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VCE Mathematical Methods ½
Functions & Relations I [2.1]
Test Solutions

37 Marks. 39 Minutes Writing.

Results:

Test Questions	_____ / 29
Extension Test Questions	_____ / 8

Section A: Test Questions (29 Marks)

Question 1 (5 marks)

Tick whether the following statements are **true** or **false**.

Statement	True	False
a. Positive hyperbolas generally take up the 1^{st} and 3^{rd} quadrants.	✓	
b. To find the equation of a hyperbola, you can use three points that it passes through.	✓	
c. Truncus can be both above and below the asymptote at the same time.		✓
d. All points on the circle can have different distances from the centre.		✓
e. The graph of $y = -\sqrt{2-x} + 1$ starts from $(2,1)$ and continues infinitely into the quadrant 4. It goes southwest.		✓
f. Root functions get steeper as it travels towards positive or negative infinity. We will discuss this more later!		✓
g. Left and right semicircles are given by making the x value the subject from the circle.	✓	
h. $y = \pm\sqrt{r^2 - (x-h)^2} + k$ is an equation of a semicircle. If we keep both $\pm$ then it's a circle.		✓
i. Circles do not pass a vertical line test and a horizontal line test.	✓	
j. All functions are relations, but not all relations are functions.	✓	

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Question 2 (5 marks)

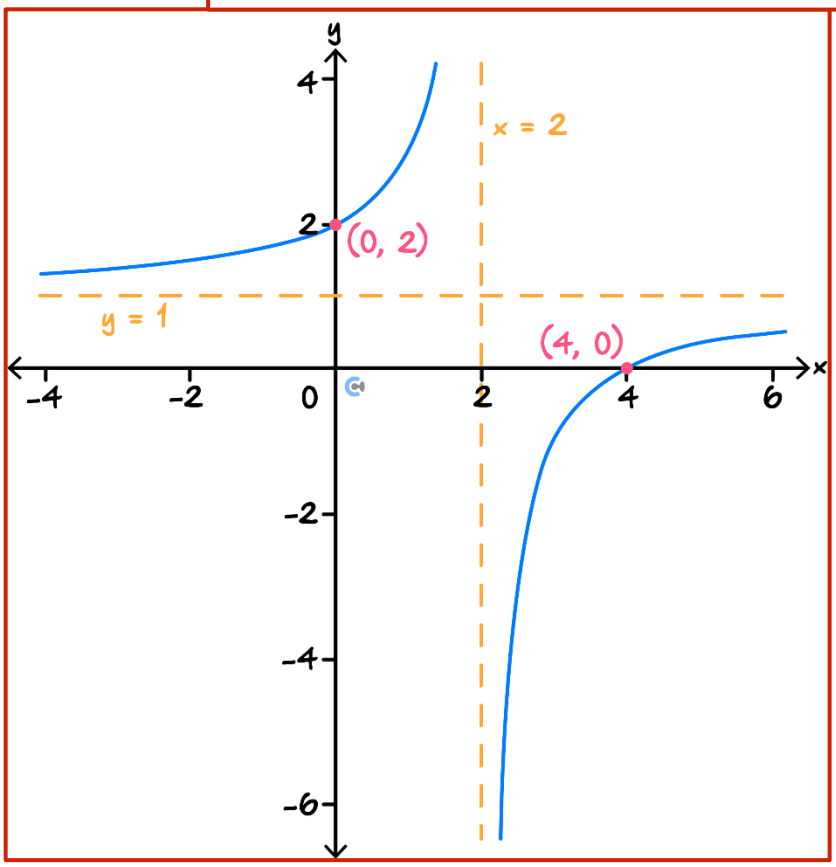
Let $f: D \to R, f(x) = \frac{x-4}{x-2}$.

a. Express f in the form $a + \frac{b}{x-2}$, stating the values of a and b. (1 mark)

$a = 1$ and $b = -2$

b. Sketch the graph of $y = 1 - \frac{2}{x-2}$ on the axes below. Label asymptotes with their equations and axis intercepts with their coordinates. (3 marks)

Asym at $x = 2$ and $y = 1$. x-int (4,0) and y-int (0,2)

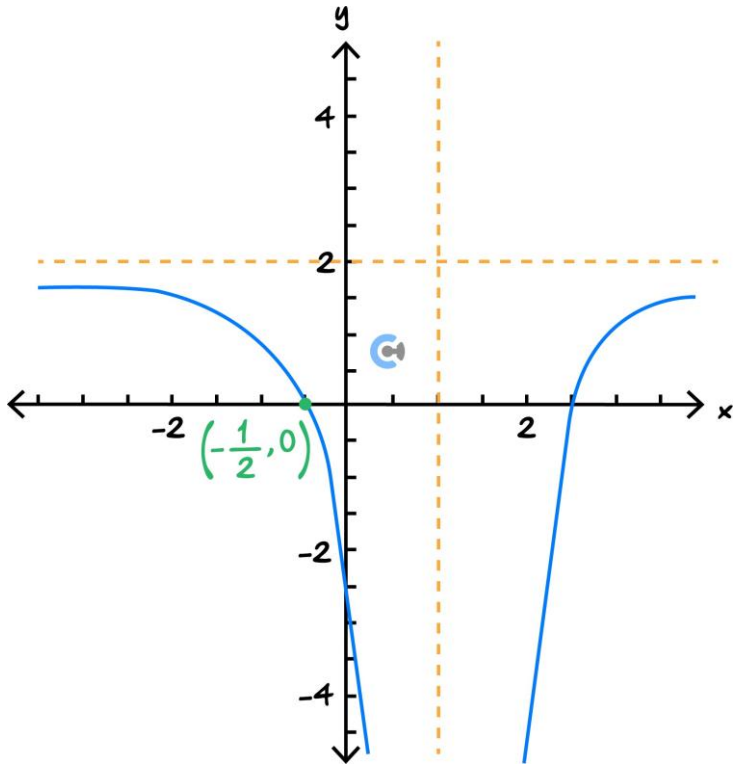


c. Find the values of x for which $1 - \frac{2}{x-2} \geq 3$. (1 mark)

$1 \leq x < 2$

Question 3 (3 marks)

Part of the graph of the function with the equation $y = \frac{a}{(x+b)^2} + c$ is shown below. Find the values of a, b, c. Show your working.



$$a = -\frac{9}{2}, b = -1, c = 2$$

Comparing the equation with the standard form

$$y = \frac{a}{(x-h)^2} + k$$

h , k are vertical and horizontal asymptotes respectively.

$$Therefore, h = 1, k = 2$$

$$On\ comparing\ with\ y = \frac{a}{(x+b)^2} + c \Rightarrow b = -1, c = 2$$

$$At\ y = 0, x = -\frac{1}{2}$$

$$0 = \frac{a}{\left(-\frac{1}{2} - 1\right)^2} + 2$$

$$a = -\frac{9}{2}$$

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Question 4 (6 marks)

The function defined by $y = a\sqrt{x-h} + k$, where a, h and k are non-zero integers, has a y-intercept at $(0, 2\sqrt{3} - 3)$ and has an endpoint at $(-3, -3)$.

a. Determine the values of a, h and k. (2 marks)

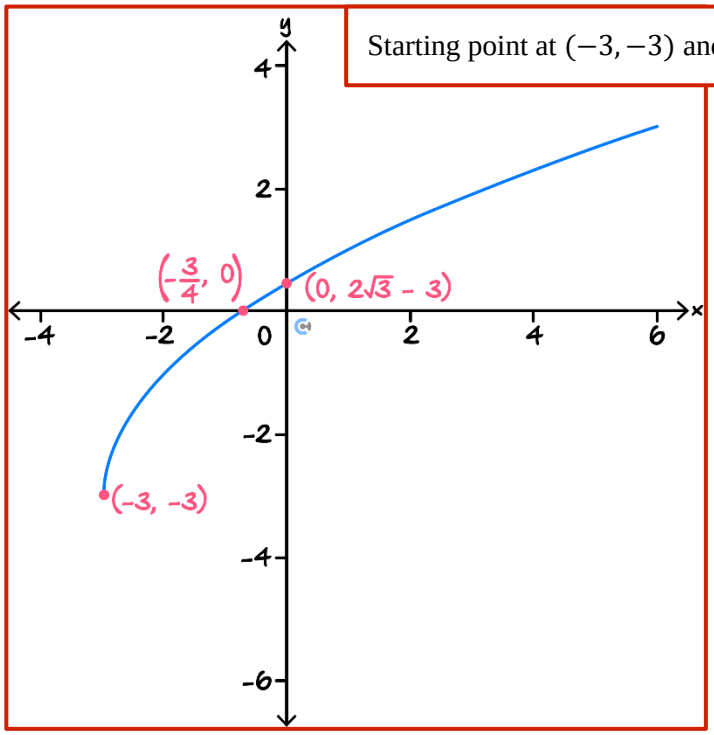
$a = 2, h = -3$ and $k = -3$

b. Find the coordinates of the x-intercept. (2 marks)

$\left(-\frac{3}{4}, 0\right)$

c. Sketch the graph of the function on the axis below, labelling all key features. (2 marks)

Starting point at $(-3, -3)$ and $\left(-\frac{3}{4}, 0\right)$ and $(0, 2\sqrt{3} - 3)$



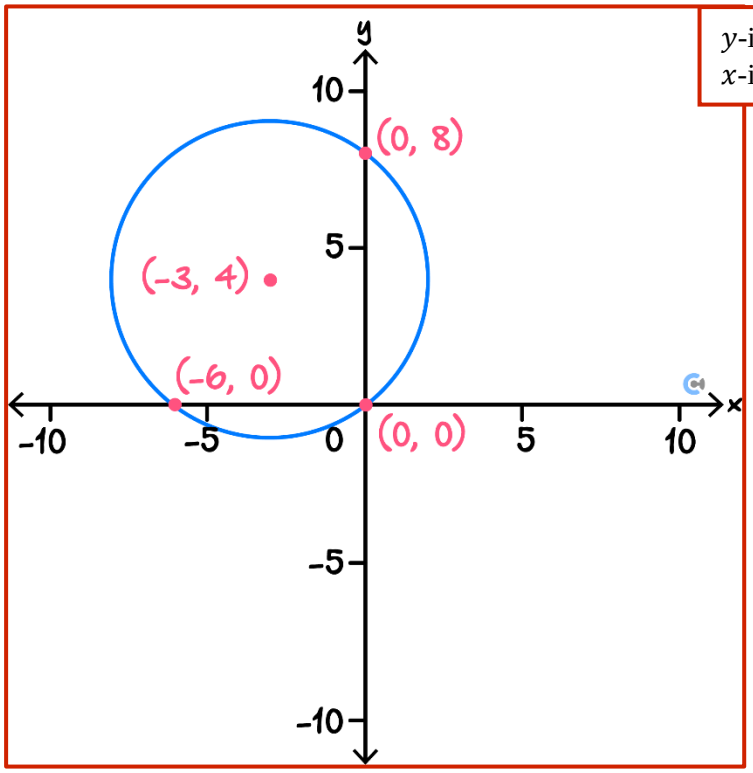
Question 5 (7 marks)

For the relation defined by $(x+3)^2+(y-4)^2=25$.

a. Find the radius and centre of the equation. (1 mark)

$r=5, C:(-3,4)$

b. Graph the relation, labelling all the coordinates of the axial intercepts. (3 marks)



y-int: (0,8) and (0,0)
x-int: $(-6,0)$ and (0,0)

c. State the domain and the range of the relation. (1 mark)

Dom: $[-8,2]$
Range: $[-1,9]$

d. Find the equation of the semicircle derived from this relation, given that it passes through $(-3, -1)$ and is considered to be a function. (2 marks)

$$y = -\sqrt{25 - (x + 3)^2} + 4$$

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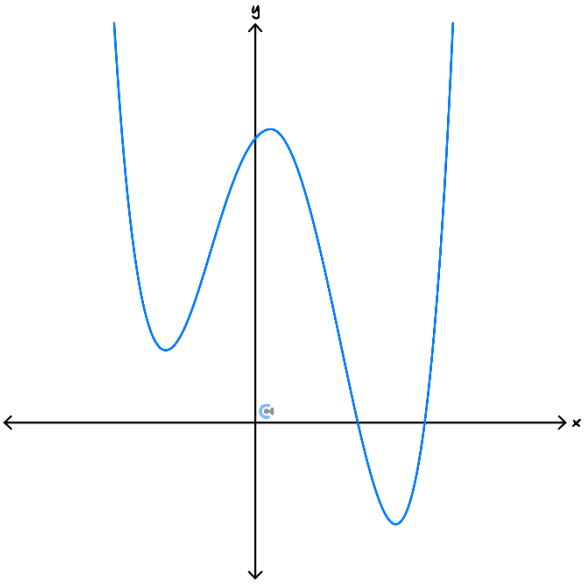
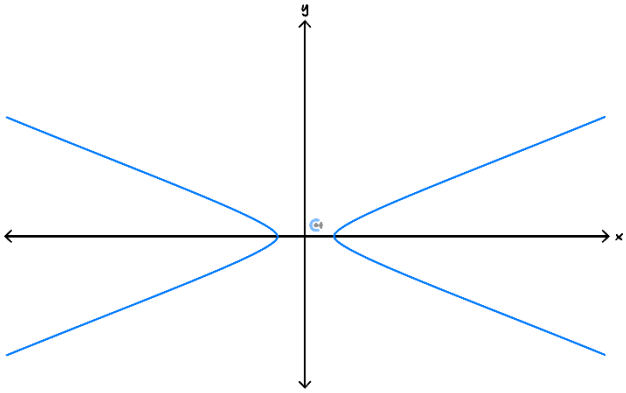
Question 6 (1 mark)

Label the following graphs as being either a function or a relation.



Function



Relation

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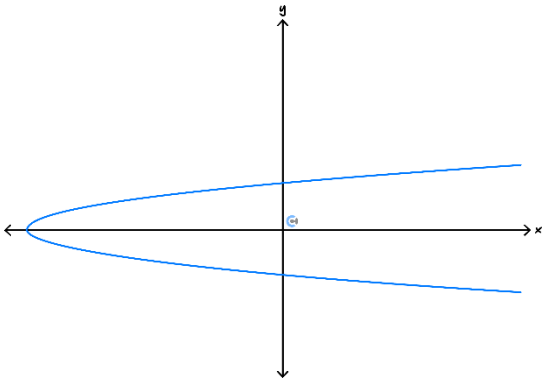
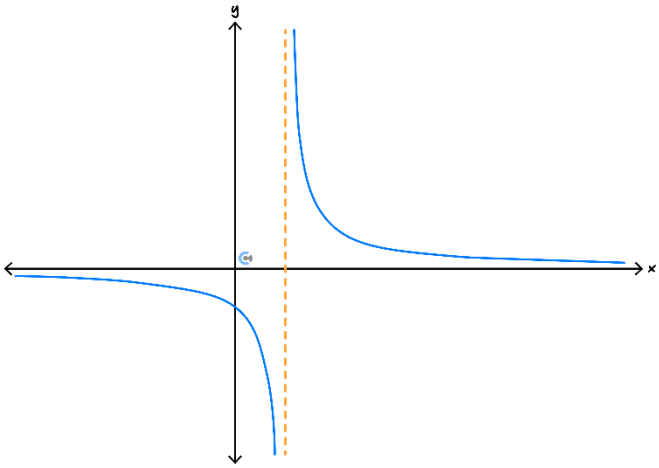
Question 7 (2 marks)

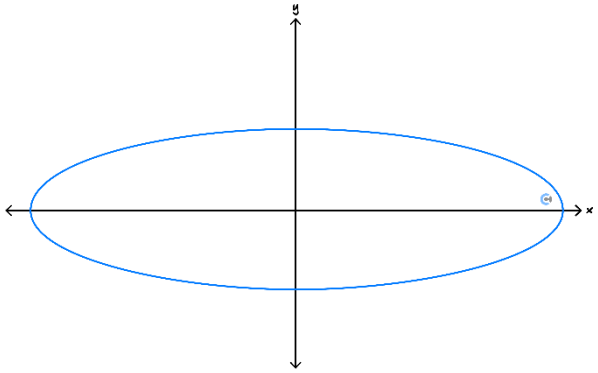
Label the following graphs as being either: one to one, one to many, many to one or many to many.



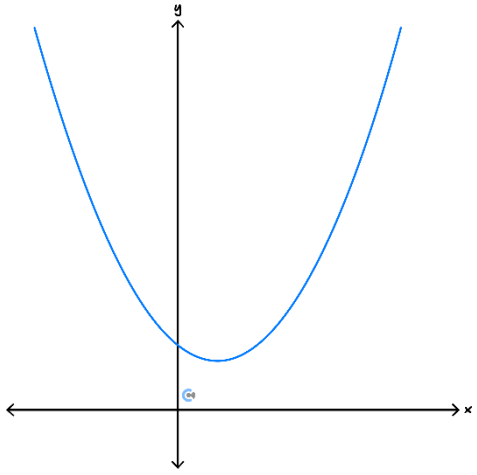
One to many



One to one



Many to many



Many to one

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Section B: Extension Test Questions (8 Marks)

Question 8 (8 marks) **Tech-Active.**

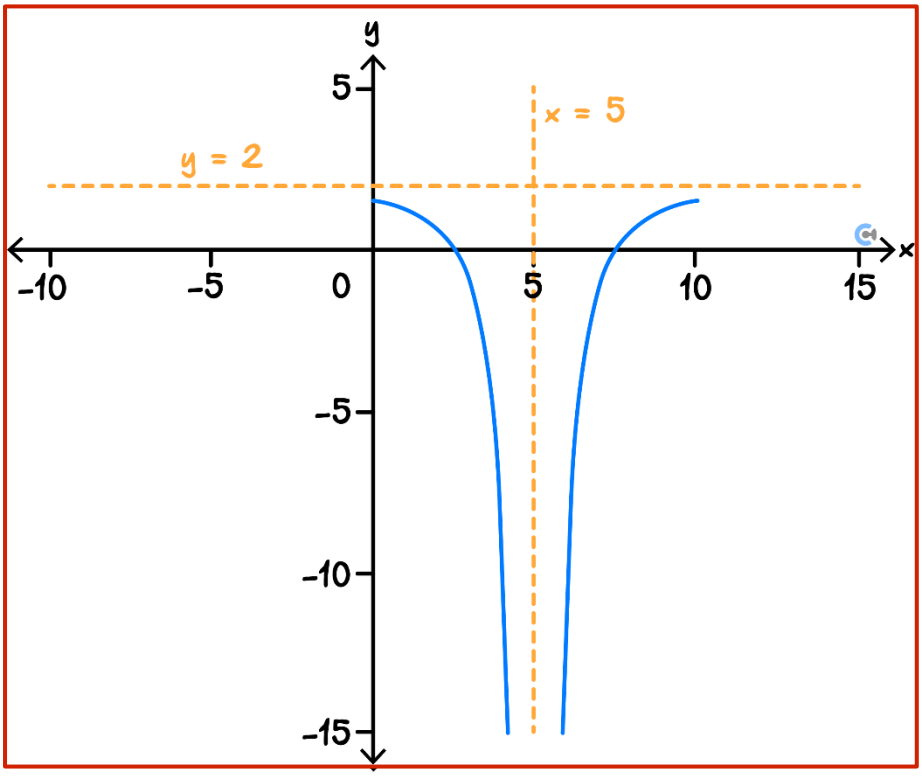
The cross-section of a water cleft is modelled with the equation $h = -\frac{12}{(x-5)^2} + 2, 0 \leq x \leq 10$ where h is the height in metres above the water's surface, and x is the horizontal distance from the warning sign (origin).

a. Find the x-intercept of the function and, hence, find the width of the cleft at the water surface. (2 marks)

```
Solve[f[x] == 0, x]
|풀이 함수
{{x → 5 - √6}, {x → 5 + √6}}

(* Distance is 2√6 *)
```

b. Sketch the graph of $h = \frac{-12}{(x-5)^2} + 2$ for $0 \leq x \leq 10$, labelling all axial intercepts and endpoints. (2 marks)



Asymptote $x = 5$ & $y = 2$ and x-intercepts solved above.

c. What's the width of the cleft at 0.5 metres above the water surface? (2 marks)

```
Solve[h[x] == 1/2, x]
|풀이 함수
{{x → 5 - 2 √2}, {x → 5 + 2 √2}}

(* ANS: 4√2 *)
```

It is known that at a metres below the water surface, the width of the cleft is given by 3 m.

d. Find the value of a. (2 marks)

Solve $h(x) = h(x-3)$

$$x = \frac{13}{2}$$

$$h\left(\frac{13}{2}\right) = -\frac{10}{3}$$

$$a = \frac{10}{3}$$

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