education

Department:
Education
PROVINCE OF KWAZULU-NATAL

ENQUIRIES: MR D.A. SEWLALL DATE: 31 MAY 2016

NATIONAL SENIOR CERTIFICATE: COMMON TEST JUNE 2016: GRADE 12

TO: THE CHIEF INVIGILATOR OF ALL SCHOOLS OFFERING: MATHEMATICS P1

ERRATA

Please take note of the following change:

PAGE	NUMBER	ERROR	CORRECTION
6	8.3	Calculate the value of the height of the prism if its volume is at a maximum.	Calculate the value of r the radius of the prism if its surface area is to be a minimum.

Kindly ensure that candidates are informed of the Errata.

MS N.V. MCAMBI
DEPUTY MANAGER
PROVINCIAL EXAMINATION ADMINISTRATION

2/6/2016
DATE

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Basic Education

KwaZulu-Natal Department of Basic Education
REPUBLIC OF SOUTH AFRICA

MATHEMATICS P1

COMMON TEST

JUNE 2016

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 125

TIME: 2.5 hours

This question paper consists of 7 pages and 1 information sheet.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. This question paper consists of 9 questions.
2. Answer ALL the questions.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Clearly show ALL calculations, diagrams, graphs, et cetera that you have used in determining your answers.
5. Answers only will not necessarily be awarded full marks.
6. You may use an approved scientific calculator (non-programmable and non-graphical), unless stated otherwise.
7. If necessary, round off answers to TWO decimal places, unless stated otherwise.
8. Diagrams are NOT necessarily drawn to scale.
9. An information sheet with formulae is included at the end of the question paper.
10. Write neatly and legibly.

QUESTION 1

1.1 Solve for x:

1.1.1 $(2x-1)\left(x+\frac{4}{5}\right)=0$ (2)

1.1.2 $x(8-x)<0$ (3)

1.1.3 $\sqrt{2x+1}-3=0$ (3)

1.2 Solve for x and y simultaneously:

$x-y=-2$ and $x^2+y^2=20$ (6)

1.3 Simplify : $\frac{4^{n+1}.8^{2n}}{16^{2n-1}}$ (5)

[19]

QUESTION 2

Given the quadratic sequence : 6 ; 6 ; 10 ; 18 ; ....

2.1 Determine a formula for the n^{th} term of the sequence. (4)

2.2 Determine between which two consecutive terms the first difference is 200? (4)

2.3 Which term in the quadratic sequence has a value of 32010? (4)

[12]

QUESTION 3

3.1 If $S_n=2n^2+3n$, calculate the 20^{th} term of the series. (4)

3.2 Given the series : 3 + 5 + 6 + 5 + 12 + 5 + ...

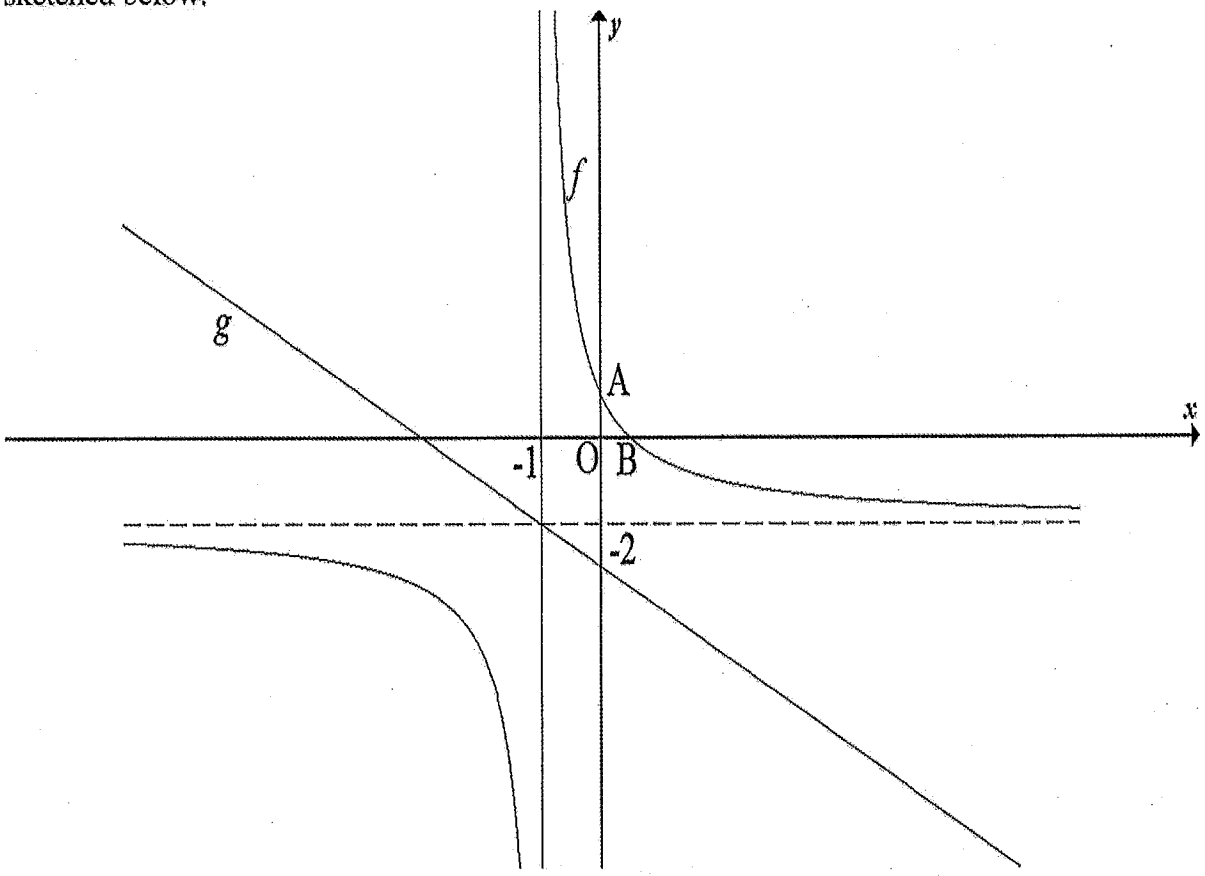
3.2.1 Calculate the sum of the first 20 terms. (4)

3.2.2 Which term of the series is equal to 6291456? (4)

[12]

QUESTION 4

4.1 The graphs of $f(x) = \frac{a}{x+p} + q$ and $g(x) = mx + c$ passing through the (-1 ; -2) are sketched below.



4.1.1 Write down the values of p and q. (2)

4.1.2 If the coordinates of B are $\left(\frac{1}{2};0\right)$, calculate the value of a. (3)

4.1.3 If $g(x)$ is one of the lines of symmetry of f, determine the equation of g. (3)
[8]

QUESTION 5

The equation $f(x) = a^x, a > 0, a \neq 1$, passes through the point $\left(-3; \frac{1}{8}\right)$.

5.1 Determine the value of a. (3)

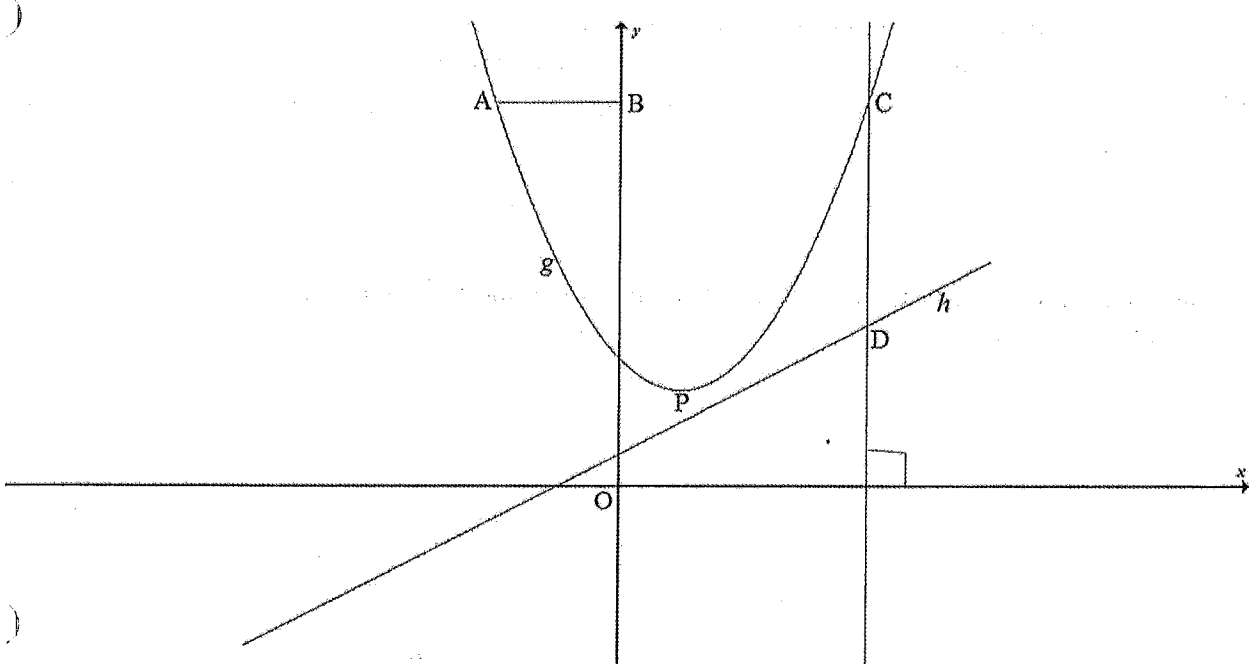
5.2 Write down the equation of f^{-1} in the form $y = \ldots$ (2)

5.3 Determine the value(s) of x for which $f^{-1}(x) > -3$. (3)

[8]

QUESTION 6

The graphs of $g(x) = x^2 - 2x + 4$ and $h(x) = x + 1$ are sketched below. AB is perpendicular to the $y-$axis and CD is perpendicular to the $x-$axis.



6.1 Calculate the coordinates of P, the turning point of g. (3)

6.2 If OB = 12 units, determine the coordinates of A. (4)

6.3 If C $(x; y)$ is on g, D is on h, such that CD is always perpendicular to the x-axis, determine an expression in terms of x for the length of CD. (2)

6.4 Hence, calculate the minimum length of CD. (3)

6.5 If $y = 2x + c$ is a tangent to the graph of g, calculate the value(s) of c. (5)

[17]

QUESTION 7

7.1 Determine the derivative of $f(x) = -2x^2 + 5$ from first principles. (5)

7.2 Determine the derivative of the following using the rules for differentiation.

7.2.1 $y = \dfrac{x^3 - 27}{3 - x}$ (4)

7.2.2 $D_x\left[\sqrt{x}\left(2x - \dfrac{7}{\sqrt[3]{x}}\right)\right]$ (4)

7.3 Given $g(x) = x^3 - x^2 - 8x + 12$

7.3.1 Determine $g(2)$. (2)

7.3.2 Solve $g(x) = x^3 - x^2 - 8x + 12 = 0$ (3)

7.3.3 Calculate the coordinates of the stationary points of g. (4)

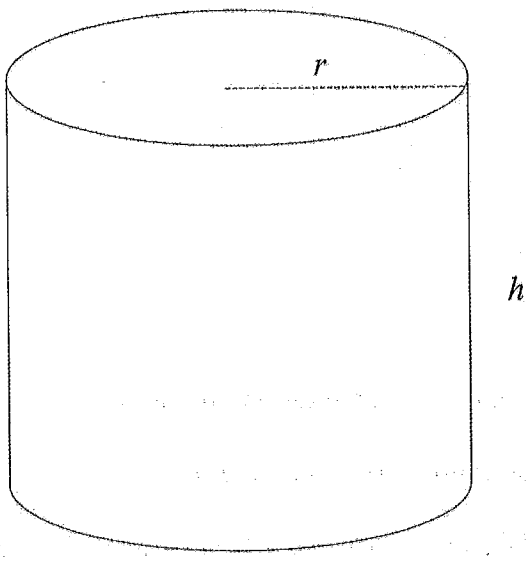
7.3.4 Sketch g indicating the intercepts and the stationary points. (4)

7.3.5 For which value(s) of k will $x^3 - x^2 - 8x + 12 = k$ have three unequal roots. (2)

[28]

QUESTION 8

A water tank in the shape of a cylindrical prism has a volume of 330 ml, height of h cm and radius of r cm..



8.1 Show that height of the cylinder is given by $h = \dfrac{330}{\pi r^2}$ (2)

8.2 Show that the Surface Area of the cylinder(A) is given by

$A = 2\pi r^2 + \dfrac{660}{r}$ (2)

8.3 Calculate the value of the height of the prism if its volume is at a maximum. (5)

[9]

QUESTION 9

The height(h) (in metres) of a golf ball t seconds after it is been hit into the air is given by $h(t) = 20t - 5t^2$. Determine the following:

9.1 the average vertical velocity of the ball during the first two seconds. (2)

9.2 the vertical velocity of the ball after 1.5 seconds. (3)

9.3 the time taken for the vertical velocity to be zero. (2)

9.4 the vertical velocity with which the ball hits the ground. (5)
[12]

TOTAL MARKS: 125

INFORMATION SHEET: MATHEMATICS
INLIGTINGSBLAD: WISKUNDE

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$A = P(1+ni) \qquad A = P(1-ni) \qquad A = P(1-i)^n \qquad A = P(1+i)^n$$

$$T_n = a + (n-1)d \qquad S_n = \frac{n}{2}\left(2a + (n-1)d\right)$$

$$T_n = ar^{n-1} \qquad S_n = \frac{a\left(r^n - 1\right)}{r-1} \; ; \quad r \neq 1 \qquad S_\infty = \frac{a}{1-r} \; ; \; -1 < r < 1$$

$$F = \frac{x\left[(1+i)^n - 1\right]}{i} \qquad P = \frac{x[1-(1+i)^{-n}]}{i}$$

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad \mathrm{M}\left(\frac{x_1 + x_2}{2}; \frac{y_1 + y_2}{2}\right)$$

$$y = mx + c \qquad y - y_1 = m(x - x_1) \qquad m = \frac{y_2 - y_1}{x_2 - x_1} \qquad m = \tan\theta$$

$$(x-a)^2 + (y-b)^2 = r^2$$

$$\text{In } \Delta ABC: \quad \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \qquad a^2 = b^2 + c^2 - 2bc.\cos A \qquad \text{area } \Delta ABC = \frac{1}{2}ab.\sin C$$

$$\sin(\alpha + \beta) = \sin\alpha.\cos\beta + \cos\alpha.\sin\beta \qquad \sin(\alpha - \beta) = \sin\alpha.\cos\beta - \cos\alpha.\sin\beta$$

$$\cos(\alpha + \beta) = \cos\alpha.\cos\beta - \sin\alpha.\sin\beta \qquad \cos(\alpha - \beta) = \cos\alpha.\cos\beta + \sin\alpha.\sin\beta$$

$$\cos 2\alpha = \begin{cases} \cos^2\alpha - \sin^2\alpha \\ 1 - 2\sin^2\alpha \\ 2\cos^2\alpha - 1 \end{cases} \qquad \sin 2\alpha = 2\sin\alpha.\cos\alpha$$

$$\bar{x} = \frac{\sum fx}{n} \qquad \sigma^2 = \frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2}{n}$$

$$\mathrm{P}(A) = \frac{n(\mathrm{A})}{n(\mathrm{S})} \qquad \mathrm{P(A \text{ or } B)} = \mathrm{P(A)} + \mathrm{P(B)} - \mathrm{P(A \text{ and } B)}$$

$$\hat{y} = a + bx \qquad b = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sum(x - \bar{x})^2}$$

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MATHEMATICS P1

COMMON TEST

JUNE 2016

MEMORANDUM

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS: 125

This memorandum consists of 10 pages.

 Please turn over

NOTE:

- If a candidate answered a question TWICE, mark only the first attempt.
- If a candidate crossed out an attempt of a question and did not redo the question, mark the crossed-out question.
- Consistent accuracy applies in ALL aspects of the marking memorandum.
- Assuming values/answers in order to solve a problem is unacceptable.

LET WEL:

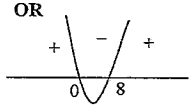
- *As 'n kandidaat 'n vraag TWEE keer beantwoord het, merk slegs die eerste poging.*
- *As 'n kandidaat 'n antwoord deurgehaal en nie oorgedoen het nie, merk die deurgehaalde antwoord.*
- *Volgehoue akkuraatheid is DEURGAANS in ALLE aspekte van die memorandum van toepassing.*
- *Aanvaarding van waardes/antwoorde om 'n problem op te los, is onaanvaarbaar.*

QUESTION/*VRAAG* 1

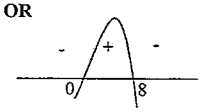
1.1.1 $x=\frac{1}{2}$ *or* $x=-\frac{4}{5}$ ✓✓ values of x (2)

1.1.2 $x(x-8)>0$ ✓$x(x-8)>0$
$x<0$ or $x>8$ ✓$x<0$ ✓$x>8$ (3)

OR



OR



✓sketch ✓$x<0$ ✓$x>8$
penalty 1 mark for writing "and" (3)

1.1.3 $\sqrt{2x+1}-3=0$
$\sqrt{2x+1}=3$ ✓transposing 3
$2x+1=9$
$2x=8$ ✓squaring both sides
$x=4$ ✓answer (3)

1.2 $x-y=-2 \rightarrow (1)$
$x^2+y^2=20 \rightarrow (2)$
$x=y-2 \rightarrow (3)$
subst. (3) into (1) ✓making x the subject
$(y-2)^2+y^2=20$ ✓substitution
$y^2-4y+4+y^2-20=0$
$2y^2-4y-16=0$ ✓std form
$y^2-2y-8=0$
$(y+2)(y-4)=0$ ✓factors
$y=-2$ *or* $y=4$ ✓y values
$x=-4$ *or* $x=2$ ✓x values (6)

OR

Also candidates can make x/y the subject in the circle and continue
i.e.
$y=\pm\sqrt{20-x^2}$
or
$x=\pm\sqrt{20-y^2}$
The suggested marking memo will apply

$x - y = -2 \rightarrow (1)$
$x^2 + y^2 = 20 \quad \rightarrow (2)$
$y = x + 2 \rightarrow (3)$
subst. (3) into (1)
$x^2 + (x+2)^2 = 20$
$x^2 + x^2 + 4x + 4 = 20$
$2x^2 + 4x - 16 = 0$
$x^2 + 2x - 8 = 0$
$(x+4)(x-2) = 0$
$x = -4 \quad or \quad x = 2$
$y = -2 \quad or \quad y = 4$

✓making y the subject
✓substitution
✓std form
✓factors
✓ x values
✓ y values
(6)

1.3 $\dfrac{4^{n+1}.8^{2n}}{16^{2n-1}}$

$= \dfrac{(2^2)^{n+1}.(2^3)^{2n}}{(2^3)^{2n-1}}$
✓writing as prime bases

$= \dfrac{2^{2n+2}.2^{6n}}{2^{8n-4}}$
✓simplifying

$= \dfrac{2^{8n+2}}{2^{8n-4}}$
$= 2^{8n+2-8n+4}$
✓ $\dfrac{2^{8n+2}}{2^{8n-4}}$ or $2^{8n+2-8n+4}$

$= 2^6$
$= 64$
✓ 2^6
✓answer
(5)

OR

$\dfrac{4^{n+1}.8^{2n}}{16^{2n-1}}$

$= \dfrac{4^n.4.8^{2n}}{16^{2n}.16^{-1}}$
✓splitting bases

$= \dfrac{2^{2n}.4.8^{2n}}{16^{2n}16^{-1}}$
✓writing $4^n = 2^{2n}$

$= \dfrac{16^{2n}.4}{16^{2n}.16^{-1}}$
$= 4 \times 16$
$= 64$
✓ $2^{2n}.8^{2n} = 16^{2n}$
✓ 4×16
✓answer
(5)

[19]

QUESTION 2

2.1 1st difference : 0 ; 4 ; 8 ; ...
2nd difference : 4 ; 4 ; 4; .....

$2a = 4$
$a = 2$
✓a value
$3a + b = 0$
$b = -6$
✓b value
$a + b + c = 6$
$c = 10$
✓c value
$T_n = 2n^2 - 6n + 10$
✓ T_n value
(4)

OR

$T_n = T_1 + (n-1)d_1 + \dfrac{(n-1)(n-2)}{2}d_2$
✓formula
$= 6 + (n-1)(0) + \dfrac{(n-1)(n-2)(4)}{2}$
✓substituting T_1, substituting d_1 and d_2
$= 6 + 2n^2 - 6n + 4$
$= 2n^2 - 6n + 10$
✓simplifying
✓ T_n value
(4)

2.2 1st difference n^{th} term : $T_n = 4n - 4$
$4n - 4 = 200$
$4n = 204$
$n = 51$
$Between\ T_{51}\ and\ T_{52}$
✓ $T_n = 4n - 4$
✓ $4n - 4 = 200$
✓ $n = 51$
✓ $Between\ T_{51}\ and\ T_{52}$ (4)

OR

$T_n - T_{n-1} = 2n^2 - 6n + 10 - \left[2(n-1)^2 - 6(n-1) + 10\right]$
$= 2n^2 - 6n + 10 - 2n^2 + 4n - 2 + 6n - 6 - 10$
$= 4n - 8$
$4n - 8 = 200$
$4n = 208$
$n = 52$
$Between\ T_{51}\ and\ T_{52}$

NB.
Any other form can arise here
i.e.
$T_{n+1} - T_n$ etc

✓substitution into formula
✓ $4n - 8 = 200$
✓ $n = 52$
✓ $Between\ T_{51}\ and\ T_{52}$
(4)

2.3 $2n^2-6n+10=32010$ ✓equating $T_n=32010$

$2n^2-6n-32000=0$ ✓form

$n^2-3n-16000=0$

$(n-128)(n+125)=0$ ✓factors/substitution into formula

$\therefore n=128$ or $n=-125n/a$ ✓rejecting value of n (4)

[12]

QUESTION 3

3.1 $S_n=2n^2+3n$

$T_{20}=S_{20}-S_{19}$ ✓$T_{20}=S_{20}-S_{19}$

$=\left[2(20)^2+3(20)\right]-\left[2(19)^2+3(19)\right]$ ✓$\left[2(20)^2+3(20)\right]$ ✓$\left[2(19)^2+3(19)\right]$

$=81$ ✓answer (4)

OR

$S_n=2n^2+3n$

$S_1=2+3=5=T_1=a$

$S_2=T_1+T_2=2(2)^2+3(2)=14$ ✓calculation of first three sums

$T_2=14-5=9$

$S_3=T_1+T_2+T_3=2(3)^2+3(3)=27$ ✓calculation of a and d

$T_3=27-(5+9)=13$

$d=4$

$T_{20}=a+19d=5+19(4)=81$ ✓substitution into 20th term ✓answer (4)

3.2.1 Two sequences are in the given sequence

$3+6+12+24+\ldots$ and $5+5+5+\ldots$

$S_n=\dfrac{a(1-r^n)}{1-r}$

$S_{10}=\dfrac{3\left(2^{10}-1\right)}{2-1}$ ✓correct substitution into sum formula

$=3069$ ✓3069

$S_{10}=5(10)=50$ ✓50

$S_{20}=3119$ ✓3119

(4)

Use of the other sum formula as well is accepted.

3.2.2 $T_n=ar^{n-1}$ ✓$T_n=3.2^{n-1}$ (following from 3.2.1 for a and r)

$3.2^{n-1}=6291456$ ✓$3.2^{n-1}=6291456$

$2^{n-1}=2097152$

$2^{n-1}=2^{21}$ ✓$2^{n-1}=2^{21}$/correct use of log

$n=22$ ✓$n=22$

Therefore the 22nd term of the series will be equal to 6291456 (4)

[12]

Use of logs.
$\log_2 2097512=n-1$
$21=n-1$
$n=22$

QUESTION 4

4.1.1 $p=1$ ✓$p=1$

$q=-2$ ✓$q=-2$ (2)

4.1.2 $y=\dfrac{a}{x+p}+q$

$0=\dfrac{a}{\frac{1}{2}+1}-2$ ✓substitution of p and q

✓substitution $(\frac{1}{2};0)$

$2=\dfrac{a}{1,5}$

$a=3$ ✓answer (3)

4.1.3 Point of intersection of asymptotes : $(-1;-2)$

$y=mx+c$

$-2=-1(-1)+c$ ✓gradient = -1

$c=-3$ ✓substituting $(-1;-2)$ into equation of line

$y=-x-3$ ✓equation of line (3)

OR

$y=-(x+1)-2$ ✓✓$y=-(x+1)-2$

$y=-x-3$ ✓equation of line (3)

[8]

QUESTION 5

5.1 $y=a^x$

$\dfrac{1}{8}=a^{-3}$ ✓substituting $\left(-3;\dfrac{1}{8}\right)$

$\left(\dfrac{1}{2}\right)^3=a^{-3}=2^{-3}$ ✓$\left(\dfrac{1}{2}\right)^3$

$a=2$ ✓a value (3)

5.2 $f^{-1}(x):y=\log_2 x$ ✓✓answer (2)

5.3 $\log_2 x=-3$ ✓setting up equation

$x=2^{-3}=\dfrac{1}{8}$ ✓applying defn of log.

$x>\dfrac{1}{8}$ ✓answer
(answer only full marks) (3)

[8]

QUESTION 6

6.1
$g(x)=x^2-2x+4$
$x=-\frac{b}{2a}=-\frac{(-2)}{2(1)}=1 \quad or \quad 2x-2=0 \ \therefore x=1$
$y=(1)^2-2(1)+4=3$
$P(1;3)$

✓method $-\frac{(-2)}{2(1)}$ or $2x-2=0$
or $(x-1)^2+3$
✓$x=1$
✓$y=3$ (coordinate form) (3)

6.2
$g(x)=x^2-2x+4=12$
$x^2-2x-8=0$
$(x+2)(x-4)=0$
$x=-2 \quad or \quad x=4$
$y=12$
$A(-2;12)$

✓equating to 12
✓factors
✓x values
✓ coordinates of A (4)

6.3
$CD=x^2-2x+4-(x+1)$
$=x^2-3x+3$

✓for subtraction of both graphs
✓answer (2)

6.4
$CD=x^2-3x+3$
$CD'=2x-3=0$
$x=\frac{3}{2}$
$CD=\left(\frac{3}{2}\right)^2-3\left(\frac{3}{2}\right)+3=\frac{3}{4}$ units

✓method
✓x value
✓CD value (3)

6.5
$x^2-2x+4=2x+c$
$x^2-4x+4-c=0$
$\Delta=b^2-4ac=0$
$(-4)^2-4(1)(4-c)=0$
$16-16+4c=0$
$c=0$

✓equating graphs
✓standard form
✓for discriminant =0
✓substitution
✓answer (5)

OR
$g'(x)=2x-2$
$2x-2=2$
$2x=4$
$x=2$
$y=(2)^2-2(2)+4=4$
$y=2x+c$
$4=2(2)+c$
$c=0$

✓derivative
✓equating derivative to 2
✓x value
✓y value
✓answer (5)
[17]

QUESTION 7 (penalize **once** for notational errors in Q 7,8 & 9)

7.1
$f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$
$=\lim_{h\to 0}\frac{-2(x+h)^2+5-(-2x^2+5)}{h}$
$=\lim_{h\to 0}\frac{-2x^2-4xh-2h^2+5+2x^2-5}{h}$
$=\lim_{h\to 0}\frac{-4xh-2h^2}{h}$
$=\lim_{h\to 0}\frac{h(-4x-2h)}{h}$
$=-4x$

✓formula
✓correct substitution into formula
✓simplification
✓factorization
✓answer (5)

OR
$f(x+h)=-2(x+h)^2=-2x^2-4xh-2h^2+5$
$f(x+h)-f(x)=-4xh-2h^2$
$f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$
$=\lim_{h\to 0}\frac{-4xh-2h^2}{h}$
$=\lim_{h\to 0}\frac{h(-4x-2h)}{h}$
$=-4x$

✓finding $f(x+h)$
✓ finding $f(x+h)$ - $f(x)$
✓formula
✓factorization
✓answer (5)

7.2.1
$y=\frac{x^3-27}{3-x}$
$y=\frac{(x-3)(x^2+3x+9)}{-(x-3)}$
$y=-x^2-3x-9$
$\frac{dy}{dx}=-2x-3$

✓factors in numerator
✓ $y=-x^2-3x-9$
✓✓each answer (4)

7.2.2
$D_x\left[\sqrt{x}\left(2x-\frac{7}{\sqrt[3]{x}}\right)\right]$
$D_x\left[2x^{\frac{3}{2}}-7x^{\frac{1}{6}}\right]$
$=3x^{\frac{1}{2}}-\frac{7}{6}x^{-\frac{5}{6}}$

✓$2x^{\frac{3}{2}}$✓$-7x^{\frac{1}{6}}$ simplifying
✓✓each answer (4)

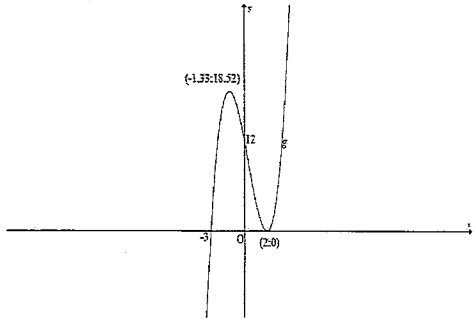
7.3.1
$g(x)=x^3-x^2-8x+12$
$g(2)=(2)^3-(2)^2-8(2)+12$
$=0$

✓correct substitution
✓answer (2)

7.3.2 $g(x) = x^3 - x^2 - 8x + 12 = 0$
$(x-2)(x^2+x-6) = 0$ ✓factorization
$(x-2)(x-2)(x+3) = 0$
$x = 2 \quad or \quad x = -3$ ✓✓x values (3)

7.3.3 $g'(x) = 3x^2 - 2x - 8 = 0$ ✓derivative and equal to 0
$(3x+4)(x-2) = 0$ ✓factors
$x = -\frac{4}{3} \quad or \quad x = 2$ ✓x values
$y = \left(\frac{-4}{3}\right)^3 - \left(\frac{-4}{3}\right)^2 - 8\left(\frac{-4}{3}\right) + 12 = \frac{500}{27} \quad or \quad y = 0$ ✓y values
$\left(\frac{-4}{3}; 18{,}52\right) \quad (2;0)$ (4)

7.3.4



✓x - Intercepts
✓y - Intercept
✓Turning points
✓shape (4)

7.3.5 $0 < k < 18{,}52$ ✓✓answer (2)
[28]

QUESTION 8

8.1 $\pi r^2 h = 330$ ✓volume formula
$h = \frac{330}{\pi r^2}$ ✓volume equal to 330 (2)

8.2 $A = 2\pi r^2 + 2\pi rh$ ✓surface area formula
$\Rightarrow A = 2\pi r^2 + 2\pi r\left(\frac{330}{\pi r^2}\right)$ ✓correct substitution
$A = 2\pi r^2 + \frac{660}{r}$ (2)

8.3 $A = 2\pi r^2 + \frac{660}{r}$
$A = 2\pi r^2 + 660r^{-1}$ ✓derivative
$A' = 4\pi r - 660r^{-2} = 0$ ✓derivative = 0
$4\pi r = \frac{660}{r^2}$
$4\pi r^3 = 660$
$r^3 = \frac{660}{4\pi}$ ✓$\frac{660}{4\pi}$
$r = \sqrt[3]{\frac{660}{4\pi}} = 3{,}74cm$ ✓making r the subject
✓$r = 3{,}74cm$ (5)
[9]

QUESTION 9

9.1 Average Velocity $= \frac{h(2) - h(0)}{2-0}$
$= \frac{\left[20(2) - 5(2)^2\right] - \left[20(0) - 5(0)^2\right]}{2}$ ✓substitution into gradient formula
$= 10\ m/s$ ✓answer (2)

9.2 Vertical velocity: $h'(t) = 20 - 10t$ ✓derivative
$h'(1.5) = 20 - 10(1.5)$ ✓substitution
$= 5\ m/s$ ✓answer (3)

9.3 $20 - 10t = 0$ ✓derivative =0
$t = 2$ ✓answer
Time taken for vertical velocity to be zero is 2 seconds (2)

9.4 $20t - 5t^2 = 0$ ✓$h(t)$=0
$5t(4-t) = 0$ ✓factors
$t = 0 \quad or \quad t = 4$ ✓t values
$h'(4) = 20 - 10(4) = -20$ ✓substitution of $t = 4$
✓velocity = -20 (5)
[12]

TOTAL MARKS: 125