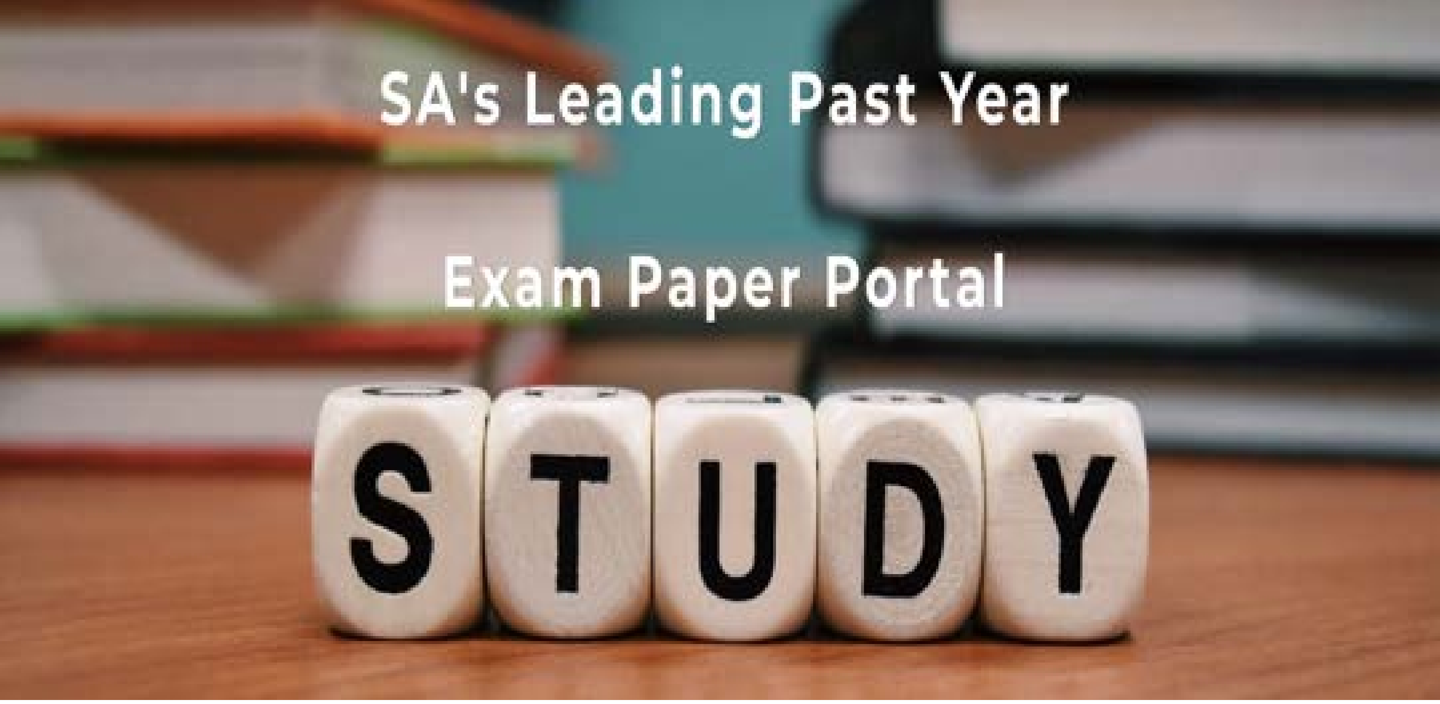
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Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL MATHEMATICS P1

2022

MARKS: 150

TIME: 3 hours

This question paper consists of 11 pages, 2 information sheets and 1 answer sheet.

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. This question paper consists of NINE questions.

2. Answer ALL the questions.

3. Answer QUESTION 4.2.3 on the ANSWER SHEET provided. Write your centre number and examination number in the spaces provided on the ANSWER SHEET and hand in the ANSWER SHEET with your ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Clearly show ALL calculations, diagrams, graphs, etc. that you have used in determining your answers.

6. Answers only will NOT necessarily be awarded full marks.

7. You may use an approved scientific calculator (non-programmable and non-graphical), unless stated otherwise.

8. If necessary, round off answers to TWO decimal places, unless stated otherwise.

9. Diagrams are NOT necessarily drawn to scale.

10. An information sheet with formulae is included at the end of the question paper.

11. Write neatly and legibly.

QUESTION 1

1.1 Given: $f(x) = x^2 - 3x - 10$

Solve for x if:

1.1.1 $f(x) = 0$ (2)

1.1.2 $f(x) < 0$ and represent the solution on a number line (3)

1.2 Solve for x:

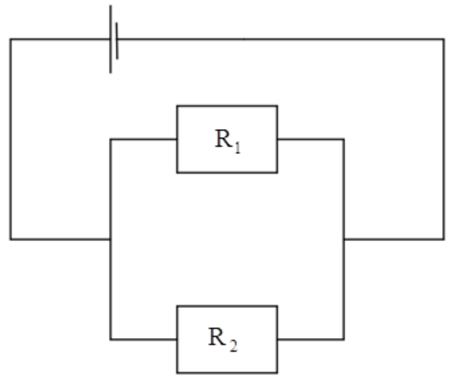
$2x^2 - 11 = -7x$ (correct to TWO decimal places) (3)

1.3 Solve for x and y if:

$y - x + 1 = 0$ and $y + 7 = x^2 + 2x$ (6)

1.4 The formula used to determine the resistance in the diagram below, in a circuit where resistors are connected in parallel, is given by:

$$\frac{1}{\mathrm{R_p}} = \frac{1}{\mathrm{R_1}} + \frac{1}{\mathrm{R_2}}$$



$\mathrm{R_p}$ = total resistance in ohms (Ω)
$\mathrm{R_1}$ = resistance of resistor 1 in ohms (Ω)
$\mathrm{R_2}$ = resistance of resistor 2 in ohms (Ω)

1.4.1 Make $\mathrm{R_p}$ the subject of the formula. (2)

1.4.2 Hence, or otherwise, calculate the total resistance $\mathrm{R_p}$ if:

$\mathrm{R_1} = 40\ \Omega$ and $\mathrm{R_2} = 45\ \Omega$ (2)

1.5 Evaluate $1101100_2 \div 1100_2$ (Leave your answer in binary form.) (2)

[20]

QUESTION 2

2.1 Given: $X = \sqrt{e-4}$

Write down the value of e, for which X is:

2.1.1 Zero (1)

2.1.2 Non-real (1)

2.2 Determine the value(s) of m for which the equation $mx^2 - 12x + 9 = 0$ has equal roots. (4)

[6]

QUESTION 3

3.1 Simplify the following WITHOUT using a calculator:

3.1.1 $\dfrac{3^x \times 3^{x-2}}{9^{x-3}}$ (3)

3.1.2 $\left(\sqrt{5}+4\right)^2 - \sqrt{45}$ (3)

3.1.3 $\log_{32} 8 + \log 10$ (4)

3.2 Solve for x: $\log_4 x + \log_4 (x-6) = \log_5 25$ (6)

3.3 In the RLC circuit, the impedance of the two impedances connected in series are:

$$z_1 = 4\sqrt{2}\, cis\, 225° \text{ and } z_2 = 3 - 4i$$

3.3.1 Express z_1 in rectangular form. (2)

3.3.2 Hence, determine $(z_1 + z_2)$, the total impedance of the circuit. (2)

3.4 Determine (showing ALL working) the numerical values of p and q if:

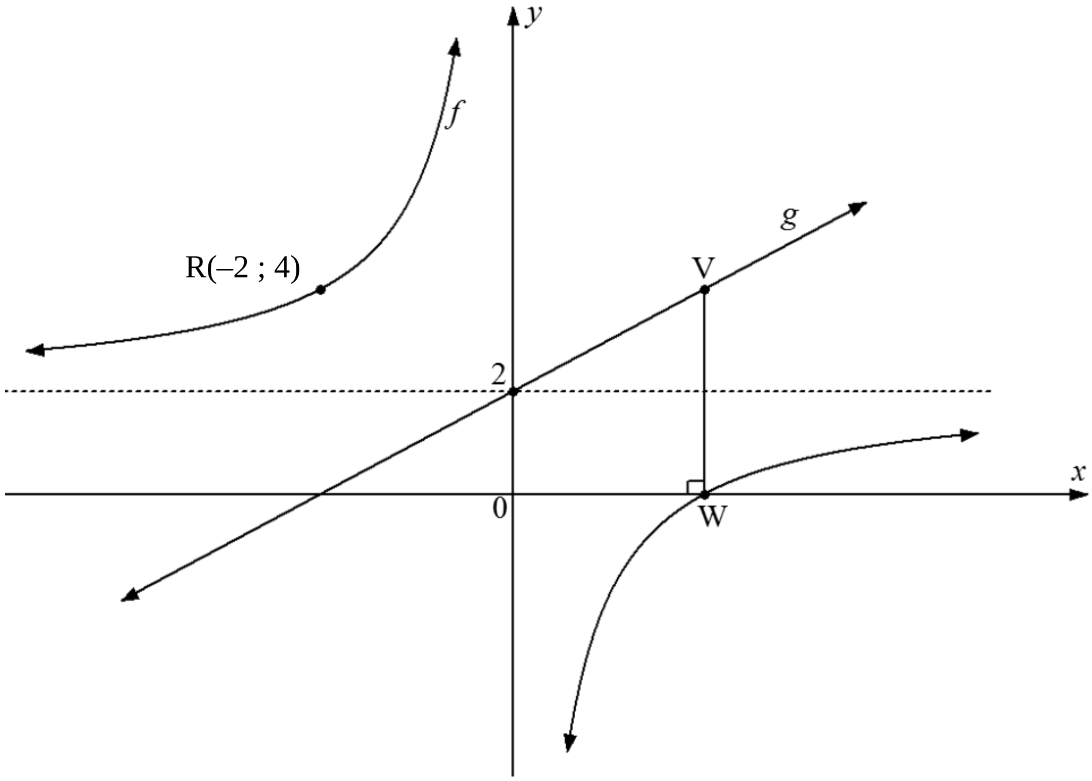
$$-p + qi = 4i^5 - 2(7 + 3i)$$ (5)

[25]

QUESTION 4

4.1 The diagram below represents the graphs of the functions defined by $f(x) = \frac{a}{x} + q$ and $g(x) = mx + c$.

R$(-2\ ;\ 4)$ is a point on f.
g is the line of symmetry of f which cuts the y-axis at 2.
W is the x-intercept of f.
Point V is on g such that VW is perpendicular to the x-axis.



4.1.1 Determine the equation of f. (3)

4.1.2 Write down the equation of g. (1)

4.1.3 Write down the range of f. (2)

4.1.4 Determine the coordinates of W. (2)

4.1.5 Determine the coordinates of V. (2)

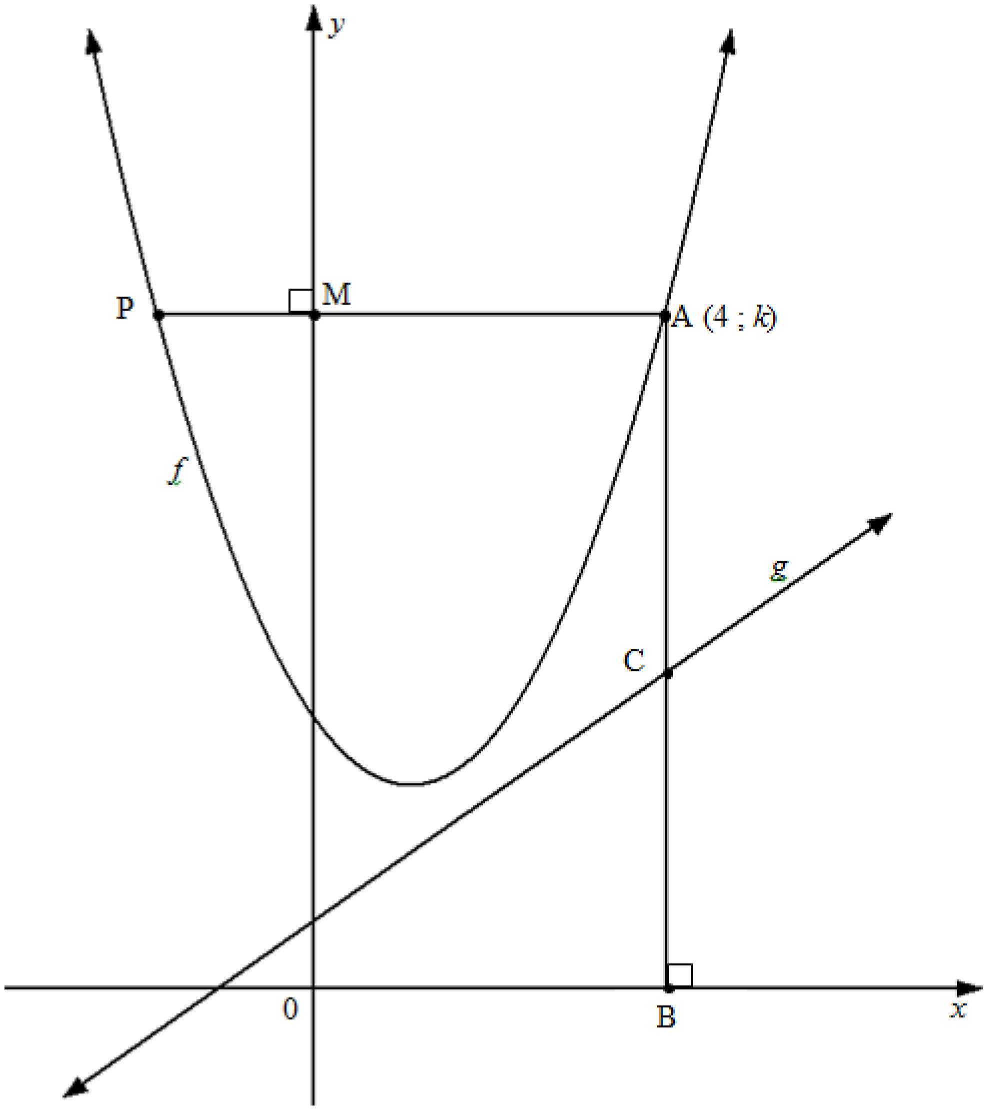
4.2 Given the function $p(x) = 2^x - 4$

4.2.1 Write down the equation of the asymptote of p. (1)

4.2.2 Determine the x- and y-intercepts of p. (3)

4.2.3 Draw the sketch graph of p on the ANSWER SHEET provided. Indicate ALL the intercepts with the axes and the asymptote. (3)

4.3 The sketch below represents the functions defined by $f(x) = x^2 - 2x + 4$ and $g(x) = x + 1$
PM is perpendicular to the y-axis and AB is perpendicular to the x-axis.
C is a point on g and A$(4\,;\,k)$ is a point on f.



Determine:

4.3.1 The value of k (2)

4.3.2 The length AC (3)

4.3.3 The coordinates of P (4)
[26]

QUESTION 5

5.1 Thabile buys a cement mixing machine from a hardware shop on hire purchase at a simple interest rate of 21% per annum. The cement mixing machine costs R15 350 and Thabile plans to pay it off over a period of 2 years in equal monthly instalments.

Calculate how much she will pay monthly. (4)

5.2 The production of metal pellets by a machine that already makes 500 metal pellets a day is increased at a compound rate of 25% per day for 10 days.

5.2.1 How many metal pellets are produced on the first day? (1)

5.2.2 Determine the number of pellets produced on the tenth day. (3)

5.3 Zane invested an amount of money into an account that earned an interest rate of 6,78% per annum, compounded monthly. At the end of 2 years, the interest rate changed to 5,20% per annum, compounded quarterly. The value of the investment is R50 962,58 at the end of a 3,5(three and half)-year investment period.

Determine the initial amount Zane invested. (6)

[14]

QUESTION 6

6.1 Determine $f^{/}(x)$ using FIRST PRINCIPLES if $f(x) = 5 + x$ (5)

6.2 Determine:

6.2.1 $\dfrac{dy}{dx}$ if $y = x(x+9)$ (3)

6.2.2 $D_x\left[\sqrt[7]{x} + \pi p^3\right]$ (3)

6.2.3 $f^{/}(x)$ if $f(x) = \dfrac{1-x^9}{x^2}$ (4)

6.3 Given $g(x) = -4x^2$

Determine:

6.3.1 $g(2)$ (1)

6.3.2 The equation of the tangent to g at a point where $x = 2$ (4)

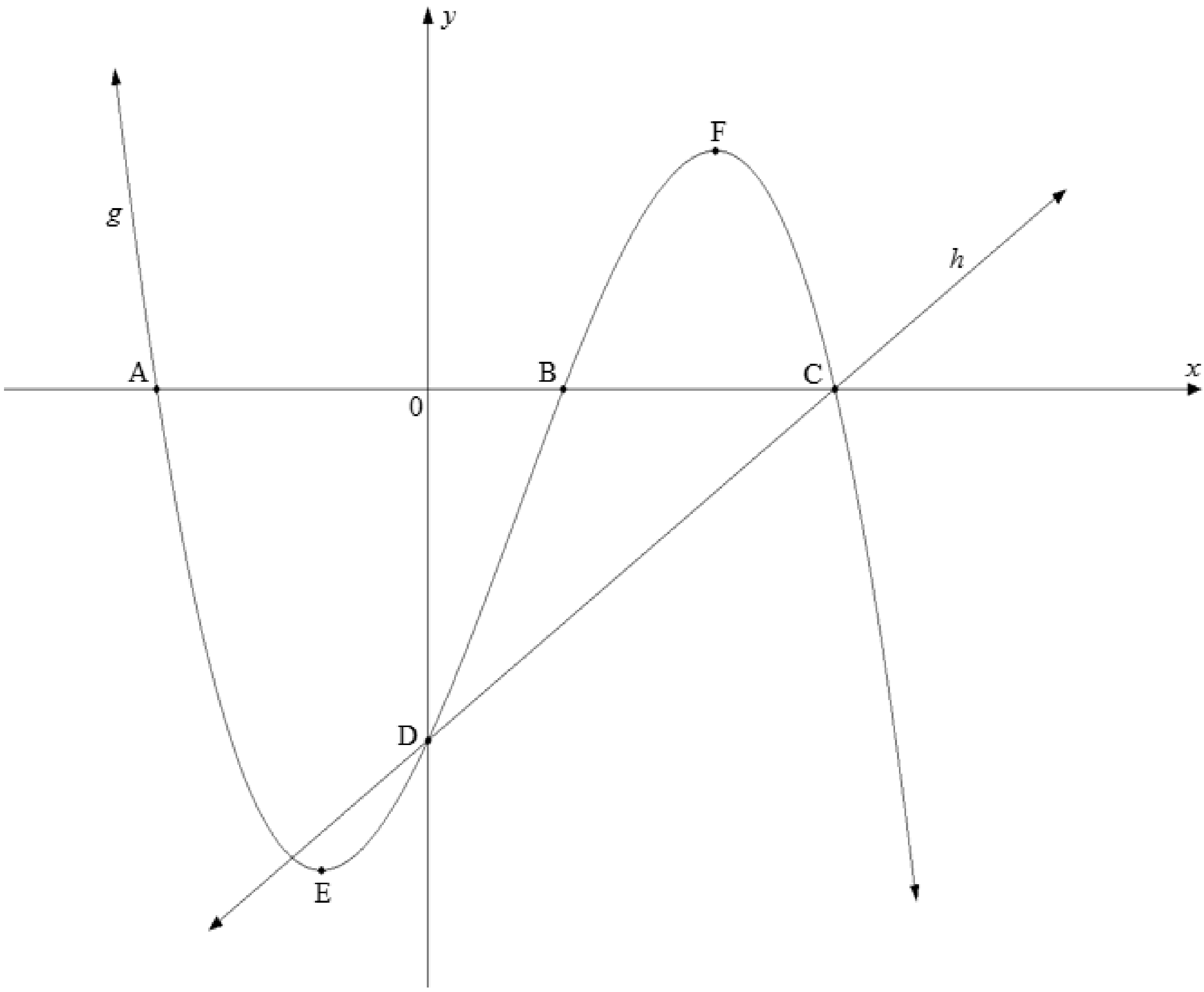
[20]

QUESTION 7

The graphs below represent the functions defined by $g(x) = -(x+2)(x-1)(x-3)$ and $h(x) = 2x + p$

E and F are the turning points of g.

A, B, C and D are intercepts on the axes.



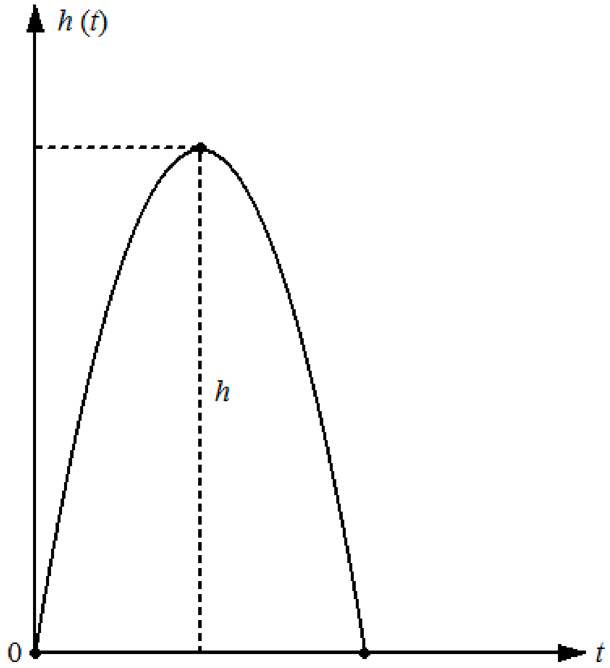
7.1	Write down the coordinates of C.	(2)
7.2	Write down the value of p.	(1)
7.3	Determine the length of AC.	(2)
7.4	Express $g(x) = -(x+2)(x-1)(x-3)$ in the form $g(x) = ax^3 + bx^2 + cx + d$	(2)
7.5	Determine the coordinates of E and F.	(5)
7.6	Write down the values of x for which $g(x) > 0$	(3)

[15]

QUESTION 8

A toy rocket is launched upwards from the ground. The height (h) in metres (m) of the rocket above the starting point t seconds after being launched is given by $h(t) = -5t^2 + 25t$

The diagram below illustrates the motion of the toy rocket.



Determine:

8.1 The height of the toy rocket after 1 second (2)

8.2 The initial velocity of the toy rocket
(HINT: velocity = $h^{/}(t)$) (3)

8.3 The maximum height that the toy rocket reached (3)

8.4 The values of t for which the rocket will be 30 m above the ground (3)
[11]

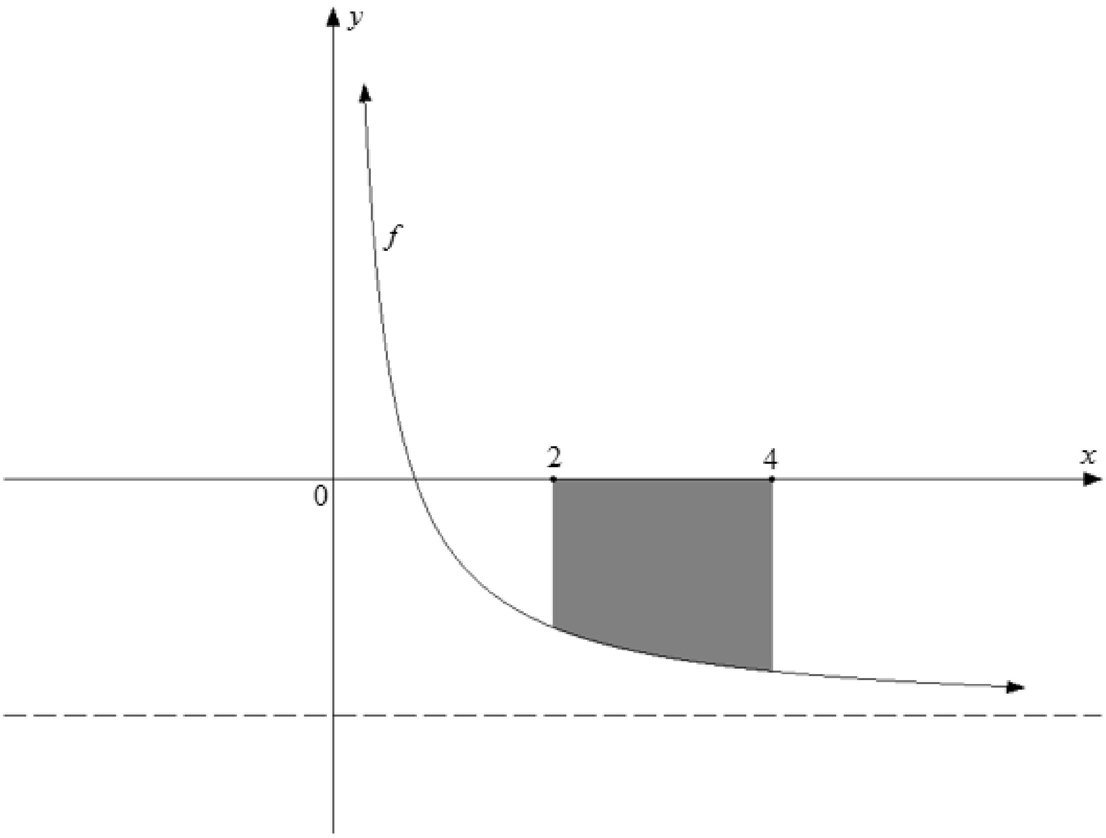
QUESTION 9

9.1 Determine the following integrals:

9.1.1 $\int (10^{x} + 6)\,dx$ (3)

9.1.2 $\int \left(x^{4}(x+2) - 2x^{-3}\right)dx$ (4)

9.2 The sketch below represents the shaded area bounded by the curve of the function defined by $f(x) = \frac{3}{x} - 4$; $x > 0$ and the x-axis between the points where $x = 2$ and $x = 4$



Determine (showing ALL calculations) the shaded area bounded by the curve and the x-axis between the points where $x = 2$ and $x = 4$ (6)

[13]

TOTAL: 150

INFORMATION SHEET: TECHNICAL MATHEMATICS

$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $\quad x = -\dfrac{b}{2a}$ $\quad y = \dfrac{4ac - b^2}{4a}$

$a^x = b \Leftrightarrow x = \log_a b, \quad a > 0,\ a \neq 1 \text{ and } b > 0$

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

$i_{eff} = \left(1 + \frac{i}{m}\right)^m - 1$

$f^{/}(x) = \lim\limits_{h \to 0} \dfrac{f(x+h) - f(x)}{h}$

$\int x^n\, dx = \dfrac{x^{n+1}}{n+1} + C, \quad n \neq -1$ $\quad \int k x^n\, dx = k.\dfrac{x^{n+1}}{n+1} + C, \quad n \neq -1$

$\int \dfrac{1}{x} dx = \ln x + C, \quad x > 0$ $\quad \int \dfrac{k}{x} dx = k.\ln x + C, \quad x > 0$

$\int a^x\, dx = \dfrac{a^x}{\ln a} + C, \quad a > 0$ $\quad \int k a^{nx}\, dx = k.\dfrac{a^{nx}}{n \ln a} + C, \quad a > 0$

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

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

$\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$

In ΔABC: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$ $\quad a^2 = b^2 + c^2 - 2bc \cdot \cos A$

$\textit{area of } \Delta ABC = \dfrac{1}{2} ab. \sin C$

$\sin^2\theta + \cos^2\theta = 1$ $\quad 1 + \tan^2\theta = \sec^2\theta$ $\quad 1 + \cot^2\theta = \operatorname{cosec}^2\theta$

$\pi\, rad = 180^\circ$

Angular velocity = $\omega = 2\pi n$ where n = rotation frequency

Angular velocity = $\omega = 360^\circ n$ where n = rotation frequency

Circumferential velocity $= v = \pi D n$ where D = diameter and n = rotation frequency

Arc length $s = r\theta$ where r = radius and θ = central angle in radians

Area of a sector $= \dfrac{rs}{2}$ where r = radius, s = arc length

Area of a sector $= \dfrac{r^2\theta}{2}$ where r = radius, s = arc length and θ = central angle in radians

$4h^2 - 4dh + x^2 = 0$ where h = height of segment, d = diameter of circle and x = length of chord

$A_T = a\left(m_1 + m_2 + m_3 + ... + m_n\right)$ where a = equal parts, $m_1 = \dfrac{o_1 + o_2}{2}$
and n = number of ordinates

OR

$A_T = a\left(\dfrac{o_1 + o_n}{2} + o_2 + o_3 + ... + o_{n-1}\right)$ where a = equal parts, $o_i = i^{th}$ ordinate
and n = number of ordinates

ANSWER SHEET

CENTRE NUMBER							

EXAMINATION NUMBER													

QUESTION 4.2.3