

**TOPIC TEST**

**Non-linear functions**

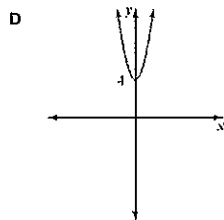
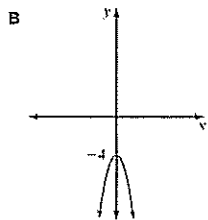
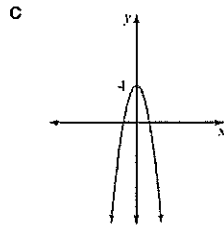
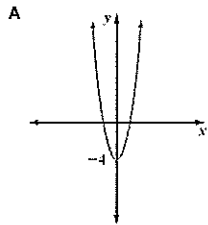
- Time allowed: 45 minutes
- Part A: 20 multiple-choice questions (20 marks)
- Part B: 9 free-response questions (30 marks)
- Total: 50 marks

**Part A**

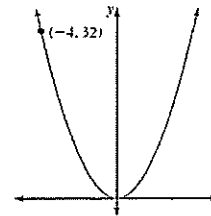
20 multiple-choice questions  
1 mark each: 20 marks  
Circle the correct answer.

- 1 If  $y = 2x^2 - 3x$ , find  $y$  when  $x = -2$ .
- A 2                      B 14  
C -10                    D -22

- 2 Which graph best represents the function  $y = 4 - 2x^2$ ?



- 3 What is the equation of this parabola?

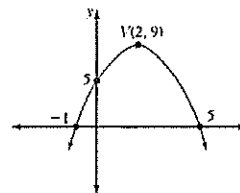


- A  $y = \frac{1}{2x^2}$   
B  $y = 2x^2$   
C  $y = \frac{1}{2}x^2$   
D  $y = -2x^2$

- 4 The function  $y = 3x^2 - 4$  has:

- A a maximum value of -4  
B a maximum value of 0  
C a minimum value of -4  
D a minimum value of 0

- 5 What could be the equation of this parabola?



- A  $y = -x^2 + 3x + 7$   
B  $y = -x^2 + 5$   
C  $y = -x^2 + 4x + 5$   
D  $y = x^2 + 5$

- 6 The points (4, -12) and (5, -12) lie on the parabola  $y = x^2 - 9x + 8$ . What is the minimum value of the parabola?

- A -12.25                B -12  
C -11.25                D 8

- 7 Which quadratic function when graphed will lie below the graph of  $y = -x^2$ ?

- I  $y = -\frac{1}{2}x^2$             II  $y = -2x^2$   
III  $y = -x^2 - 1$         IV  $y = -2x^2 + 6$   
A I only  
B II only  
C II and III  
D II and IV

- 8 Which equation is an increasing exponential function?

- A  $y = 2x^2$   
B  $y = 4(5)^{-x}$   
C  $y = \left(\frac{1}{3}\right)^x$   
D  $y = 4(0.3)^{-x}$

- 9 Which table of values represents  $y = 80(0.5)^x$ ?

A	x	1	2	3	4	5
	y	80	40	20	10	5
B	x	1	2	3	4	5
	y	80.5	81	81.5	82	82.5
C	x	1	2	3	4	5
	y	40	80	120	160	200
D	x	1	2	3	4	5
	y	40	20	10	5	2.5

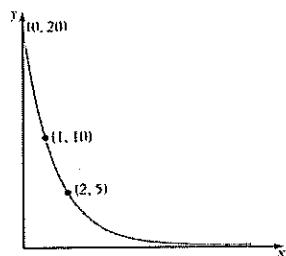
10 What is the  $y$ -intercept of the graph of  $y = 3(2^x)$ ?

- A 2                      B 3  
C 0                        D 1

11 Which function represents exponential decay?

- A  $y = 2(5^x)$   
B  $y = 3(0.2)^x$   
C  $y = \frac{3}{x}$   
D  $y = 4x^3$

12 What is the equation of this curve?



- A  $y = 20 - 2x^2$   
B  $y = 20(2)^x$   
C  $y = \frac{20}{x}$   
D  $y = 20 \left(\frac{1}{2}\right)^x$

13 Which equation's graph is a hyperbola that lies in the second and fourth quadrants?

- A  $y = \frac{5}{x}$                       B  $y = \frac{1}{2x}$   
C  $y = -\frac{3}{2x}$                     D  $y = \frac{2}{x}$

14 Which equation matches this table of values?

$x$	1	2	3	4	5
$y$	120	60	40	30	24

- A  $y = 120 - x$   
B  $y = 120 - x^2$   
C  $y = \frac{120}{x}$   
D  $y = \frac{x}{120}$

15 If  $y = \frac{k}{x}$  and  $y = 4$  when  $x = 2$ , find  $k$ .

- A 2                              B  $\frac{1}{2}$   
C  $\frac{1}{4}$                               D 8

16 Which formula below shows density ( $d$ ) varying inversely with volume ( $V$ )?

- A  $d = \frac{V}{k}$                       B  $d = \frac{k}{V}$   
C  $d = kV$                      D  $d = k - V$

17 If  $m$  varies inversely as  $n$ , and  $m = 16$  when  $n = 0.75$ , what is  $m$  when  $n = 6$ ?

- A  $\frac{1}{2}$                               B  $\frac{1}{3}$   
C 1                                D 2

18 The volume,  $V \text{ cm}^3$ , of a gas varies inversely as the pressure,  $p \text{ kg/cm}^2$ , exerted on it. Under a pressure of  $30 \text{ kg/cm}^2$ , the volume of a particular gas is  $240 \text{ cm}^3$ . What pressure would need to be exerted on the gas for its volume to be  $180 \text{ cm}^3$ ?

- A  $40 \text{ kg/cm}^2$   
B  $4 \text{ kg/cm}^2$   
C  $400 \text{ kg/cm}^2$   
D  $22.5 \text{ kg/cm}^2$

19 The population of Eastside in 2020 is decreasing exponentially according to the formula  $P = 40\,000(0.6)^t$ .

At the same time, the population of Westside is increasing exponentially according to the formula  $P = 16\,000(1.05)^t$ . What is the expected difference in their populations in 2023?

- A 3240  
B 8725  
C 9882  
D 9892

20 James invests  $\$8000$  at 6% p.a. compound interest for 8 years. This can be modelled by:

- A a quadratic function  
B an increasing exponential function  
C a decreasing exponential function  
D a hyperbolic function

Part B

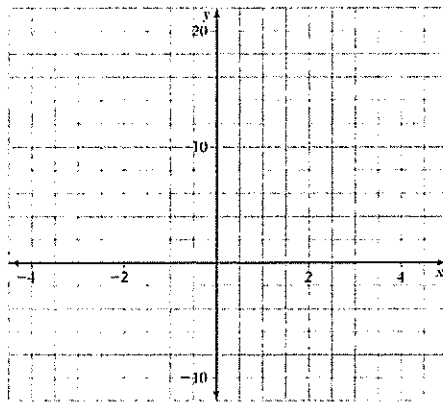
9 free-response questions.  
30 marks  
Show all working

21 a Complete the table of values for  $y = 2x^2 - 8x + 11$ .

$x$  0 1 2 3 4

$y$

b Graph this quadratic function on the axes below.



c What are the coordinates of the vertex?

[4 marks]

22 Describe how the graph of  $y = -\frac{1}{2}x^2$  compares with the graph of  $y = x^2$ .

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[2 marks]

23 A ball is thrown vertically upwards from the ground. Its height ( $h$  metres) after  $t$  seconds is given by  $h = 30t - 5t^2$ .

a Complete the table of values for this quadratic function.

$t$  0 1 2 3 4 5 6

$h$

b Draw a sketch graph of the parabola.

c What are the coordinates of the vertex of the parabola and what does this mean?

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d What are the  $t$ -intercepts (horizontal intercepts) and what do they signify?

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e Explain why  $t$  cannot take values outside this range.

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[6 marks]

- 24 Farmer Fran has 32 m of fencing and wants to build a rectangular enclosure for her goose. Let  $x$  be the width of the enclosure and let  $y$  be the length of the enclosure in metres.
- Express the perimeter of the enclosure in terms of  $x$  and  $y$ .  
\_\_\_\_\_
  - Show that  $y = 16 - x$ .  
\_\_\_\_\_  
\_\_\_\_\_
  - Hence show that the area of the enclosure,  $A$  m<sup>2</sup>, is given by the function  $A = 16x - x^2$ .  
\_\_\_\_\_
  - Complete the table of values and find the largest possible area of the enclosure.  

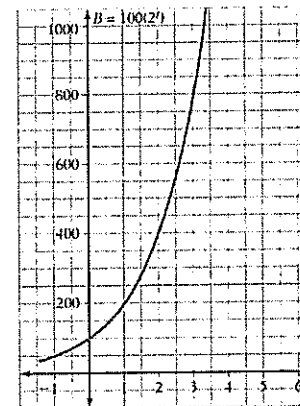
$x$	0	4	8	12	16
$A$					
  - What do you notice about the shape of the enclosure that gives the maximum area?  
\_\_\_\_\_

[6 marks]

- 25 A vehicle purchased for \$28 400 loses 7% p.a. of its value ( $V$ ) at the end of the previous year ( $n$ ). Write an equation for the value  $V$  in terms of  $n$ .  
\_\_\_\_\_

[1 marks]

- 26 The number of bacteria on a hamburger grows exponentially according to the function  $B = 100(2^t)$ , where  $B$  is the number of bacteria on the hamburger and  $t$  is the number of hours after the hamburger is cooked. The graph of this function is shown.



- How many bacteria were on the hamburger when it was cooked?  
\_\_\_\_\_
- How many bacteria were on the hamburger 3 hours after it was cooked?  
\_\_\_\_\_
- Use the graph to determine how long after cooking there were 550 bacteria on the hamburger.  
\_\_\_\_\_

[3 marks]

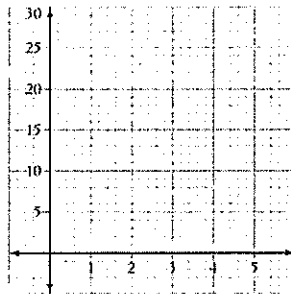
- 27 The population of a bird species is declining according to the formula  $P = 20\,000(0.908)^t$ , where  $t$  is the number of years. What percentage of the initial population is expected to remain after 10 years? Answer correct to 1 decimal place.  
\_\_\_\_\_

[2 marks]

28 a Complete this table of values for the function  $y = \frac{30}{x}$ .

$x$	1	2	3	4	5
$y$					

b Graph  $y = \frac{30}{x}$  on the axes below.



c Use the graph to estimate the value of  $x$  when  $y = 7$ . \_\_\_\_\_  
 [3 marks]

29 Rose has a free-range poultry farm. The number of birds ( $N$ ) she can accommodate varies inversely with the amount of space ( $S$ ) allowed per bird. If  $23 \text{ m}^2$  of space is allowed per bird, she can run 247 birds. How many birds can be accommodated if  $19 \text{ m}^2$  of space is allowed per bird?

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[3 marks]

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**Answers**

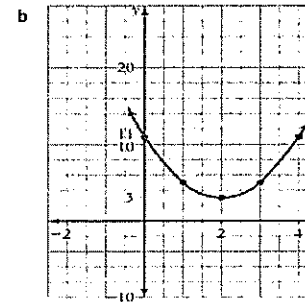
**Part A**

- |      |      |      |      |      |
|------|------|------|------|------|
| 1 B  | 2 C  | 3 B  | 4 C  | 5 C  |
| 6 A  | 7 C  | 8 D  | 9 D  | 10 B |
| 11 B | 12 D | 13 C | 14 C | 15 D |
| 16 B | 17 A | 18 A | 19 C | 20 B |

**Part B**

21 a

$x$	0	1	2	3	4
$y$	11	5	3	5	11

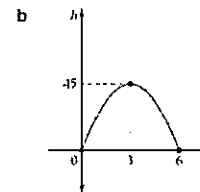


c  $V(2, 3)$

22 Concave down instead of concave up and flatter.

23 a

$t$	0	1	2	3	4	5	6
$h$	0	25	40	45	40	25	0



c  $V(3, 45)$ . The ball has reached its maximum height of 45 m after 3 seconds.

d 0 and 6. The ball starts at ground level and hits the ground again after 6 seconds.

e  $t$  represents time, so it cannot be negative. The ball hits the ground after 6 seconds, so it cannot continue downward.

24 a  $2x + 2y = 32$

b  $2y = 32 - 2x, y = 16 - x$

c  $A = lw$   
 $= x(16 - x)$   
 $= 16x - x^2$

d Maximum area =  $64 \text{ m}^2$

$x$	0	4	8	12	16
$A$	0	48	64	48	0

e The rectangle is a square, since  $x = y = 8 \text{ m}$ .

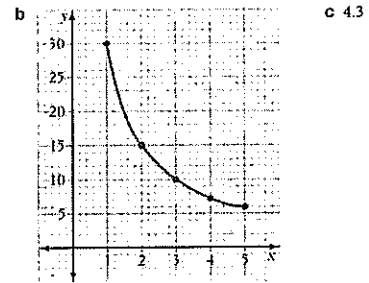
25  $V = 28\,400(0.93)^n$

26 a 100      b 800      c 2.5 hours

27 38.1%

28 a

$x$	1	2	3	4	5
$y$	30	15	10	7.5	6



27 299 birds