HORNSBY GIRLS HIGH SCHOOL

Mathematics Advanced

Year 11 Assessment 2 Term 2 2024

STUDENT NUMBER: ______________________________

General Instructions

- Reading Time – 5 minutes
- Working Time – 60 minutes
- Write using black pen
- Calculators approved by NESA may be used
- In Questions 6 – 9, show relevant mathematical reasoning and/or calculations
- Marks may be deducted for untidy and poorly arranged work
- Do not use correction fluid or tape
- Do not remove this paper from the examination
- Students are permitted to refer to one double-sided A4 page of handwritten topic summaries which they prepared prior this assessment

Total marks – 49

Section I Pages 2 – 3

5 marks

Attempt Questions 1 – 5

Allow about 8 minutes for this section

Answer on the Objective Response Answer Sheet provided

Section II Pages 4 – 13

44 marks

Attempt Questions 6 -9

Allow about 52 minutes for this section

Write your answers in the space provided.

Question	*1-5*	*6*	*7*	*8*	*9*	*Total*
Total	/5	/11	/11	/11	/11	/49

This assessment task constitutes 35% of the Preliminary Higher School Certificate Course School Assessment

Section I

5 marks
Attempt Questions 1 – 5
Allow about 8 minutes for this section

Use the Objective Response answer sheet for Questions 1 – 5

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1 What is the maximum value of $y = 12 - 4x - x^2$?

A. 4

B. 8

C. 12

D. 16

2 What is $\sec^2 x - \tan^2 x - \cos^2 x$ simplified?

A. $-\tan^2 x$

B. $\sin^2 x$

C. $1 - \tan^2 x$

D. $\cot^2 x$

3 The circle $x^2 - 6x + y^2 + 2y + 6 = 0$ has:

A. centre $(3, -1)$, radius 2 units.

B. centre $(3, -1)$, radius 4 units.

C. centre $(-3, 1)$, radius 2 units.

D. centre $(-3, 1)$, radius 4 units.

4 How many solutions does the equation $(\sin x+1)(2\tan x-3)=0$ for $0 \le x \le 2\pi$ have?

A. 2

B. 3

C. 4

D. 5

5 Given the function $y=-\sqrt{x-1}$, the domain and the range for this function is:

A. Domain: $(-\infty,\infty)$, Range: $(-\infty,\infty)$

B. Domain: $[1,\infty)$, Range: $(-\infty,0]$

C. Domain: $(1,\infty)$, Range: $(-\infty,0)$

D. Domain: $(0,\infty)$, Range: $(-\infty,-1)$

End of Section I

Section II
44 **marks**
Attempt Questions 6-10

Question 6 (11 marks)

(a) Find the angle of inclination to the nearest degree of the line $3x-2y-5=0$ with the positive direction of the x - axis. **2**

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(b) If $\sin x=-\frac{2}{3}$, and $\tan x>0$, find the exact value of $\cos x$. **2**

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(c) A function is given by the rule: **2**

$$f(x)=\begin{cases}(x-1)^2+3, & x\le 1\\ 5x-2 \quad , & x>1\end{cases}$$

What is the value of $f\left(f(0)\right)$?

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Question 6 continues on page 5

Question 6 (continued)

(d) For what values of k does the quadratic equation $3x^2 - 2x + k = 0$ have no real roots? **2**

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(e) Show that $\dfrac{\sin 150^\circ - \sin 300^\circ}{\cos 330^\circ - \cos 60^\circ} = \sqrt{3} + 2$ **3**

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End of Question 6

Question 7 (11 marks)

(a) Solve for x: $|3x+7|=10$ **2**

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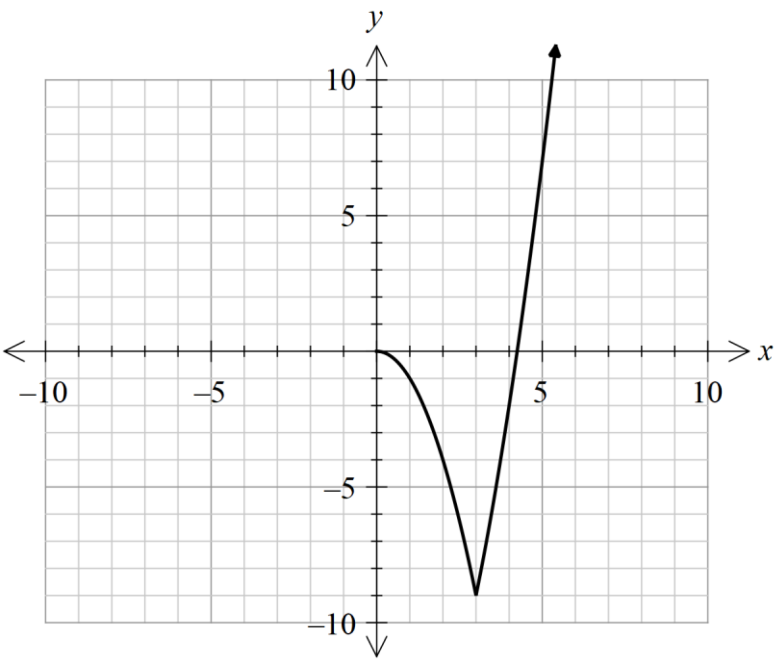
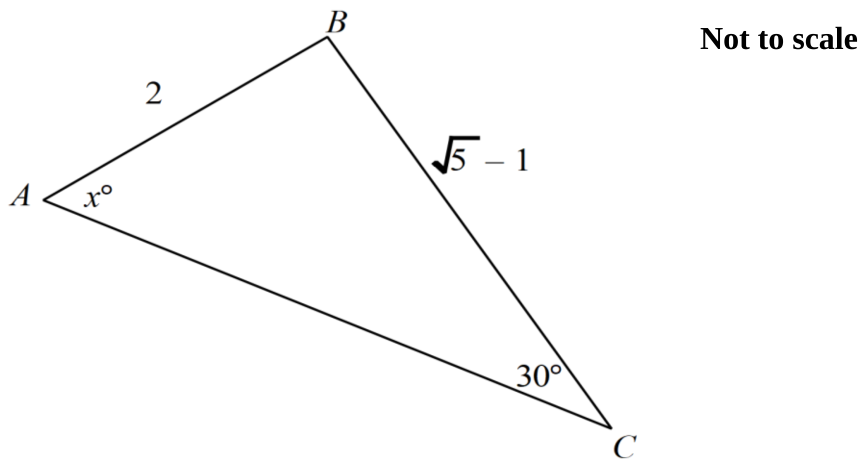
(b) The graph of $y=f(x)$ for $x \geq 0$ is shown below. **2**



Complete the graph above for $x<0$, given that $y=f(x)$ is an odd function for $(-\infty, \infty)$.

Question 7 continues on page 7

(c) Find the value of the acute angle x in the following triangle. **2**



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(d) Determine whether the function $f\left(x\right)=\dfrac{x^3}{x-x^5}$ is odd, even or neither. **2**

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Question 7 continues on page 8

(e) Find the points of intersection for $xy = 2$ and $2x + 5y = 12$. **3**

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End of Question 7

Question 8 (11 marks)

(a) If $f(x) = 2x^2 + x - 3$ and $g(x) = x^3 + 2$, find:

(i) the degree of the polynomial $y = f(x)g(x)$. **1**

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(ii) a simplified expression for $f(g(x))$. **1**

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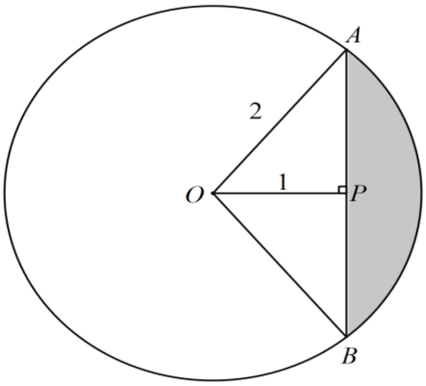
(b) The diagram below shows a circle with centre *O*, radius 2 cm and $OP = 1$ cm.



Not to scale

(i) Find the exact area of the minor sector AOB. **2**

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(ii) Hence, or otherwise, find the exact area of the shaded region. **2**

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Question 8 continues on page 10

(c) Solve $4\sin^2\theta - 1 = 0$ for $-180^\circ \le \theta \le 180^\circ$. **3**

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(d) A variable y is inversely proportional to the square of x. When $x = 3$, $y = 2$. **2**

Evaluate x when $y = 10$, correct to 2 decimal places, if $x > 0$.

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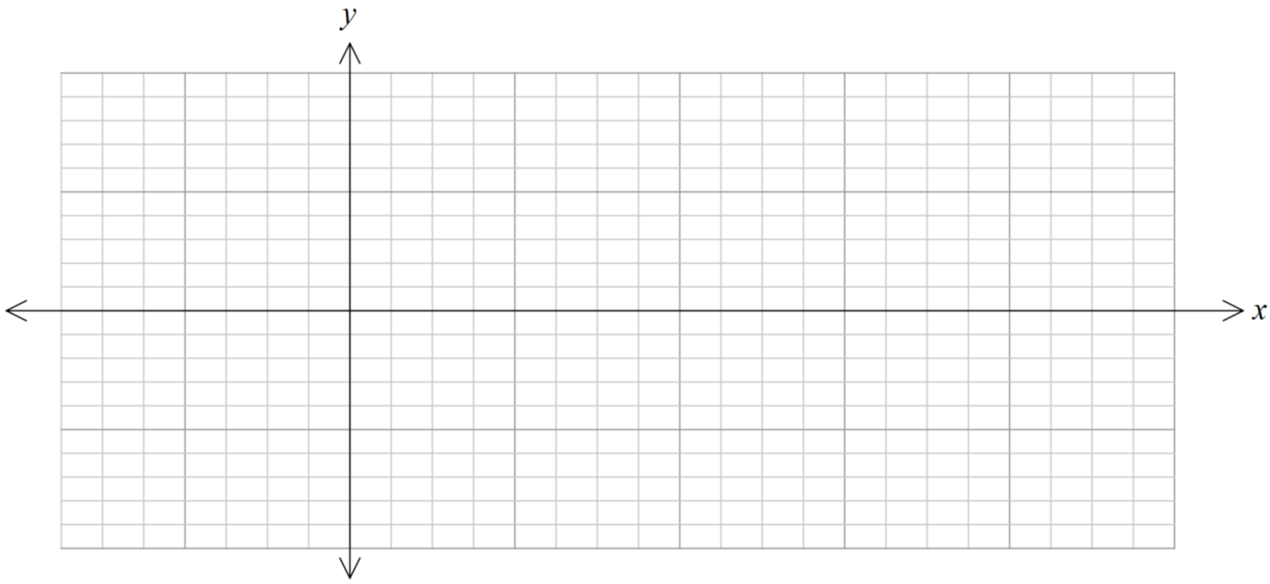
End of Question 8

Question 9 (11 marks)

(a) Graph $y = \cos x$ for $-\frac{\pi}{2} \le x \le 2\pi$ on the number plane below. **2**



(b) Solve $\sin^2 x - 2\cos x = 1$ for $-\frac{\pi}{2} \le x \le 2\pi$. **3**

Question 9 continues on page 12

(c) Prove that $\dfrac{\cos\theta}{1-\sin\theta}-\tan\theta=\sec\theta$. **2**

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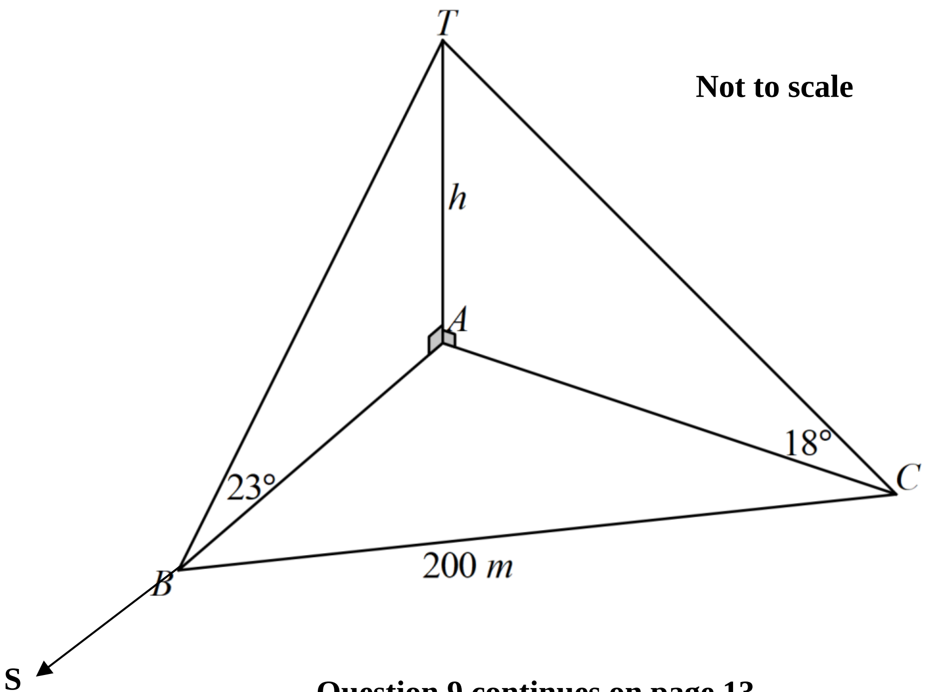
(d) TA is a vertical tower of height h metres. **4**

B and C are points at the same level as A, the foot of the tower, and $BC = 200$ m.

The point B is due south of the tower and C is on a bearing of $120^\circ T$ from the base of the tower. The angles of elevation to the top of the tower from B and C are 23° and 18°, respectively. Find the height of the tower, correct to one decimal place.

Not to scale



Question 9 continues on page 13

Question 9 (continued)

End of Assessment

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HORNSBY GIRLS HIGH SCHOOL

Mathematics Advanced

Year 11 Assessment 2 Term 2 2024

STUDENT NUMBER: SOLUTIONS

General Instructions

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- Working Time – 60 minutes
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5 marks

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Total	/5	/11	/11	/11	/11	/49

This assessment task constitutes 35% of the Preliminary Higher School Certificate Course School Assessment

Section I

5 marks
Attempt Questions 1 – 5
Allow about 8 minutes for this section

Use the Objective Response answer sheet for Questions 1 – 5

---

1 What is the maximum value of $y = 12 - 4x - x^2$?

A. 4

B. 8

C. 12

D. 16

$x = -\frac{b}{2a}$
$= -\frac{(-4)}{2(-1)}$
$= -2$
when $x = -2$ $y = 12 - 4(-2) - (-2)^2$
$= 12 + 8 - 4$
$= 16$

58% got the correct answer.
Majority incorrect choice was C.

2 What is $\sec^2 x - \tan^2 x - \cos^2 x$ simplified?

A. $-\tan^2 x$

B. $\sin^2 x$

C. $1 - \tan^2 x$

D. $\cot^2 x$

$\sec^2 x - \tan^2 x - \cos^2 x$
$= (1 + \tan^2 x) - \tan^2 x - \cos^2 x$
$= 1 - \cos^2 x$
$= \sin^2 x$

92% ~~obtain~~ gave correct answer.
89% incorrectly chose C.

3 The circle $x^2 - 6x + y^2 + 2y + 6 = 0$ has:

A. centre $(3,-1)$, radius 2 units.

B. centre $(3,-1)$, radius 4 units.

C. centre $(-3,1)$, radius 2 units.

D. centre $(-3,1)$, radius 4 units.

$x^2 - 6x + 3^2 + y^2 + 2y + 1^2 = -6 + 3^2 + 1^2$
$(x-3)^2 + (y+1)^2 = 4$

$\therefore$ C: $(3,-1)$ Radius: 2units

75% got the correct answer.
72% ~~of~~ incorrect answers had chosen B

4 How many solutions does the equation $(\sin x+1)(2\tan x-3)=0$ for $0 \le x \le 2\pi$ have?

A. 2

B. 3

C. 4

D. 5

$\sin x + 1 = 0$ or $2\tan x - 3 = 0$

$\sin x = -1$ $\tan x = \frac{3}{2}$

$x = \tan^{-1}\left(\frac{3}{2}\right)$

$x = \frac{3\pi}{2}$

Not a solution as not defined for $\tan x$. Hence only 2 solutions.

Poorly done. 90% of cohort chose incorrectly and Majority chose B forgetting $\frac{3\pi}{2}$ is undefined for $\tan\frac{3\pi}{2}$.

5 Given the function $y=-\sqrt{x-1}$, the domain and the range for this function is:

A. Domain: $(-\infty,\infty)$, Range: $(-\infty,\infty)$

B. Domain: $[1,\infty)$, Range: $(-\infty,0]$

C. Domain: $(1,\infty)$, Range: $(-\infty,0)$

D. Domain: $(0,\infty)$, Range: $(-\infty,-1)$

D: $x-1 \ge 0$

$x \ge 1$

R: $y \le 0$

Mostly done well (90% of cohort chose correct answer)

End of Section I

Section II

44 marks
Attempt Questions 6-10

Question 6 (11 marks)

(a) Find the angle of inclination to the nearest degree of the line $3x-2y-5=0$ with the positive direction of the x - axis. **2**

mostly well done.

$3x-2y-5=0$

$-2y=5-3x$

$y=-\frac{5}{2}+\frac{3}{2}x$

$\therefore m=\frac{3}{2}$

$\tan\theta=m$

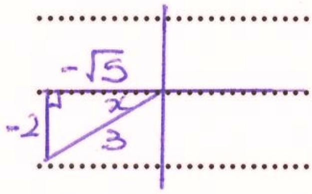
$\tan\theta=\frac{3}{2}$

$\theta=\tan^{-1}\left(\frac{3}{2}\right)$

$=56.309\ldots$

$\doteqdot 56^\circ$ (nearest degree)

(b) If $\sin x=-\frac{2}{3}$, and $\tan x>0$, find the exact value of $\cos x$. **2**



$\therefore \cos x=-\frac{\sqrt{5}}{3}$

Some students didn't get the sign right. The angle is in Q3, i.e, negative cos.

(c) A function is given by the rule: **2**

$$f(x)=\begin{cases}(x-1)^2+3, & x\le 1\\ 5x-2 & , x>1\end{cases}$$

What is the value of $f(f(0))$?

$f(0)=(0-1)^2+3$

$=4$

$f(4)=5(4)-2$

$=18$

mostly well done. Some students didn't find the correct branch based on the x value.

Question 6 continues on page 5

Question 6 (continued)

(d) For what values of k does the quadratic equation $3x^2 - 2x + k = 0$ have no real roots? **2**

No real roots when $\Delta <$ ~~b^2+4ac~~

$\therefore\ b^2 - 4ac < 0$

$(-2)^2 - 4(3)(k) < 0$

$4 - 12k < 0$

$-12k < -4$

$\therefore k > \frac{4}{12}$

$k > \frac{1}{3}$

Many students understand when $\Delta < 0$, there is no real roots. However, some mistakes solving the inequation. Also, when $\Delta = 0$, there is one/double solution, so the answer shouldn't be $k \geq \frac{1}{3}$.

(e) Show that $\dfrac{\sin 150^\circ - \sin 300^\circ}{\cos 330^\circ - \cos 60^\circ} = \sqrt{3} + 2$ **3**

$= \dfrac{\frac{1}{2} - \left(-\frac{\sqrt{3}}{2}\right)}{\frac{\sqrt{3}}{2} - \frac{1}{2}}$

$= \dfrac{1 + \sqrt{3}}{\sqrt{3} - 1} \times \left(\dfrac{\sqrt{3} + 1}{\sqrt{3} + 1}\right)$

$= \dfrac{\sqrt{3} + 1 + 3 + \sqrt{3}}{(\sqrt{3})^2 - (1)^2}$

$= \dfrac{4 + 2\sqrt{3}}{2}$

$= \dfrac{2(2 + \sqrt{3})}{2}$

$= 2 + \sqrt{3}$

This is a show question so all steps need to be done.

Many missed writing this

And went straight to this

Other than this error most did it correctly, except for some arithmetic errors.

End of Question 6

Question 7 (11 marks)

(a) Solve for x: $|3x+7| = 10$ **2**

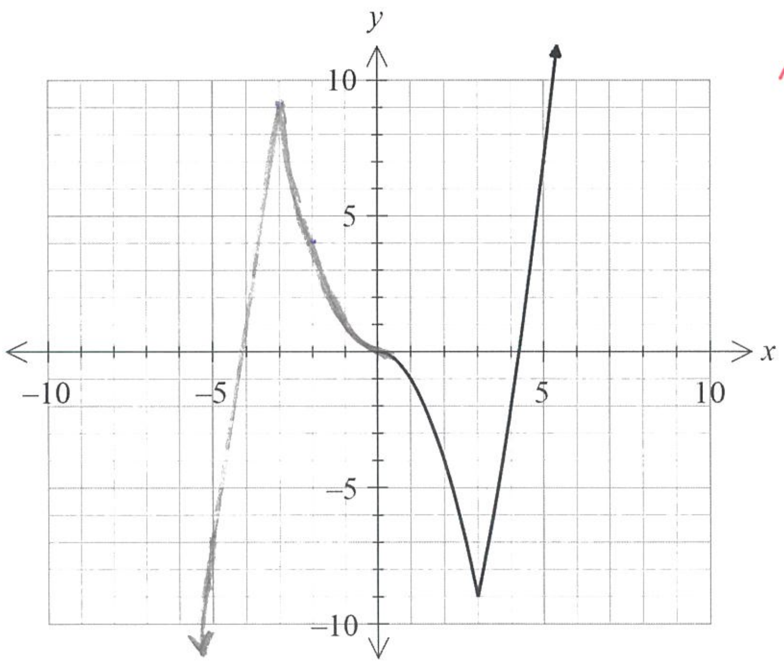
$3x+7=10$ $3x+7=-10$

$3x=3$ $3x=-17$

$x=1$ $x=-\frac{17}{3}$

Well done question. About 99% got this fully correct.

(b) The graph of $y=f(x)$ for $x \geq 0$ is shown below. **2**



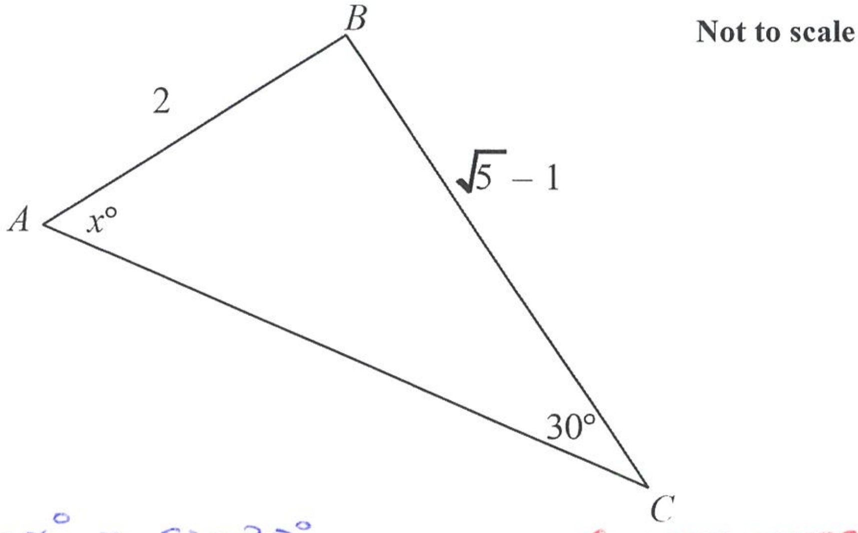
A real mixed bag here. A lot of even functions drawn instead of odd. Some very confused attempts.

Complete the graph above for $x<0$, given that $y=f(x)$ is an odd function for $(-\infty, \infty)$.

Question 7 continues on page 7

Question 7 (continued)

(c) Find the value of the acute angle x in the following triangle. **2**



$$\frac{\sin x°}{\sqrt{5}-1} = \frac{\sin 30°}{2}$$

$$\sin x° = \frac{\frac{1}{2}(\sqrt{5}-1)}{2}$$

$$x° = \sin^{-1}\left(\frac{\sqrt{5}-1}{4}\right)$$

$$= 18°$$

Common error

$\sin x = \frac{(\sqrt{5}-1)(\frac{1}{2})}{2}$ NEEDS brackets

$x = 60.23°$

$\therefore x = 18$

Some students considered the ambiguous case which is good, but the question stated the acute angle. The obtuse angle $180°-18° = 162°$ will not work because it will exceed the angle sum of the triangle.

(d) Determine whether the function $f(x) = \dfrac{x^3}{x - x^5}$ is odd, even or neither. **2**

$$f(-x) = \frac{(-x)^3}{(-x)-(-x)^5}$$

$$= \frac{-x^3}{-x+x^5} \neq -\left(\frac{x^3}{x-x^5}\right)$$

$$= \frac{-}{-}\left[\frac{x^3}{x-x^5}\right]$$

$$= \frac{x^3}{x-x^5}$$

$$= f(x)$$

Most students showed good working for $f(-x)$

Many students only took a single negative out as a factor.

$\therefore f(-x) = f(x)$ hence the function is even.

Poorly done.

Question 7 continues on page 8

(e) Find the points of intersection for $xy = 2$ and $2x + 5y = 12$. **3**

$y = \frac{2}{x}$ ① $2x+5y=12$ ②

Sub ① into ② $2x+5\left(\frac{2}{x}\right)=12$

$2x + \frac{10}{x} - 12 = 0$

$2x^2 + 10 - 12x = 0$ 1. for substitution to create a quadratic

$2(x^2 - 6x + 5) = 0$

$(x-5)(x-1) = 0$

$\therefore x=5$ or $x=1$. 1. for two values of x

When $x = 5$ $y = \frac{2}{5}$

When $x=1$ $y = \frac{2}{1} = 2$

$\therefore x=5, y=\frac{2}{5}$ or $x=1, y=2$.

The points of intersection are

$\left(5, \frac{2}{5}\right)$, $(1, 2)$

End of Question 7

OR $x = \frac{2}{y}$

$2 \times \frac{2}{y} + 5y = 12$

$4 + 5y^2 = 12y$ 1.

$5y^2 - 12y + 4 = 0$

$(5y-2)(y-2) = 0$

$y = \frac{2}{5}$ or $y = 2$ 1.

$x = 2 \div \frac{2}{5}$ $x = \frac{2}{2}$

$= 5$ $= 1$

$\left(5, \frac{2}{5}\right)$, $(1, 2)$ 1.

or

$\vdots$

$2x^3 - 12x^2 + 10x = 0$

$2x(x^2 - 6x + 5) = 0$

$2x(x-5)(x-1) = 0$

$x = 0, 1, 5$

Must give reason for discarding $x=0$

i.e. since $xy = 2$ then $x \neq 0$, $y \neq 0$

Question 8 (11 marks)

(a) If $f(x)=2x^2+x-3$ and $g(x)=x^3+2$, find:

most students got this correct.

(i) the degree of the polynomial $y=f(x)g(x)$. **1**

Degree is 5.

(ii) a simplified expression for $f(g(x))$. **1**

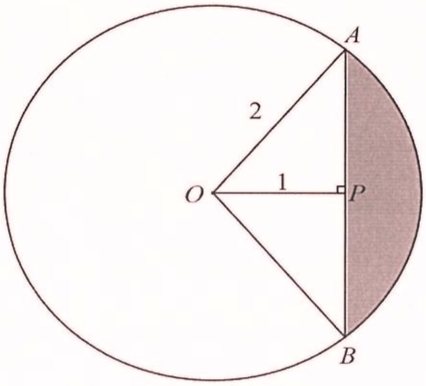
$f(g(x)) = 2(x^3+2)^2 + (x^3+2) - 3$

$= 2x^6 + 8x^3 + 8 + x^3 - 1$

$= 2x^6 + 9x^3 + 7$.

Some students did $g(f(x))$. Some did simple arithmetic errors so didnt get final answer correct

(b) The diagram below shows a circle with centre *O*, radius 2 cm and $OP = 1$ cm.



Not to scale

(i) Find the exact area of the minor sector *AOB*. **2**

$A = \frac{1}{2}r^2\theta$ OR $A = \frac{\theta}{360^\circ} \times \pi r^2$

$= \frac{1}{2}(2)^2\left(120^\circ \times \frac{\pi}{180}\right)$; $= \frac{120}{360} \times \pi(2)^2$

$= \frac{4\pi}{3}$ cm^2. ; $= \frac{4\pi}{3}$

Well answered.

(ii) Hence, or otherwise, find the exact area of the shaded region. **2**

Area of Shaded region = Area of Sector − Area of triangle

$= \frac{4\pi}{3} - \frac{1}{2}(2)^2 \sin 120^\circ$

$= \frac{4\pi}{3} - 2 \times \frac{\sqrt{3}}{2}$

$= \frac{4\pi - 3\sqrt{3}}{3}$ cm^2.

Some students did Area of Δ − Area of Sector

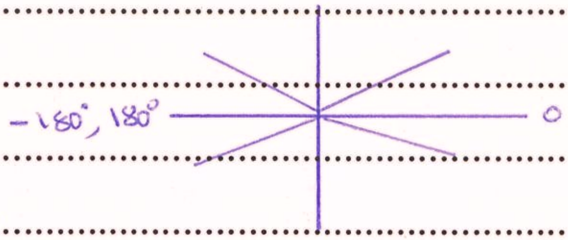
Question 8 continues on page 10

(c) Solve $4\sin^2\theta - 1 = 0$ for $-180^\circ \le \theta \le 180^\circ$. **3**

$4\sin^2\theta = 1$

$\sin^2\theta = \frac{1}{4}$

$\sin\theta = \pm\frac{1}{2}$



Related Acute Angle:

$\theta = \sin^{-1}\left(\frac{1}{2}\right)$ * Many do not know $\pm\sqrt{\frac{1}{4}} = \pm\frac{1}{2}$.

$= 30^\circ$

$\therefore \theta = -150^\circ, \theta = -30^\circ, \theta = 30^\circ, \theta = 150^\circ$

* Completed by most quite well.

(d) A variable y is inversely proportional to the square of x. When $x = 3$, $y = 2$. **2**

Evaluate x when $y = 10$, correct to 2 decimal places, if $x > 0$.

$y \propto \frac{1}{x^2}$

$y = \frac{K}{x^2}$

when $x = 3, y = 2$

$2 = \frac{K}{(3)^2}$

$\therefore K = 18$

$\therefore y = \frac{18}{x^2}$

when $y = 10$, $10 = \frac{18}{x^2}$

$x^2 = \frac{18}{10}$

$x = \sqrt{\frac{18}{10}}, x > 0$

$= 1.3416\ldots$

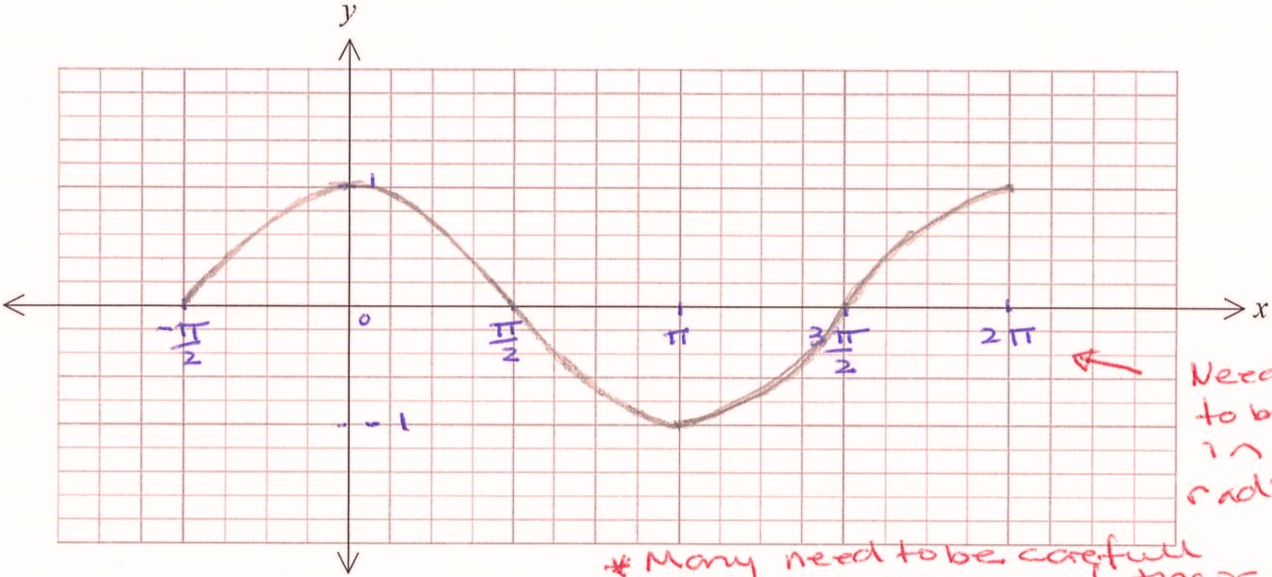
$\doteqdot 1.34$ (2dp).

Most students got this correct. Some did $y \propto \frac{1}{x}$.

End of Question 8

Question 9 (11 marks)

(a) Graph $y = \cos x$ for $-\frac{\pi}{2} \le x \le 2\pi$ on the number plane below. **2**



Needs to be in radians.

* Many need to be carefull with the shape of their graph.

(b) Solve $\sin^2 x - 2\cos x = 1$ for $-\frac{\pi}{2} \le x \le 2\pi$. **3**

$(1-\cos^2 x) - 2\cos x - 1 = 0$

$1 - \cos^2 x - 2\cos x - 1 = 0$

$-(\cos^2 x + 2\cos x) = 0$

$\cos x(\cos x + 2) = 0$ Many not factorising correctly

$\therefore \cos x = 0$ or $\cos x + 2 = 0$

From graph $\cos x = -2$

$x = \cos^{-1}(0)$ No solutions as $-1 \le \cos x \le 1$.

Need to conclude.

$\therefore x = -\frac{\pi}{2}, \frac{\pi}{2}, \frac{3\pi}{2}$.

Not correct if final answer in degrees.

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Question 9 (continued)

(c) Prove that $\dfrac{\cos\theta}{1-\sin\theta} - \tan\theta = \sec\theta$. **2**

$$\text{LHS} = \frac{\cos\theta}{1-\sin\theta} - \tan\theta$$

$$= \frac{\cos\theta}{1-\sin\theta} - \frac{\sin\theta}{\cos\theta}$$

$$= \frac{\cos^2\theta - \sin\theta(1-\sin\theta)}{(1-\sin\theta)\cos\theta}$$

$$= \frac{\cos^2\theta - \sin\theta + \sin^2\theta}{(1-\sin\theta)\cos\theta}$$

$$= \frac{1-\sin\theta}{(1-\sin\theta)\cos\theta}$$

$$= \frac{1}{\cos\theta}$$

$$= \sec\theta$$

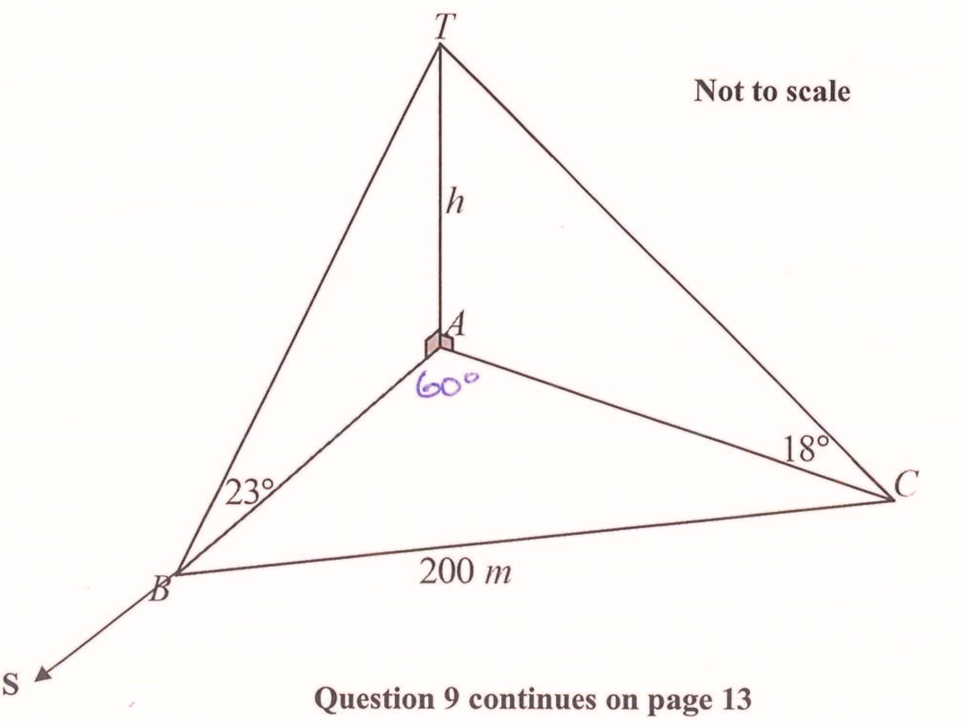
$$= \text{RHS}.$$

Mostly done well. Student had problem with this proof had poor technique, leaving denominator off fraction and ~~obtaining~~ were unable to arrive to correct required answer. Some student had problems with trigonometric identities.

(d) TA is a vertical tower of height h metres. **4**

B and C are points at the same level as A, the foot of the tower, and $BC = 200$ m.

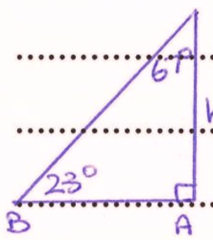
The point B is due south of the tower and C is on a bearing of $120^\circ T$ from the base of the tower. The angles of elevation to the top of the tower from B and C are 23° and 18°, respectively. Find the height of the tower, correct to one decimal place.



Question 9 continues on page 13

Question 9 (continued)

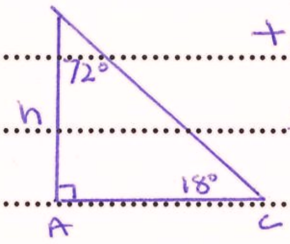
In ΔTAB:



$\tan 67° = \frac{BA}{h}$

$\therefore BA = h\tan 67°$

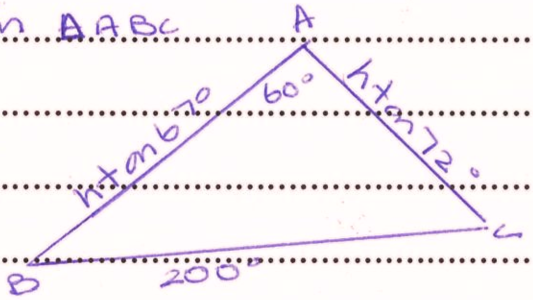
In ΔTAC:



$\tan 72° = \frac{AC}{h}$

$\therefore AC = h\tan 72°$

In ΔABC



$BC^2 = AB^2 + AC^2 - 2 \times AB \times AC \times \cos\angle BAC$

$200^2 = (h\tan 67°)^2 + (h\tan 72°)^2 - 2 \times h\tan 67° \times h\tan 72° \times \cos 60°$

$200^2 = h^2(\tan^2 67° + \tan^2 72 - \tan 67° \tan 72°)$

$\therefore h^2 = \dfrac{200^2}{\tan^2 67° + \tan^2 72° - \tan 67° \tan 72°}$

$= 5146.939803$

$\therefore h = \sqrt{5146.939803}, \ h > 0$

$= 71.74217\ldots$

$\doteqdot 71.7 \text{ m (1dp)}$

Mostly did yet and presented work succesfully.

Students with incorrect answer were due to calculator error or had problem in solving for h when using Cosine Rule $\cos C = \frac{a^2+b^2-c^2}{2ab}$, especially using cot 23° and cot 18°.

End of Assessment

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