *f* is translated 1 unit to the right and 2 units down. The graph of *g* is the image of the graph of *f* after this translation.

## Markscheme

***A1A1 N2***

***[2 marks]***

 **6b.** *[2 marks]*

## Markscheme

 (accept  ,  ) ***A1A1 N2***

***[2 marks]***

 **6c.** *[2 marks]*

## Markscheme

***A1A1 N2***

***[2 marks]***

 **7a.** *[6 marks]*

Let  and  be functions such that  .

## Markscheme

(a) (i)  ***A1 N1***

(ii) ***A1 N1***

(iii) ***A1 N1***

***[3 marks]***

(b) recognizing one transformation ***(M1)***

*eg*  horizontal stretch by  , reflection in -axis

 is (, ) ***A1A1 N3***

***[3 marks]***

***Total [6 marks]***

 **7b.** *[3 marks]*

## Markscheme

(i)  ***A1 N1***

(ii) ***A1 N1***

(iii) ***A1 N1***

***[3 marks]***

 **7c.** *[3 marks]*

## Markscheme

recognizing one transformation ***(M1)***

*eg*  horizontal stretch by  , reflection in -axis

 is (, ) ***A1A1 N3***

***[3 marks]***

***Total [6 marks]***

 **8a.** *[2 marks]*

Let  .

## Markscheme

***A1***

***A1***

***AG N0***

***[2 marks]***

 **8b.** *[8 marks]*

## Markscheme

(i) vertex is  ***A1A1 N2***

(ii)  (**must** be an equation) ***A1 N1***

(iii) ***A1 N1***

(iv) evidence of solving ***(M1)***

e.g. factorizing, formula,

correct working ***A1***

e.g.  , 

, ***A1A1 N1N1***

***[8 marks]***

 **8c.** *[2 marks]*

## Markscheme

 ***A1A1 N2***

**Note**: Award ***A1*** for a parabola opening upward, ***A1*** for vertex and intercepts in approximately correct positions.

***[2 marks]***

 **8d.** *[3 marks]*

## Markscheme

 , (accept  ,  ,  ) ***A1A1A1 N3***

***[3 marks]***

 **9a.** *[2 marks]*

Part of the graph of a function *f* is shown in the diagram below.



## Markscheme

 ***M1A1 N2***

**Note**: Award ***M1*** for evidence of reflection in *x*-axis, ***A1*** for correct vertex **and** all intercepts approximately correct.

 **9b.** *[4 marks]*

## Markscheme

(i)  ***(A1)***

***A1 N2***

(ii) translation (accept shift, slide, etc.) of ***A1A1 N2***

***[4 marks]***

 **10a.** *[2 marks]*

Consider the graph of  shown below.



## Markscheme

 ***A2 N2***

***[2 marks]***

 **10b.** *[2 marks]*

The following four diagrams show **images** of *f* under different transformations.



## Markscheme

 ***A1A1 N2***

***[2 marks]***

 **10c.** *[2 marks]*

## Markscheme

translation (accept move/shift/slide etc.) with vector ***A1A1 N2***

***[2 marks]***

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