

VCE Specialist Mathematics Units 3&4

Written Examination 2

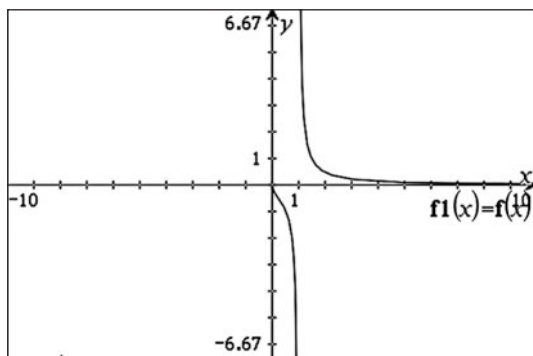
Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

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

Question 1 B

Sketching the graph of $f(x)$ using a CAS calculator gives:



Thus, finding the solutions of $f(x)$ when $x \geq 0$ gives:

$f(x) := \frac{\sqrt{x}}{x^2 - 1}$ Done
 solve $\left(\frac{d^2}{dx^2}(f(x)) = 0, x \right) | x \geq 0$
 $x = \frac{\sqrt{15 \cdot (4 \cdot \sqrt{6} - 9)}}{15}$

Since $\frac{d^2}{dx^2}$ has one solution in its domain, the graph has one inflection point.

Question 2 D

D is correct. Letting P represent ' n divisible by 10' and Q represent ' n divisible by 5' gives 'if P , then Q '. Therefore, the converse of this statement is 'if Q , then P ', or 'if n is divisible by 5, then it is divisible by 10'.

A is incorrect. This statement is 'if not P , then Q '.

B is incorrect. This statement is 'if not P , then not Q '.

C is incorrect. This statement is 'if P , then not Q '.

E is incorrect. This statement is 'if not Q , then not P '.

Question 3 E

Using a CAS calculator gives:

$$\frac{|0 - 2 \cdot 0 + 3 \cdot 0 - 5|}{\sqrt{1^2 + (-2)^2 + 3^2}} = \frac{5 \cdot \sqrt{14}}{14}$$

$$\frac{5\sqrt{14}}{14} = \frac{5}{\sqrt{14}}$$

Question 4 D

Given that $\tan\left(-\frac{3\pi}{4}\right) = 1$:

$$\frac{a}{5} = 1$$

$$a = 5$$

Question 5 C

C cannot be correct and is therefore the required response. Since complex roots occur in conjugate pairs, there must be an odd number of real roots. It is given that $3 - i$ is a root.

A can be correct and is therefore not the required response. $3 - i$ is a root.

B can be correct and is therefore not the required response. By the conjugate root theorem, $3 + i$ is also a root.

D and **E** may be correct and are therefore not the required response. There are two possibilities for the remaining three roots.

- Two of the roots are non-real (conjugate points) and one is real. Hence, $P(z) = 0$ has one real root only. Therefore, **D** might be correct.
- All three roots are real. Hence, $P(z) = 0$ has two non-real roots. Therefore, **E** might be correct.

Question 6 A

Using complementary angles gives:

$$z = \sin(\theta) - i \cos(\theta)$$

$$= \cos\left(\frac{\pi}{2} - \theta\right) - i \sin\left(\frac{\pi}{2} - \theta\right)$$

$$= \cos\left(\theta - \frac{\pi}{2}\right) + i \sin\left(\theta - \frac{\pi}{2}\right)$$

$$z^6 = \cos(6\theta - 3\pi) + i \sin(6\theta - 3\pi)$$

$$= \cos(6\theta - \pi) + i \sin(6\theta - \pi)$$

$$= \cos(\pi - 6\theta) - i \sin(\pi - 6\theta)$$

$$= -\cos(6\theta) - i \sin(6\theta)$$

Question 7 B

Using a CAS calculator gives:

$a := [1 \quad -3 \quad 2]$	$[1 \quad -3 \quad 2]$
$b := [6 \quad -7 \quad 2]$	$[6 \quad -7 \quad 2]$
$\frac{180}{\pi} \cdot \cos^{-1}\left(\frac{ \text{dotP}(a,b) }{\text{norm}(a) \cdot \text{norm}(b)}\right)$	28.5718

Question 8 C

$$u = 1 - x$$

$$du = -dx$$

$$x = 1 - u$$

Therefore:

$$-\int_1^0 (2-u)\sqrt{u} du = \int_0^1 (2u^{\frac{1}{2}} - u^{\frac{3}{2}}) du$$

Question 9 B

Considering the second derivative and finding the values of a that will give a positive discriminant gives:

$f(x) := a \cdot x^4 - 3 \cdot x^3 - 5 \cdot x^2$	Done
$fdd(x) := \frac{d^2}{dx^2}(f(x))$	Done
$fdd(x)$	$12 \cdot a \cdot x^2 - 18 \cdot x - 10$
$\text{solve}\left((-18)^2 - 4 \cdot 12 \cdot a \cdot -10 > 0, a\right)$	$a > \frac{-27}{40}$

Question 10 D

Finding the direction vector:

$$\begin{aligned} \underline{v} &= (2-1)\underline{i} + (1-(-2))\underline{j} + (-3-2)\underline{k} \\ &= \underline{i} + 3\underline{j} - 5\underline{k} \end{aligned}$$

D does not describe a line that passes through the two points and is therefore the required response. This vector equation does not use a multiple of $\underline{v}$ from point $(2, 1, -3)$ or $(1, -2, 2)$.

A describes a line that passes through the two points and is therefore not the required response. This vector equation is reached by multiplying $\underline{v}$ by t from point $(1, -2, 2)$.

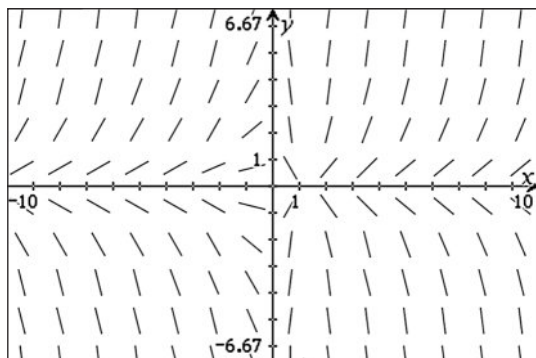
B describes a line that passes through the two points and is therefore not the required response. This vector equation is reached by multiplying $\underline{v}$ by $-t$ from point $(2, 1, -3)$.

C describes a line that passes through the two points and is therefore not the required response. This vector equation is reached by multiplying $\underline{v}$ by $2t$ from point $(1, -2, 2)$.

E describes a line that passes through the two points and is therefore not the required response. This vector equation is reached by multiplying $\underline{v}$ by $-t$ from point $(1, -2, 2)$.

Question 11 A

A is correct. Using a CAS calculator to verify the direction field of $\frac{dy}{dx} = \frac{xy}{x-1}$ gives:



B is incorrect. The direction field shows that $\frac{dy}{dx} > 0$ in the second quadrant. However, $\frac{xy}{1-x} < 0$.

C and E are incorrect. The direction field shows that $\frac{dy}{dx}$ is defined when $y = 1$.

D is incorrect. The direction field shows that $\frac{dy}{dx} = 0$ when either x or y is equal to zero. Hence, x and y need to be factors in the numerator.

Question 12 C

$$\begin{aligned}
 \frac{dm}{dt} &= \text{inflow} - \text{outflow} \\
 &= (5 \text{ grams/L} \times 2 \text{ L/min}) - \left(\frac{1 \text{ gram/L} \times m \text{ grams}}{3 \text{ L} + (2 \text{ L/min} - 1 \text{ L/min})t \text{ min}} \right) \\
 &= (5 \times 2) - \frac{1 \times m}{3 + (2 - 1)t} \\
 &= 10 - \frac{m}{3 + t}
 \end{aligned}$$

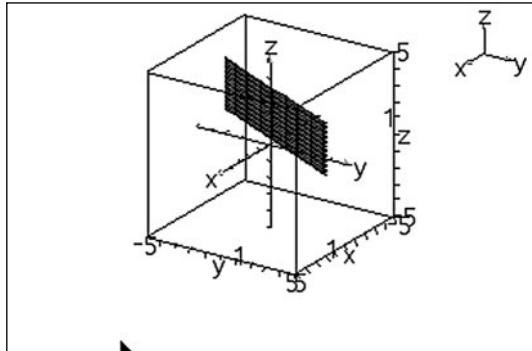
Question 13 C

Using a CAS calculator gives:

$a := [2 \ 3 \ p]$	$[2 \ 3 \ p]$
$b := [3 \ -2 \ 4]$	$[3 \ -2 \ 4]$
$c := [1 \ -2 \ q]$	$[1 \ -2 \ q]$
solve($a = m \cdot b + n \cdot c, m, n$)	
$m = \frac{7}{4}$ and $n = \frac{-13}{4}$ and $p = \frac{-(13 \cdot q - 28)}{4}$	

Question 14 C

Using a CAS calculator gives:



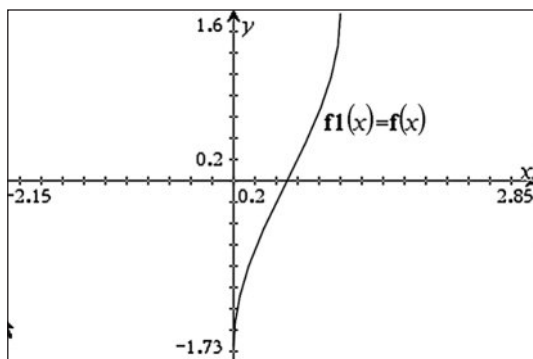
In three dimensions, $y = 2x + 1$ means that for any valid (x, y) pair, the z -coordinate can be any number. The plane will be parallel to the z -axis since (x, y) pairs are independent of z .

Question 15 D

The features of the graph need to be investigated before the correct definite integral expression is set.

Using a CAS calculator gives:

$f(x) := \sin^{-1}(2 \cdot x - 1)$	<i>Done</i>
$\text{domain}(f(x), x)$	$0 \leq x \leq 1$
$\text{solve}(f(x) = 0, x)$	$x = \frac{1}{2}$



Thus, finding the surface area of the solid of revolution gives:

$$2 \cdot 2 \cdot \pi \cdot \int_{\frac{1}{2}}^1 \left(f(x) \cdot \sqrt{1 + \left(\frac{d}{dx}(f(x)) \right)^2} \right) dx$$

16.0601

Question 16 D

Using a CAS calculator gives:

$v(x) := 2 \cdot \sin(x)$	<i>Done</i>
$\frac{1}{2} \cdot \frac{d}{dx} \left((v(x))^2 \right)$	$4 \cdot \sin(x) \cdot \cos(x)$

$$4\sin(x)\cos(x) = 2 \times 2\sin(x)\cos(x) \\ = 2\sin(2x)$$

Question 17 E

The given algorithm is used to apply Euler's method to approximate the solution of the differential equation $\frac{dy}{dx} = x^2 - 3y$.

Entering the following information into a CAS calculator gives:

- function expression: $x^2 - 3y$
- independent variable: x
- dependent variable: y
- initial x -value: 3
- final x -value: $3 + 6 \times 0.2 = 4.2$
- initial y -value: 2
- increment: 0.2

$\text{euler}(x^2 - 3 \cdot y, x, y, \{3, 4.2\}, 2, 0.2)$				
3.4	3.6	3.8	4.	4.2
.088	3.5472	4.01088	4.49235	4.99694

Question 18 E

Using a CAS calculator gives:

$m := \frac{95.3 + 110.6}{2}$	102.95
$z := -\text{invNorm}\left(\frac{1 - 0.95}{2}, 0, 1\right)$	1.95996
$\text{solve}\left(m - 95.3 = \frac{z \cdot s}{\sqrt{80}}, s\right)$	$s = 34.9107$

Question 19 E

Using a CAS calculator gives:

$\text{normCdf}\left(-\infty, 34, 32, \frac{4}{\sqrt{6}}\right)$	0.889664
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Question 20 D

D is correct. For a one-tailed test performed at a 5% level of significance, H_0 should be rejected if $p < 0.05$.
As $0.04 < 0.05$, H_0 should be rejected.

A is incorrect. As $0.005 < 0.05$, H_0 should be rejected.

B is incorrect. As $0.07 > 0.05$, H_0 should not be rejected.

C is incorrect. As $p > 0.06$ is greater than 0.05, H_0 should not be rejected.

E is incorrect. As $p < 0.04$ is less than 0.05, H_0 should be rejected.

SECTION B

Question 1 (7 marks)

- a. i. Subtracting the coordinates of A from D gives $\overrightarrow{AD} = -6\mathbf{i} + \mathbf{j} - \mathbf{k}$.

Method 1:

$$\mathbf{r} = (2-6t)\mathbf{i} + (-1+t)\mathbf{j} + (6-t)\mathbf{k} \quad \text{A1}$$

Method 2:

$$\mathbf{r} = (-4-6t)\mathbf{i} + t\mathbf{j} + (5-t)\mathbf{k} \quad \text{A1}$$

Note: Students may reach either vector equation depending on the method used.

- ii. **Method 1:**

$$2-6t = -10$$

$$t = 2$$

$$-1+t = m$$

$$-1+2 = m$$

$$m = 1$$

$$6-t = n$$

$$6-2 = n$$

$$n = 4$$

values for m and n A1

Method 2:

$$-4-6t = -10$$

$$t = 1$$

$$t = m = 1$$

$$5-t = n$$

$$5-1 = n$$

$$n = 4$$

values for m and n A1

Note: Consequential on answer to Question 1a.i. Students should reach the same answer using either method.

- b. The vectors $\overrightarrow{AB}$ and $\overrightarrow{AC}$ can be obtained by subtracting the coordinates of A from B and C , respectively.

$$\overrightarrow{AB} = 2\mathbf{i} + 9\mathbf{j} - 7\mathbf{k}, \overrightarrow{AC} = -8\mathbf{i} + 4\mathbf{j} - 4\mathbf{k} \quad \text{M1}$$

$$\overrightarrow{AB} \times \overrightarrow{AC} = -8\mathbf{i} + 64\mathbf{j} + 80\mathbf{k} \quad \text{A1}$$

Substituting point A into the vector gives:

$$-8(x-2) + 64(y+1) + 80(z-6) = 0$$

$$-x + 8y + 10z - 50 = 0 \quad \text{OR} \quad x - 8y - 10z + 50 = 0 \quad \text{A1}$$

$u := [2 \ 9 \ -7]$	$[2 \ 9 \ -7]$
$v := [-8 \ 4 \ -4]$	$[-8 \ 4 \ -4]$
$\text{crossP}(u, v)$	$[-8 \ 64 \ 80]$
$-8 \cdot (x-2) + 64 \cdot (y+1) + 80 \cdot (z-6) = 0$ $-8 \cdot x + 64 \cdot y + 80 \cdot z - 400 = 0$	

c. $\underline{v} = -6\underline{i} + \underline{j} - \underline{k}$

$\underline{n} = -8\underline{i} + 64\underline{j} + 80\underline{k}$

$$\sin^{-1}\left(\frac{|\underline{v} \cdot \underline{n}|}{|\underline{v}||\underline{n}|}\right) = \sin^{-1}\left(\frac{2\sqrt{6270}}{3135}\right)$$

M1

$$\approx 2.9^\circ$$

A1

$\underline{v} := [-6 \ 1 \ -1]$	$[-6 \ 1 \ -1]$
$\underline{n} := [-8 \ 64 \ 80]$	$[-8 \ 64 \ 80]$
$\sin^{-1}\left(\frac{ \text{dotP}(\underline{v}, \underline{n}) }{\text{norm}(\underline{v}) \cdot \text{norm}(\underline{n})}\right)$	$\sin^{-1}\left(\frac{2 \cdot \sqrt{6270}}{3135}\right)$
$\sin^{-1}\left(\frac{2 \cdot \sqrt{6270}}{3135}\right) \cdot 180$	2.89557
$\frac{\sin^{-1}\left(\frac{2 \cdot \sqrt{6270}}{3135}\right) \cdot 180}{\pi}$	

Note: Consequential on answers to Questions 1a.i. and 1b.

Question 2 (9 marks)

a.

$f(x) := \frac{x^3 - 2 \cdot x^2}{x^2 - 5 \cdot x + 6}$	Done
$\triangle \text{ expand}(f(x))$	$\frac{9}{x-3} + x + 3$

$$x = 3$$

A1

$$y = x + 3$$

A1

Note: Deduct a maximum of 1 mark for any additional asymptotes stated.

b. $f(x) = 9(x-3)^{-1} + x - 3$

$$f'(x) = -9(x-3)^{-2} + 1$$

M1

$$f''(x) = 18(x-3)^{-3}$$

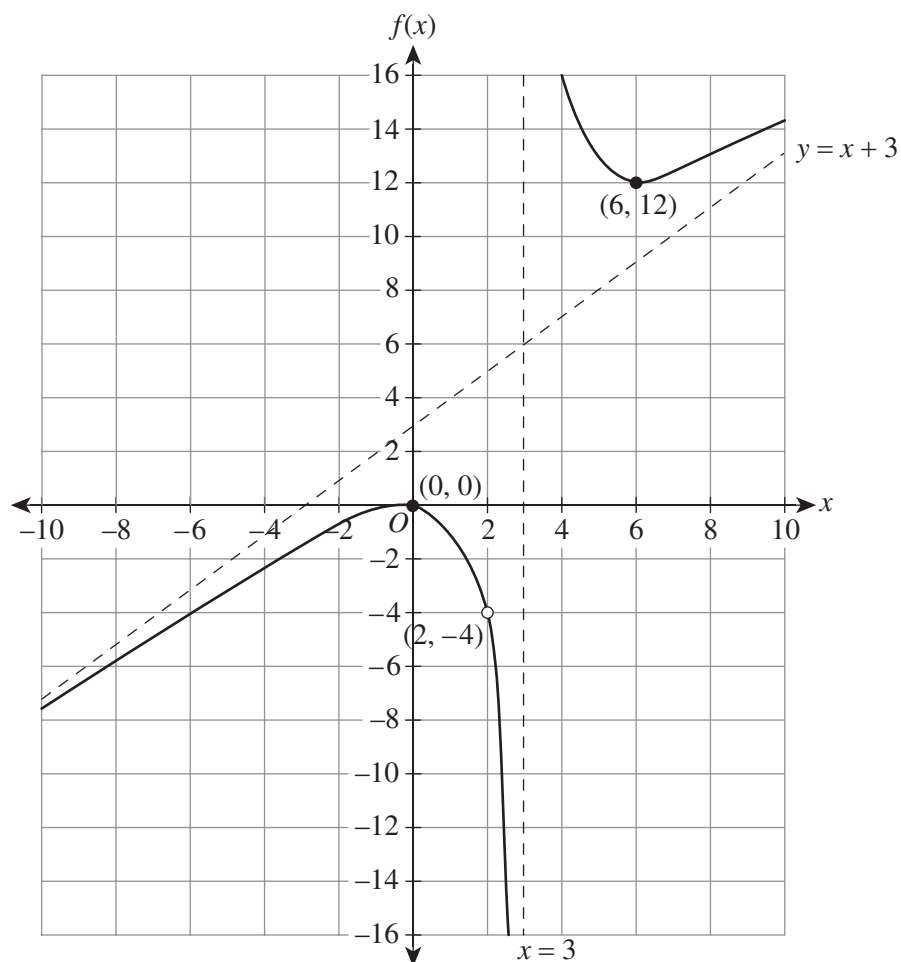
$$= \frac{18}{(x-3)^3}$$

M1

$$f''(x) = 0 \text{ has no solutions. Therefore, } f(x) \text{ has no points of inflection.}$$

M1

c.



correct shape, including asymptotical behaviour A1
correct asymptotes and key points A1

d. $g(x) = \frac{x^2(x+p)}{x^2+qx+r}$

Relationship 1: $(x+p)$ is a common factor.

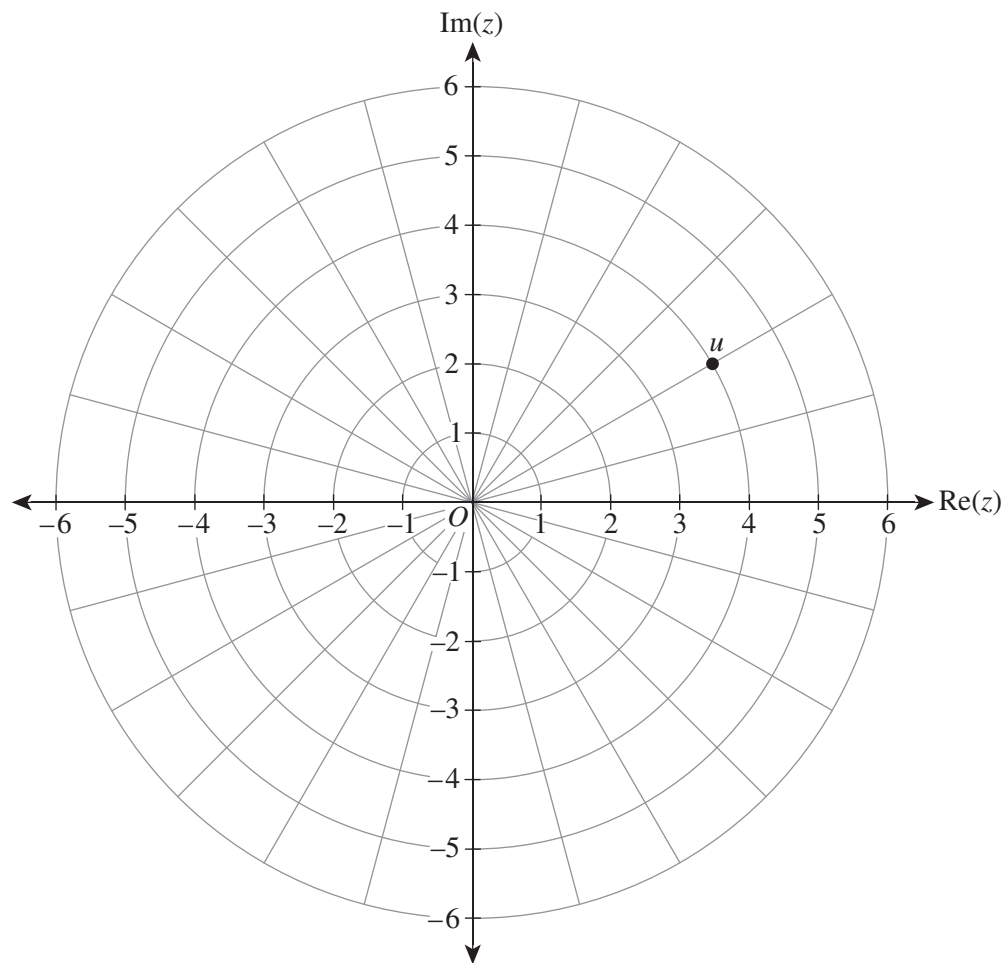
$$\therefore p^2 - pq + r = 0$$

A1

Relationship 2: The denominator is a perfect square.

$$\therefore q^2 - 4r = 0$$

A1

Question 3 (12 marks)**a.***correct point A1***b.** By the conjugate root theorem, the other solution is $2\sqrt{3} - 2i$.

A1

A quadratic equation with roots z_1 and z_2 can be written as $z^2 - (z_1 + z_2)z + z_1z_2 = 0$.

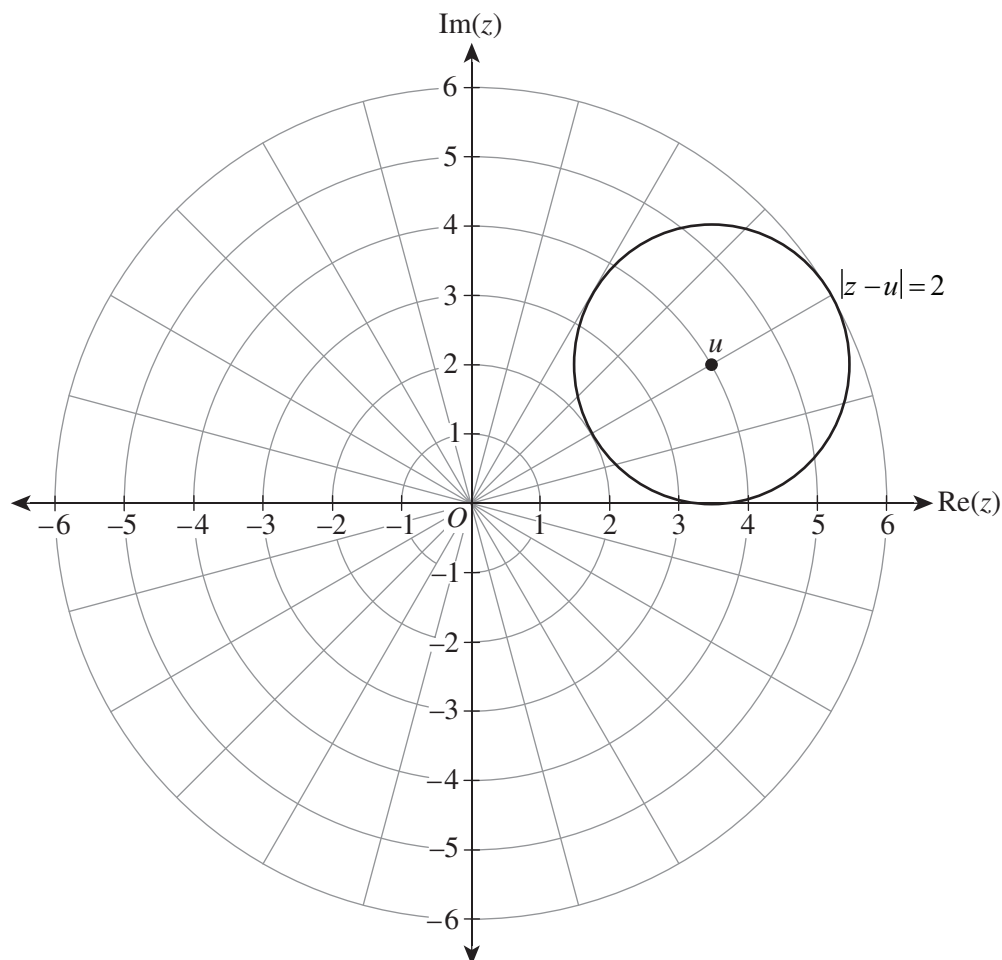
Therefore:

$$z^2 - (2\sqrt{3} + 2i + 2\sqrt{3} - 2i)z + (2\sqrt{3} + 2i)(2\sqrt{3} - 2i) = 0$$

$$z^2 - 4\sqrt{3}z + 16 = 0$$

A1

- c. $|z - u| = 2$ represents a circle with centre u and a radius of 2.



any circle with centre at point u A1
 correct shape such that the circle is tangent to the grid at least three times A1

- d. The equation of the circle is $(x - 2\sqrt{3})^2 + (y - 2)^2 = 4$.

A1

Substituting $y = kx$ into the equation of the circle gives:

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

As this will have two solutions, $\Delta > 0$.

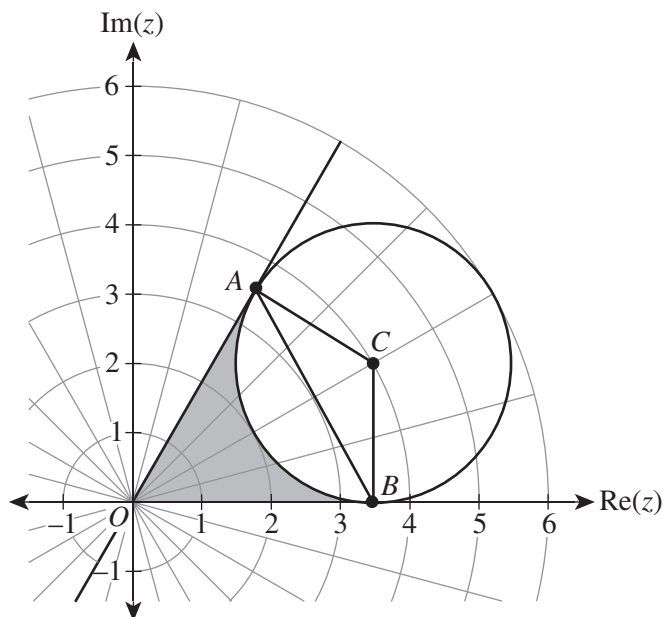
M1

$$0 < k < \sqrt{3}$$

A1

$$\begin{aligned} (x - 2\sqrt{3})^2 + (kx - 2)^2 &= 4 \\ (k^2 + 1) \cdot x^2 + (-4k - 4\sqrt{3}) \cdot x + 16 &= 4 \\ \text{solve} \left((-4k - 4\sqrt{3})^2 - 4(k^2 + 1) \cdot 12 > 0, k \right) \\ 0 < k < \sqrt{3} \end{aligned}$$

- e. The area to be found can be illustrated as follows.



To find points A and B , it is necessary to look for the intersection of the circle with lines $y = \sqrt{3}x$ and $y = 0$, respectively.

Using a CAS calculator to find the x -coordinates gives:

$\text{solve}\left((x-2\sqrt{3})^2 + (\sqrt{3}\cdot x-2)^2 = 4, x\right)$	$x = \sqrt{3}$
$\text{solve}\left((x-2\sqrt{3})^2 + (0\cdot x-2)^2 = 4, x\right)$	$x = 2\sqrt{3}$

$$A = (\sqrt{3}, 3), B = (2\sqrt{3}, 0)$$

A1

Finding $\angle ABC$ gives:

$$\angle O = 60^\circ, \angle OAC = \angle OBC = 90^\circ$$

$$\therefore \angle ACB = 120^\circ = \frac{2\pi}{3}$$

A1

Therefore:

$$OC = 4, AB = 2\sqrt{3}$$

$$\begin{aligned} \text{area}_{OABC} &= \frac{1}{2} \times OC \times AB \\ &= 4\sqrt{3} \end{aligned}$$

A1

$$\begin{aligned} \text{area}_{\widehat{CAB}} &= \frac{1}{2} \times \angle ACB \times \text{radius}^2 \\ &= \frac{4\pi}{3} \end{aligned}$$

$$\text{area} = 4\sqrt{3} - \frac{4\pi}{3}$$

A1

Note: A diagram is not required to obtain full marks.

Question 4 (12 marks)

- a. To calculate the arc length, it is necessary to find the start and end values of x by substituting the start and end values of y .

When $y = 0$:

$$0 = \log_e(x^2 - 4)$$

$$x = \sqrt{5}$$

When $y = 3$:

$$3 = \log_e(x^2 - 4)$$

$$x = \sqrt{e^3 + 4}$$

correct domain A1

Note: From the domain restrictions of the graph, the positive x -values should be chosen.

Therefore:

$$\int_{\sqrt{5}}^{\sqrt{e^3+4}} \sqrt{1 + [f'(x)]^2} dx = 4.1775$$

A1

solve($f(x)=0, x$)	$x = -\sqrt{5}$ or $x = \sqrt{5}$
solve($f(x)=3, x$)	$x = -\sqrt{e^3+4}$ or $x = \sqrt{e^3+4}$
$\int_{\sqrt{5}}^{\sqrt{e^3+4}} \sqrt{1 + \left(\frac{d}{dx}(f(x))\right)^2} dx$	4.1775

- b. $y = \log_e(x^2 - 4)$

$$x^2 - 4 = e^y$$

$$x^2 = e^y + 4$$

Therefore:

$$V = \pi \int_0^h x^2 dy$$

$$= \pi \int_0^h (e^y + 4) dy$$

A1

$$= \pi(e^h + 4h - 1)$$

A1

$\pi \cdot \int_0^h (e^y + 4) dy$	$(e^h + 4 \cdot h - 1) \cdot \pi$
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- c. The container's maximum volume is achieved when the water is at its maximum height; that is, $h = 3$.

Therefore, half of the maximum volume is:

$$V(h) = \frac{1}{2} \times V(3) \quad \text{M1}$$

$$= \frac{1}{2} \times \left(\pi (e^3 + (4 \times 3) - 1) \right)$$

$$h = 2.10 \text{ m} \quad \text{A1}$$

$v(h) := (e^h + 4 \cdot h - 1) \cdot \pi$	Done
$\Delta \text{ solve} \left(v(h) = \frac{1}{2} \cdot v(3), h \right)$	$h = 2.09808$

Note: Consequential on answer to Question 4b.

d. $\frac{dV}{dt} = \frac{dV}{dh} \times \frac{dh}{dt}$ M1

$$\frac{dV}{dt} = -2\sqrt{h}$$

$$\frac{dV}{dh} = \pi(e^h + 4)$$

$$-2\sqrt{h} = \pi(e^h + 4) \times \frac{dh}{dt} \quad \text{A1}$$

$$\frac{dh}{dt} = -\frac{2\sqrt{h}}{\pi(e^h + 4)}$$

$$\frac{dt}{dh} = -\frac{\pi(e^h + 4)}{2\sqrt{h}}$$

$$t = \int_3^0 -\frac{\pi(e^h + 4)}{2\sqrt{h}} dh \quad \text{M1}$$

$$= 44.7 \text{ min} \quad \text{A1}$$

$\text{solve} \left(\int_0^t 1 \, dt = \int_3^0 \frac{-\pi \cdot (e^h + 4)}{2 \cdot \sqrt{h}} \, dh, t \right)$
$t = 44.7403$

- e. Expressing the rate, r , as a function of h gives:

$$r(h) = \frac{-2\sqrt{h}}{\pi(e^h + 4)}$$

Differentiating $r(h)$ to find the maximum gives:

$$\frac{d}{dh} r(h) = 0$$

$$h = 1.14 \text{ m}$$

A1

Substituting $h = 1.14$ into $r(h)$ gives:

$$r(1.14) = -0.10$$

Therefore, the maximum rate is 0.10 m/min.

A1

$r(h) := \frac{-2 \cdot \sqrt{h}}{\pi \cdot (e^h + 4)}$	Done
$\Delta \text{ solve } \left(\frac{d}{dh}(r(h)) = 0, h \right)$	$h = 1.13978$
$r(1.13978)$	-0.095376

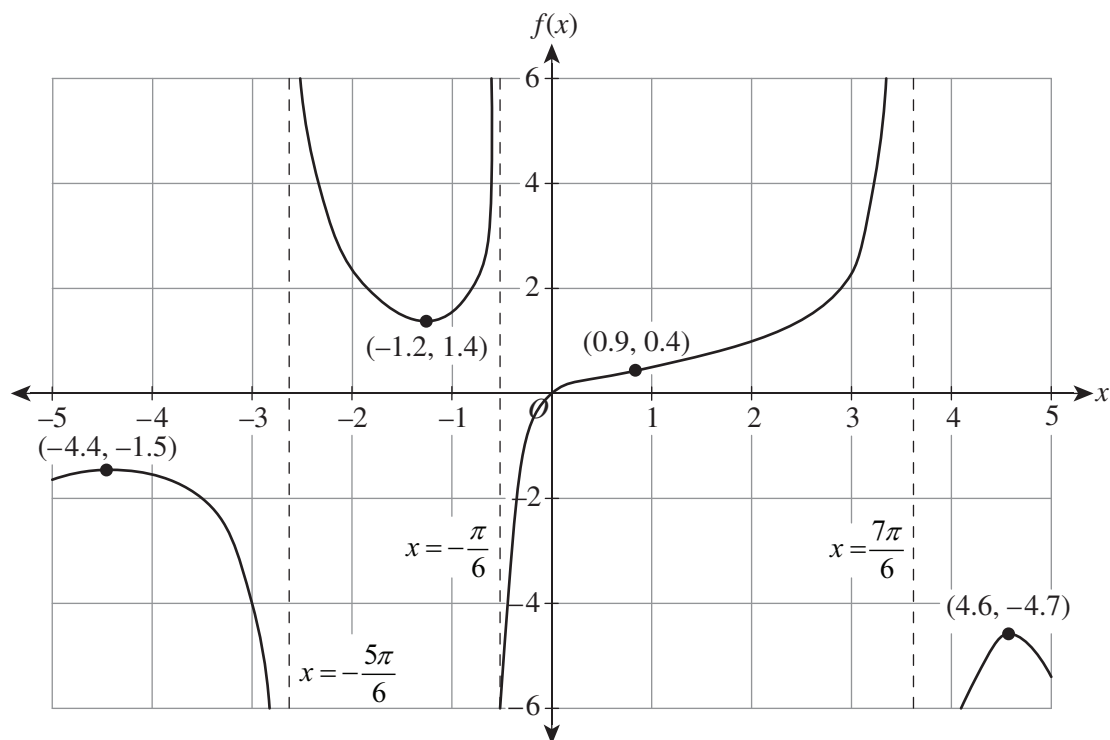
Question 5 (11 marks)

- a. The graph has vertical asymptotes when $2\sin(x) + 1 = 0$.

$$x = -\frac{\pi}{6} + 2\pi k, \quad x = \frac{7\pi}{6} + 2\pi k, \quad k \in \mathbb{Z}$$

A1

- b.



accurate sketch A1
 correct shape A1
 correct key points A1
 correct asymptotes A1

c. $f(x) = p(x)$

$$\frac{1}{2\sin(x)+1}x = p(x)$$

Letting $m = \frac{1}{2\sin(x)+1}$ and using $-1 \leq 2\sin(x) + 1 \leq 3$ gives:

$$m \leq -1 \text{ or } m \geq \frac{1}{3}$$

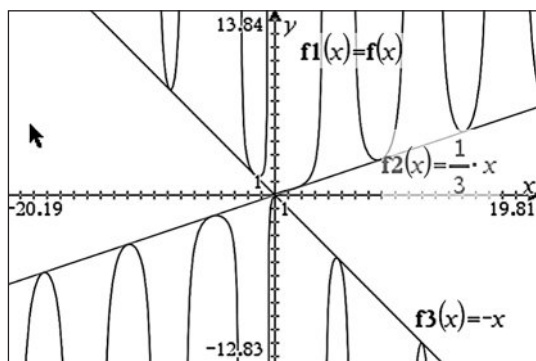
M1

If $f(x) = p(x)$ has only $x = 0$ as a solution, then m and p have no intersection.

Hence, $-1 < p < \frac{1}{3}$.

A1

Sketching the graph using a CAS calculator gives:



- d. i. If the denominator has no zeroes, then $g(x)$ has no asymptotes.

Since $-1 \leq \sin(x) \leq 1$ and $k > 0$:

$$-k \leq k \sin(x) \leq k$$

$$-k + 1 \leq k \sin(x) + 1 \leq k + 1$$

For no asymptotes:

$$-k + 1 > 0$$

$$k < 1$$

A1

- ii. The equations of the tangent lines are $y = \frac{1}{1-k}x$ and $y = \frac{1}{1+k}x$.

A1

Given that the angle between the tangent lines is 30° :

$$\frac{\frac{1}{1-k} - \frac{1}{1+k}}{1 + \frac{1}{(1-k)(1+k)}} = \tan(30^\circ)$$

$$= \frac{1}{\sqrt{3}}$$

M1

As $k > 0$, $k = \sqrt{5} - \sqrt{3}$.

A1

Question 6 (9 marks)

a. $\bar{X} \sim N\left(3200, \left(\frac{430}{\sqrt{7}}\right)^2\right)$ M1

$\Pr(\bar{X} > 3500) = 0.032$ A1

$\text{normCdf}\left(3500, \infty, 3200, \frac{430}{\sqrt{7}}\right)$	0.032455
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b. $T \sim N\left(7 \times 3200, (430 \times \sqrt{7})^2\right)$ M1

$\Pr(T > 22\,500) = 0.465$ A1

$\text{normCdf}(22500, \infty, 7 \cdot 3200, 430 \cdot \sqrt{7})$	0.464979
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c. Bakery: $B \sim N(3200, 430^2)$

Grocery store: $G \sim N(3600, 840^2)$

$G - B \sim N(400, 430^2 + 840^2)$ M1

$\Pr(G - B > 0) = 0.664$ A1

$\text{normCdf}(0, \infty, 400, \sqrt{430^2 + 840^2})$	0.664173
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d. i. $H_0: \mu = 3600$
 $H_1: \mu < 3600$

both hypotheses A1

ii. $p\text{-value} = \Pr(G < 3440)$
 $= 0.1971\dots$ A1

Since $p\text{-value} \not< 0.05$, H_0 should be accepted. A1

$\text{normCdf}\left(-\infty, 3440, 3600, \frac{840}{\sqrt{20}}\right)$	0.197153
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