

NBT PRACTICE PROBLEMS (MAT)

- NBT'S look for understanding of concepts in core mathematics.
 - There is no scaffolding and answers are multiple choice.
 - NB *** No calculators may be used *** NB
 - No long calculations are required.
 - These questions are simply meant to check student understanding of core mathematical concepts, stimulate critical thought and problem solving, and familiarise dealing with multiple choice answers.
 - Questions move between "Paper 1" and "Paper 2", and between algebraic and geometric concepts.
 - The questions are a mix of Recall, Knowledge, Problem solving and Complex, with the latter two being more dominant. A rough guide in this regard is given on the last page.
 - They are not meant to emulate exact NBT questions.
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- There are 40 questions in practice for the MAT section.
 - Sketches are not necessarily to scale.
 - A Formula Sheet is provided.
 - The Answer Key may be found on the last page.
 - If working under the same environment as the MAT test, then allow exactly 2 hours to complete all the questions. (3 minutes a question)
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- ✓ Consideration of these questions will certainly have the added benefit of improving student knowledge of core mathematics principles found in any test or examination.
 - ✓ Think twice, think outside the box, and select once.
 - ✓ Most importantly, have fun!
 - ✓ All the best in your National Benchmark Test.

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QUESTION 1

An ordered set of seven data points with no outliers is given as follows:

$$a; 15; b; 15; c; 40; d \quad \text{where } a, b, c, d \in \mathbb{Z}$$

Maximum sum $a + b + c + d = ?$

- A. 110 B. 147 C. 125 D. 133

QUESTION 2

In a convergent geometric series, $T_1 = a$ and the sum of all terms is $3m$. Which of the following is true?

- A. $-6m \leq a \leq 6m$ B. $0 < a < 3m$ C. $0 < a < 6m$ D. $-3m < a < 3m$

QUESTION 3

$$\sqrt{15 - 4\sqrt{11}} = ?$$

- A. $\sqrt{11} - \sqrt{3}$ B. $\sqrt{15} - \sqrt{7}$ C. $\sqrt{11} - 2$ D. $\sqrt{2}$

QUESTION 4

$$\sum_{n=25}^{65} \cos^2 n = ?$$

- A. 20,75 B. 21 C. 20,5 D. $20\frac{\sqrt{3}}{2}$

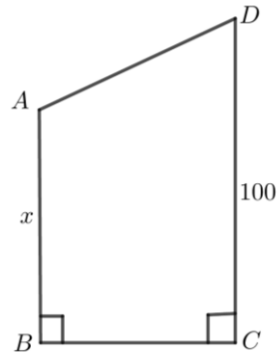
QUESTION 5

A sum of R2000 is invested for 10 years and earns compound interest annually. The final amount after 10 years is R3000. Which expression represents the annual rate of interest, r ?

- A. $\frac{(1,5)^{10}-1}{100}$ B. $100\left({}^{10}\sqrt{1,5} + 1\right)$ C. $100{}^{10}\sqrt{1,5} - 1$ D. $100\left({}^{10}\sqrt{1,5} - 1\right)$

QUESTION 6

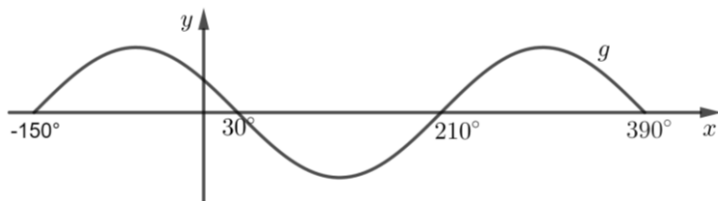
In the sketch, A, B, C , and D lie in the same vertical plane, with ground level BC . The angle of elevation of D from A is 30° , while the angle of depression of C from A is 60° . What is the value of x ?



- A. 65 B. 75 C. 80 D. 70

QUESTION 7

In the graph, the range of $g(x)$ is $[-1; 1]$. $g(x) = ?$



- A. $\cos(x - 60^\circ)$ or $\sin(x - 30^\circ)$ C. $\cos(x + 60^\circ)$ or $-\sin(x - 30^\circ)$
 B. $\sin(x - 30^\circ)$ D. $\cos(x + 30^\circ)$

QUESTION 8

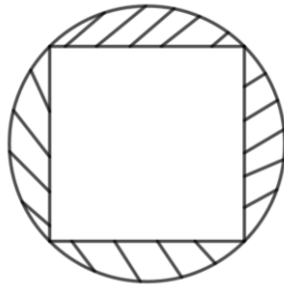
Given the exponential function $g(x) = ab^{x-p} + q$, where $b > 0$, $b \neq 1$. The graph g will have an x - intercept when:

- (1) $a > 0$ and $q < 0$ (3) $a < 0$ and $q > 0$
 (2) $a > 0$ and $q > 0$ (4) $a < 0$ and $q < 0$

- A. (1) Only B. (4) Only C. (1) or (3) Only D. (2) or (4) Only

QUESTION 9

In the figure, a square is symmetrically located in a circular target, radius r . A dart is randomly thrown at the target, hitting it. What is the probability that the dart landed in the hatched region?



- A. $1 - \frac{2}{\pi}$ B. $\frac{\pi}{2+\sqrt{2}}$ C. $\frac{\pi-1}{\pi}$ D. $1 - \frac{1}{2\pi}$

QUESTION 10

If $cd = 2$, $de = \frac{5}{8}$, and $ce = 20$, what is a possible value of cde ?

- A. -4 B. 8 C. -5 D. 10

QUESTION 11

$f(x) = 4 - \sin 4x \cdot \tan 2x$ and $g(x) = m$, where m is a constant. For which values of m will the graphs of f and g never intersect?

- A. $m > 2$ or $m < -4$ B. $m > 4$ or $m < -2$
C. $m > 4$ or $m \leq 2$ D. $m \geq 4$ or $m < 2$

QUESTION 12

The following was recorded after a maths test in Grade 12 at a local school:

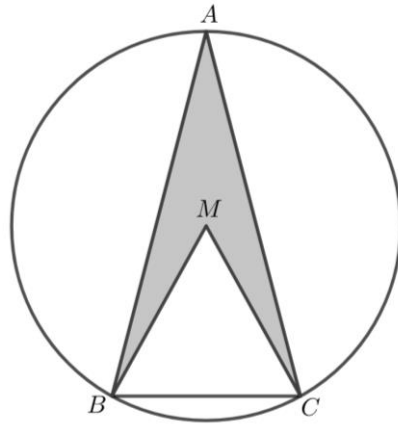
MEAN ($\bar{x}$): 50 RANGE (R): 50 STANDARD DEVIATION (SD): 5
MEDIAN (Q_2): 45

It was agreed to award every student an extra 5 marks. New $\bar{x} + R + SD + Q_2 = ?$

- A. 170 B. 160 C. 175 D. 165

QUESTION 13

A, B , and C lie on the circle centre M with radius r . $\triangle ABC$ is isosceles with base BC . $AC = m$ and $\widehat{BMC} = 60^\circ$. The shaded area is given by:



- A. $\frac{1}{4}(m^2 - \sqrt{3}r^2)$ B. $\frac{1}{4}(m^2 - r^2)$ C. $\frac{\sqrt{3}}{4}m^2 - \frac{r^2}{4}$ D. $m^2 - \frac{\sqrt{3}}{2}r^2$

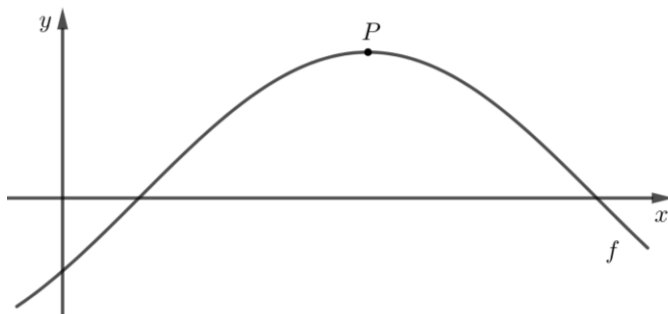
QUESTION 14

$x^2 = 17x + y$ and $y^2 = 17y + x$, $x \neq y$. $\sqrt{x + y} = ?$

- A. 3 B. 5 C. 4 D. 6

QUESTION 15

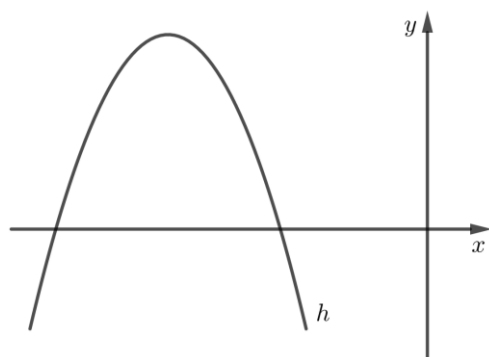
The graph of $f(x) = \sin(x + m)$ for constant m is shown. $P(120^\circ; 1)$ is a turning point on f . $g(x) = \frac{\sqrt{2}}{2}(\sin x + \cos x)$. $g(x) = ?$



- A. $f(x + 15^\circ)$ B. $f(x + 45^\circ)$ C. $f(x - 15^\circ)$ D. $f(x + 75^\circ)$

QUESTION 16

The diagram shows the graph of $h(x)$. If $f(x) = x^2$, which of the following could represent $h(x)$?



A. $h(x) = -f(x + 3) - 2$

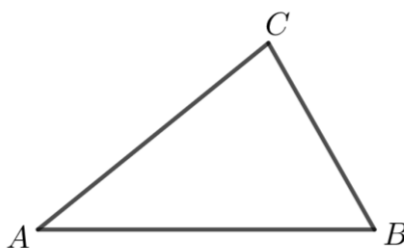
B. $h(x) = -f(x - 4) + 3$

C. $h(x) = f(x + 3) - 2$

D. $h(x) = -f(x + 4) + 3$

QUESTION 17

In the given triangle ABC , $\tan A = \frac{3}{4}$ and $\sin B = \frac{5}{13}$. What is the value of $\cos C$?



A. $\frac{4}{13}$

B. $-\frac{33}{65}$

C. $\frac{3}{5}$

D. $-\frac{63}{65}$

QUESTION 18

P and Q are the respective maximum and minimum values of the expression

$$(3 \sin \theta - 1)^2 + 2. \quad P + Q = ?$$

A. 20

B. 8

C. 16

D. 6

QUESTION 19

Points $A(4; 6)$, $B(m; n)$, and $C(10; -3)$ are colinear. Which of the following equations is correct?

- A. $n = -\frac{3}{2}m$ B. $n = -\frac{3}{2}m + 12$ C. $m = \frac{3}{2}n$ D. $2n - 3m = 12$

QUESTION 20

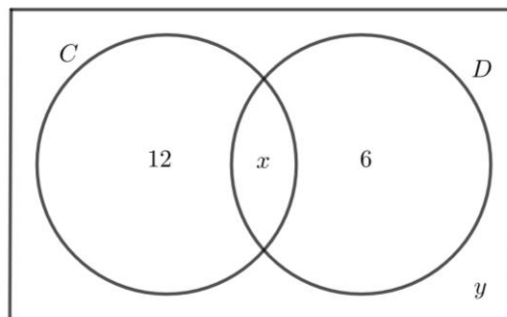
If $(3a + 2) + (3b + 7) = 2025$, what is the value of the sum of $\left(\frac{a}{3} + 4\right)$ and $\left(\frac{b}{3} - 9\right)$?

- A. 675 B. 408 C. 219 D. 670

QUESTION 21

The Venn diagram shows events C and D . The numbers shown indicate the number of elements (eg, 12 means twelve elements). C and D are independent events.

$$xy = ?$$



- A. 84 B. 24 C. 72 D. 52

QUESTION 22

The expression $2x^3 + mx^2 - 3x + n$ is divisible by $x^2 - x - 2$. $m + n = ?$

- A. -2 B. 2 C. -1 D. 1

QUESTION 23

If $m^2 - n^2 = 2021$ and $47(m + n)^{-1} = 1$, what is the value of $m - n$?

- A. 37 B. 21 C. 43 D. 41

QUESTION 24

$A + B$ are the first two terms of a geometric series. The sum of the series is $-\frac{27}{4}$.
 $B - A = 12$. $A + B = ?$

- A. 21 B. -4 C. 5 D. -6

QUESTION 25

M and N are the respective maximum and minimum values of the expression:

$\cos\theta - \sqrt{3}\sin\theta$. $M - N = ?$

- A. 4 B. $\sqrt{3}$ C. 1 D. $2\sqrt{3}$

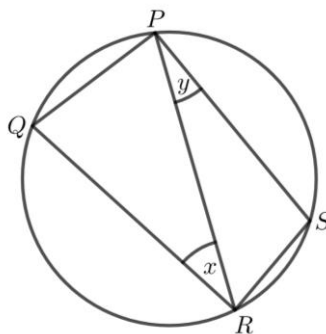
QUESTION 26

A cylindrical metal water pipe is 1 km long. The outside diameter of the pipe is 1,04 m and the pipe is 2 cm thick. What is the approximate volume of metal making up the pipe?

- A. $64m^3$ B. $34m^3$ C. $256m^3$ D. $46m^3$

QUESTION 27

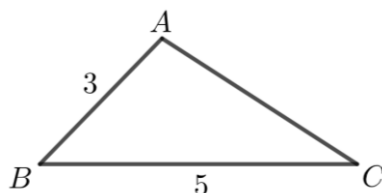
In the figure, P, Q, R , and S lie on a circle as shown. $\angle QPS = 90^\circ$. $PR = ?$



- A. $\frac{PQ \cdot \cos(y-x)}{\sin x}$ B. $\frac{PQ \cdot \sin y}{\sin x}$ C. $\frac{QR \cdot \sin(y-x)}{\sin y}$ D. $\frac{PQ \cdot \cos y}{\sin x}$

QUESTION 28

In the figure, $AC = \sqrt{19}$ units. The magnitude of $\hat{B}$ is halved whilst retaining the lengths of sides AB and BC . What is the area of ΔA^1BC , where A^1 is the new position of A ?



- A. $\frac{15}{4} \text{ units}^2$ B. $\frac{7\sqrt{3}}{4} \text{ units}^2$ C. 4 units^2 D. $\sqrt{19} \text{ units}^2$

QUESTION 29

If $y - \frac{1}{y} = 4$, what is the value of $\left(\frac{y^2+1}{y}\right)^2 - 10$?

- A. 8 B. 10 C. 4 D. 16

QUESTION 30

$\cos x = \frac{4}{5}$ and $x + y = 90^\circ$ for acute x, y . $\sin(90^\circ + y) = ?$

- A. $-\frac{4}{5}$ B. $\frac{3}{5}$ C. $\frac{4}{5}$ D. $-\frac{3}{5}$

QUESTION 31

Given $3^{2x} = 5$ and $125^{\frac{y}{2}} = 243$. $3xy = ?$

- A. 15 B. 5 C. 9 D. 3

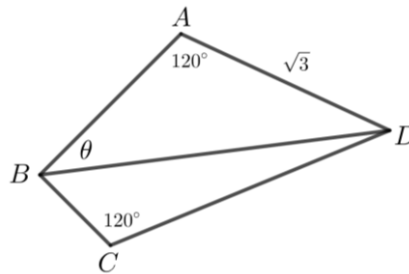
QUESTION 32

The product of two positive numbers is m . The difference of their reciprocals is n , where $n > 0$. What is the sum of the squares of the two numbers?

- A. $m^2n^2 + 2m$ B. $mn - 2n^2$ C. $\frac{m^2n^2}{m-n}$ D. $\frac{m+n}{m^2n^2}$

QUESTION 33

In the figure, A, B, C, D are in the same horizontal plane. $\widehat{ABC} = 90^\circ$. $CD = ?$

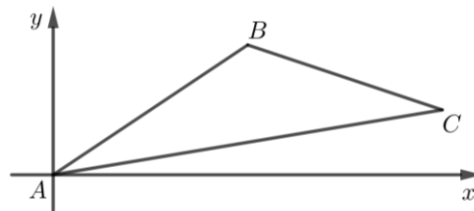


- A. $\frac{\sqrt{3}}{\tan \theta}$ B. $\frac{\sqrt{3} \sin \theta}{2}$ C. $\frac{2}{\sqrt{3} \cos \theta}$ D. $\tan \theta$

QUESTION 34

In the figure, $\triangle ABC$ lies in the cartesian plane with $A(0 ; 0)$, $B(2 ; 3)$ and $C(6 ; 1)$.

Area of $\triangle ABC = ?$



- A. 8 units^2 B. 10 units^2 C. 7 units^2 D. 9 units^2

QUESTION 35

If $\sin A = \frac{1}{10}$ and $-A + B = 90^\circ$, what is the value of $10 \cdot \cos B$?

- A. $-\frac{1}{100}$ B. 1 C. $\frac{1}{5}$ D. -1

QUESTION 36

$f(x) = \frac{5}{2x+3}$ and $g(x) = mx - 3$. The graphs of f and g intersect at $x = n$ and $x = 1$.

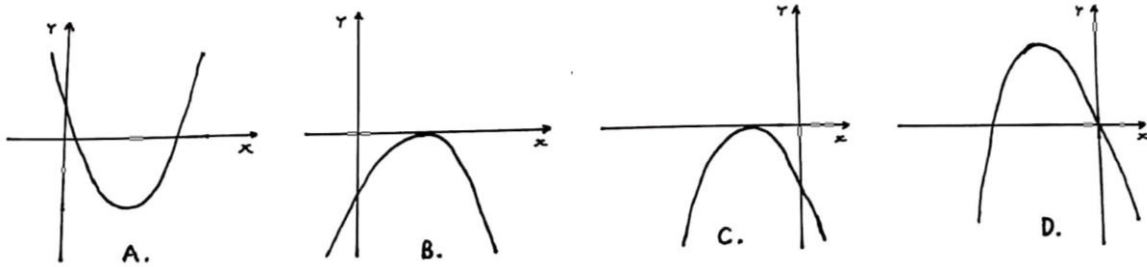
$n + m = ?$

- A. $\frac{5}{2}$ B. $-\frac{1}{2}$ C. $\frac{3}{2}$ D. $\frac{9}{4}$

QUESTION 37

$$f(x) = -x^2 + bx + c. \quad ac = \frac{1}{4}b^2 \quad \text{and} \quad \frac{b}{2a} > 0.$$

Which of the following graphs best represents f ?



QUESTION 38

$f(x) = \cos\left(\frac{1}{2}x - 30^\circ\right)$. g is the graph of f shifted 120° to the left. $g(x) = ?$

A. $\cos\left(\frac{1}{2}x + 90^\circ\right)$ B. $\cos\left(\frac{1}{2}x + 30^\circ\right)$ C. $\cos\left(\frac{1}{2}x + 60^\circ\right)$ D. $\cos\left(\frac{1}{2}x - 150^\circ\right)$

QUESTION 39

a, b, c, d are the first four terms of a quadratic sequence. $a + b + c + d = 36$.

$$2b - c + d = ?$$

A. 18 B. 24 C. 16 D. 36

QUESTION 40

$f(x) = -2 \sin^2 x - 4 \sin x + 3$. For $k \in \mathbb{Z}$, $f(x)$ is a maximum for $x = ?$

A. $180^\circ + k \cdot 360^\circ$ B. $90^\circ + k \cdot 360^\circ$ C. $k \cdot 180^\circ$ D. $-90^\circ + k \cdot 360^\circ$

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FORMULA SHEET

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

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

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

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

$$T_n = a + (n - 1)d$$

$$S_n = \frac{n}{2}[2a + (n - 1)d]$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a(r^n - 1)}{r - 1}; \quad r \neq 1$$

$$S_\infty = \frac{a}{1 - r}; \quad -1 < r < 1$$

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

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$M\left(\frac{x_1 + x_2}{2}; \frac{y_1 + y_2}{2}\right)$$

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

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

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

$$\sin(A + B) = \sin A \cos B + \cos A \sin B \quad \sin(A - B) = \sin A \cos B - \cos A \sin B$$

$$\cos(A + B) = \cos A \cos B - \sin A \sin B \quad \cos(A - B) = \cos A \cos B + \sin A \sin B$$

$$\cos 2A = \cos^2 A - \sin^2 A = 2\cos^2 A - 1 = 1 - 2\sin^2 A$$

$$\sin 2A = 2\sin A \cos A$$

$$\bar{x} = \frac{\sum x_i}{n}$$

$$\sigma^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$$

$$P(E) = \frac{n(E)}{n(S)}$$

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

ANSWER KEY

Question	Answer	Question	Answer	Question	Answer	Question	Answer
1	B	11	C	21	C	31	B
2	C	12	B	22	C	32	A
3	C	13	A	23	C	33	A
4	C	14	C	24	D	34	A
5	D	15	D	25	A	35	D
6	B	16	D	26	A	36	D
7	C	17	B	27	A	37	C
8	C	18	A	28	A	38	B
9	A	19	B	29	B	39	A
10	C	20	C	30	B	40	D

ROUGH GUIDE: QUESTIONS

- Knowledge/Recall: 5, 6, 9, 12, 13, 19, 26, 27, 30, 33, 35
- Problem Solving: 1, 2, 4, 7, 8, 10, 15, 16, 18, 21, 23, 24, 25, 28, 31, 32, 34, 36, 37, 38, 39, 40
- Complex: 3, 11, 14, 17, 20, 22, 29

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