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MATHEMATICS

CLASSIFIED WORKBOOK

PAPER 1 AND PAPER 2

WITH ANSWERS

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Content

Formulae Sheets

Conversion Factors:

Length:	**Mass:**	**Volume:**
1 km = 1000 m	1 kg = 1000 gm	1 liter = 1000 cm^3
1 m = 100 cm	1 gm = 1000 milligram	1 m^3 = 1000 liters
1 cm = 10 mm	1 tonne = 1000 kg	$1ml$ =1 cm^3

Standard form $A \times 10^n$ where A lies between 1 and 10 and n is a natural number.

Significant figures

- All non-zero digits are significant. $36152.1 \approx 6\ S.f$
- Zeros b/w non-zero digits are significant. $301 \approx 3\ S.f$
- Zeros before the first non-zero digit are not significant. $0.000361 \approx 3\ S.f$
- Zeros following a non-zero digit after the decimal point are significant. $0.300 \approx 3\ S.f$
- Zeros following a non-zero digit in a whole number may or may not be significant. $36100 \approx 3\ S.f$

Percentages:

Profit = S.P. – C.P.

Loss = C.P. – S.P.

Profit/loss percentage $= \frac{Profit/loss}{C.P} \times 100$

Discount percentage $= \frac{Discount}{Original\ Amount} \times 100$

Increase/Decrease percent $= \frac{Increse/Decrease}{Original\ Amount} \times 100$

Simple Interest $= \frac{PRT}{100}$

Compound Interest $= P\left(1 + \frac{r}{100}\right)^t$

Speed, Distance and Time:

Distance = *speed* × *time*

Speed = *distance*÷ *time*

Time = *distance*÷ *Speed*

Average speed $= \frac{total\ distance}{total\ time}$

Acceleration/Retardation $= \frac{v-u}{t}$

Quadratic formula

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

$$a^2 + 2ab + b^2 = (a + b)^2$$
$$a^2 - 2ab + b^2 = (a - b)^2$$
$$a^2 - b^2 = (a + b)(a - b)$$

Variation:

Direct Variation: $y = kx$

Inverse Variation: $y = \frac{k}{x}$

Formulae Sheets

Algebraic indices:

- $a^m \times a^n = a^{m+n}$
- $a^m \div a^n = a^{m-n}$
- $a^{-m} = \frac{1}{a^m}$
- $a^0 = 1$

Upper and lower bounds:

Add. & Multiplication Rule:

To get the lower bound = Add (or multiply) two lower bounds.
To get the Upper bound = Add (or multiply) two upper bounds.

Subtraction& Division Rule:

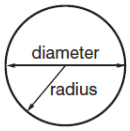
To get lower bound = L.B of larger value – or(÷) U.B of smaller value
To get Upper bound = U.B of larger value or(÷) L.B of smaller value

Matrices:

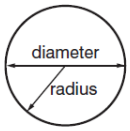
- *If* $A=\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ *then determinant of A or* $|A| = ad - bc$
- *If* $A=\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ *then Adjoint of* $A = \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$ $A^{-1} = \frac{1}{|A|} \times$ *Adjoint of A*

Mensuration

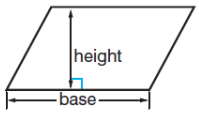
Circumference of circle
= π × diameter
= 2 × π × radius



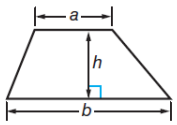
Area of circle
= π × (radius)²



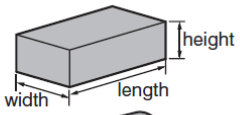
Area of parallelogram
= base × height



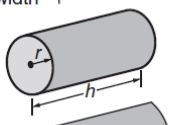
Area of trapezium
$= \frac{1}{2}(a + b)h$



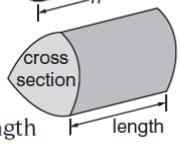
Volume of cuboid
= length × width × height



Volume of cylinder
$= \pi r^2 h$



Volume of prism
= area of cross-section × length



Length of Arc $= \frac{\theta}{360} 2\pi r$

Area of Sector $= \frac{\theta}{360} \pi r^2$

Area of right angled triangle $= \frac{1}{2} \times$ *base* $\times$ *height,*

Area of Rectangle $= l \times b$

Perimeter of Rectangle $= 2(l + b)$

Area of Square $= l \times l$: *Perimeter of Square* $= 4l$

Formulae Sheets

Similarity & Congurency

Congruent triangles:

- SSS Postulate
- SAS Postulate
- AAS Postulate
- RHS Postulate

Similar triangles:

Two triangles are similar if

- *Two angles of one Δ are equal to two angles of other Δ.*
- *Ratios of the corresponding sides are equal.*
- *iii.* $\frac{A_1}{A_2} = \left(\frac{l_1}{l_2}\right)^2$ *iv.* $\frac{V_1}{V_2} = \left(\frac{l_1}{l_2}\right)^3$

v. $\frac{A_1}{A_2} = \frac{b_1}{b_2}$ Δ`s with the same height

Trigonometry

- $\text{Sin}\theta = \frac{Opp.}{Hyp.} = \frac{Per.}{Hyp.}$
- $\text{Cos}\ \theta = \frac{Adj.}{Hyp.} = \frac{Base}{Hyp.}$
- $\text{Tan}\theta = \frac{Opp.}{adj.} = \frac{per.}{Base}$
- ***Pythagoras Theorem*:**

$$a^2 = b^2 + c^2$$

Further Trigonometry

- ***Area of triangle*** $= \frac{1}{2}.\ b.\ c.\ sin\ A$ (SAS)
- ***Sine Rule:*** $\frac{A}{Sina} = \frac{B}{Sinb} = \frac{C}{Sinc}$ (ASS, AAS)
- ***Cosine Rule:*** $a^2 = b^2 + c^2 - 2bc \times cosA$ (SAS)
- $\text{Cos A} = \frac{b^2 + c^2 - a^2}{2bc}$ (SSS)

Co-ordinate Geometry:

- $Gradiant = \frac{y_2 - y_1}{x_2 - x_1}$
- $y = mx + c$
- Midpoint $M(x, y) = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$
- $AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- ***Parallel lines*** have the same gradient. $m_1 = m_2$
- ***Perpendicular Lines*****:** $m_1 \times m_2 = -1$

Formulae Sheets

Patterns and sequences:

- *Linear sequences:* $nth\ term = a + (n - 1)\,d$
- *Quadratic sequences:* $nth\ term = a + (n - 1)$ 1st difference $+ \frac{(n-1)(n-2)}{2}$ 2nd difference

Polygons

- *Sum of an Interior angles of a polygon* $= (n - 2) \times 180°$
- *Sum of all the exterior angles of a polygon* $= 360°$.
- *Each Interior angles of a polygon* $= \frac{(n-2)\times 180°}{n}$
- *No. of sides of a polygon* $= \frac{360°}{Each\ Exterior\ angle}$
- Exterior angle $= 180^0 -$ Interior angle

Probability:

- $P(E) = \frac{No.of\ favourable\ outcomes}{Total\ possible\ outcomes}$
- $\sum P = 1$
- $P(A\ or\ B) = P(A) + P(B)$
- $P(A\ and\ B) = P(A) \times P(B)$

Cumulative Frequency:

- *Median:* 50% of Total Frequency
- *Lower Quartile:* 25% of Total Frequency
- *Upper Quartile:* 75% of Total Frequency
- *Inter Quartile Range:*

  Upper Quartile – Lower Quartile
- *Range* = greatest value – least value

Statistics:

Histogram:

- *Class width = upper limit – lower limit*
- *Frequency Density = Frequency / C.W*

Mean

- $\bar{X} = \frac{\sum x}{n}$: $\bar{X} = \frac{\sum fx}{\sum f}$

Median

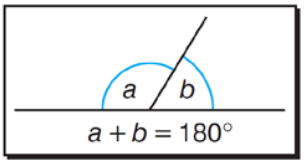
- $Median = \frac{\sum n+1}{2}$ $Median = \frac{\sum f+1}{2}$

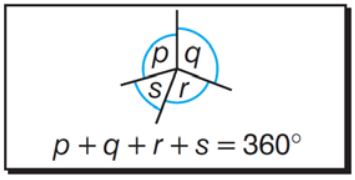
Mode:

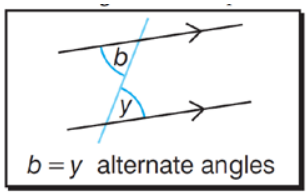
Most repeated number

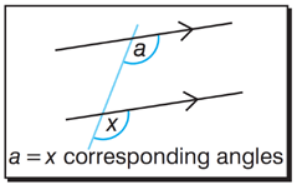
Formulae Sheets

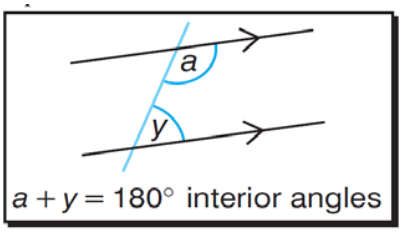
Angles Properties:

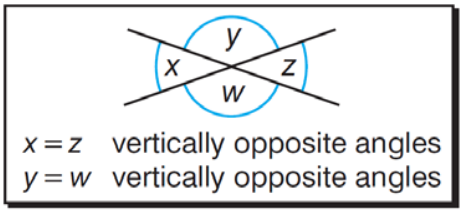




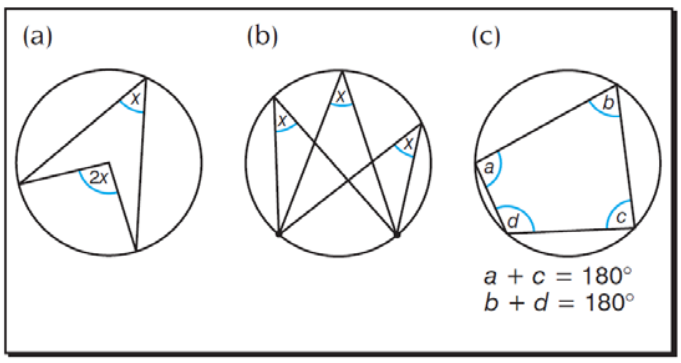


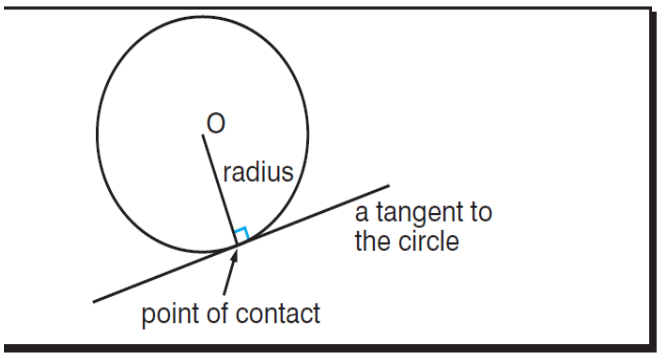






Angles in a circle:



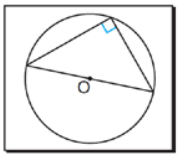


(a) The angle subtended by an arc (or chord) at the centre is twice that subtended at the circumference.

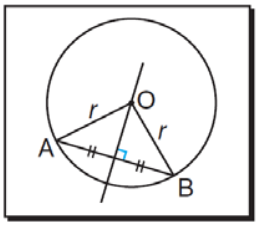
(b) Angles subtended by the same arc (or chord) are equal.

(c) The opposite angles of a cyclic quadrilateral are supplementary (i.e. they add up to 180°).

(d) A tangent to a circle is perpendicular to the radius at the point of contact.

(e) The angle in a semicircle is always 90°. 

(f) The perpendicular bisector of a chord passes through the centre of the circle.



Locus of points:

(a) Locus from a point is ***Circle***.

(b) Locus from two points is ***Perpendicular Bisector***.

(c) Locus from two Lines is ***Angle Bisector***.

(d) Locus from one Line is ***Parallel Line***.

Numbers

Subject Contents:

Candidates should be able to identify and use:

- Natural numbers,
- Integers (positive, negative and zero),
- Prime numbers,
- Square numbers,
- Cube numbers,
- Common factors and common multiples,
- Rational and irrational numbers (e.g.π, $\sqrt{2}$), real numbers.

Notes & examples:

- Includes expressing numbers as a product of prime factors,
- Finding theLowest Common Multiple (LCM) andHighest Common Factor (HCF) of twoor more numbers.

1. O/N/20/11/4a

(a) Write the number 3456.789 correct to the nearest 100. **[1]**

2. M/J/20/11/6

Safoora is buying some apples, bananas and peaches. She can buy

- **packs of 6 apples**
- **packs of 5 bananas**
- **packs of 12 peaches.** She needs to buy the **same** number of each fruit.

Calculate the smallest number of packs of apples, bananas and peaches that she needs to buy. [2]

3. M/J/20/12/13

(a) Write 108 as the product of its prime factors. [2]

(b) Find the lowest common multiple (LCM) of 108 and 180. [2]

4. M/J/19/12/15

(a) Write 168 as a product of its prime factors.

(b) The highest common factor of 168 and N is 42.Given that $200 < N < 300$, find two possible values of N.

5. O/N/19/11/14

$$p = 2^3 \times 3 \times 5^2 \qquad q = 2 \times 3^2 \times 5$$

(a) Find the highest common factor (HCF) of p and q. [1]

(b) Find the lowest common multiple (LCM) of p, q and 21. Give your answer as the product of prime factors. [1]

(c) Find the smallest integer N, such that pN is a square number. [1]

6. O/N/19/12/3

$\sqrt{35}$ $\sqrt{36}$ 36 $\frac{36}{37}$ 37 $\frac{37}{36}$ 3.7 From this list of numbers, write down

(a) a prime number, [1]

(b) a square number, [1]

(c) an irrational number. [1]

7. O/N/18/11/8

(a) Write down an irrational number which has a value between 4 and 5.

(b) Kofi is using number cards to form a 5-digit number. His number is a multiple of 8.Complete the final digit of his number.

1	2	3	4	

8. O/N/18/11/17

$120 = 2^3 \times 3 \times 5$

(a) Express 1200 as the product of its prime factors.

(b) Find the smallest value of n, such that $120n$ is a square number.

9. M/J/18/21/1C

(i) Write 540 as the product of its prime factors.

(ii) $p$is the smallest possible integer such that $540p$is a square number.Find $\sqrt{540p}$, giving your answer as the product of its prime factors.

10. M/J/18/22/4b
(b) Find the lowest common multiple (LCM) of 140 and 770.

(c) A rectangular field measures 450 m by 306 m. The whole field is divided into identical square plots with no land remaining. Find the largest possible side length for the squares.

11. S/P/18/1 (a) Find the Highest Common Factor (HCF) of 36 and 54.

12. O/N/02/1/7 Written as product of prime factors, $198=2\times3^2\times11$ & $90 = 2 \times 3^2 \times 5$
Use these results to find highest common factor of 198 and 90.

13. M/J/10/12/9 Written as product of prime factors, $168=2^3\times3\times7$.
(a) Express 140 as a product of its prime factors.

(b) Find highest common factor of 168 and 140.

(c) Find the smallest positive integer, n, such that $168n$ is a square number.

14. M/J/07/1/6 Find lowest common multiple of 154 & 49.

15. O/N/03/1/6(a) Find lowest common multiple of 12, 30 and 66.

(b) Three lightships flash simultaneously at 6 00 a.m.
The first lightship flashes every 12 seconds, the second lightship every30 seconds and the third lightship every 66 seconds. At what time will the three lightships next flash together?

16. O/N/01/1/11
Numbers 168 & 324, written as the products of their prime factors, $168 = 2^3 \times 3 \times 7, 324 = 2^2 \times 3^4$
Find **(a)** largest integer which is a factor of both 168 & 324.

(b) Smallest positive integer value of n for which $168n$ is a multiple of 324.

17. O/N/06/1/8 Written as product of its prime factors, $360 = 2^3 \times 3^2 \times 5$.
(a) Write 108 as the product of its prime factors.

(b) Find lowest common multiple of 108 and 360.

18. O/N/09/1/4 The numbers 294 and 784, written as product of their prime factors, are $294 = 2 \times 3 \times 7^2$, $784 = 2^4 \times 7^2$. Find largest integer which is a factor of both 294 & 784.

19. O/N/01/1/11
The numbers 168 and 324, written as the products of their prime factors, $168 = 2^3 \times 3 \times 7, 324 = 2^2 \times 3^4$
Find **(a) L**argest integer which is a factor of both 168 & 324.

(b) The smallest positive integer value of n for which $168n$ is a multiple of 324.

20. A no. written as product of its prime factors is $2^2 \times 5^2 \times 7$. **(a)** Evaluate this number.

(b) Lowest common multiple of $2^2 \times 5^2 \times 7$ & another number, N, is $2^2 \times 3 \times 5^2 \times 7^2$. Find the lowest possible value of N.

21. M/J/05/1/10
Green Line buses run every 10 minutes.
Red Line buses run every 20 minutes.
Purple Line buses run every 35 minutes.
One bus from each Line leaves city centre at 09 00.
After how many minutes will buses from all three Lines next leave the city centre at the same time?

22. M/J/12/11/9
Buses following route A leave bus station every 5 min.
Buses following route B leave the bus station every 6 min.
Buses following route C leave the bus station every 9 min.
Three buses, following routes A, B and C, leave together at 13 00.
What is the next time when buses following all three routes leave the bus station together?

23. M/J/17/11/4(a) Express 36 as the product of its prime factors.

(b) Write down two prime numbers whose sum is 15.

24. M/J/17/12/20(a) (i) Write 54 as the product of its prime factors.

(ii) Find the smallest possible integer m such that $54m$ is a cube number.

25. M/J/04/1/25 Express 7056 as the product of its prime factors.

26. M/J/07/1/6 Express 154 as the product of its prime factors.

27. M/J/09/1/3b Write down two prime numbers between **30 & 40.**

28. O/N/03/1/4 State which of the following numbers are irrational$\sqrt{2} \times \sqrt{8}$, $\frac{22}{7}$, π, $2\sqrt{3}$

29. O/N/07/1/16b The numbers 225 and 540, written as the products of their prime factors, are
$225 = 3^2 \times 5^2$, $540 = 2^2 \times 3^3 \times 5$.
(i) Write 2250 as the product of its prime factors.

(ii) Find the smallest positive integer value of n for which $225n$ is a multiple of 540.

30. M/J/03/1/6(a) Express 99 as the product of its prime factors.

(b) Find the smallest possible integer value of n for which $99n$ is a multiple of 24.

31. M/J/12/11/12

0.2	2	$\sqrt{2}$	$\frac{1}{3}$	0.83	8	81

From nos. listed above, write down **(a)** a prime number, **(b)** a cube number, **(c)** an irrational number.

32. M/J/13/11/12

6	9	1

The three cards above can be rearranged to make three-digit numbers, for example 916.
Arrange the three cards to make
(a) the three-digit number that is closest to 650,

(b) the three-digit number that is a multiple of 7,

(c) a three-digit number that is a square number.

33. M/J/13/12/8
(a) James thinks of a **2 digit** number. It is a cube number. It is an even number. **What is his number?**

(b) Omar thinks of a **two-digit** number. It is a factor of 78. It is a prime number. **What is his number?**

(c) Write down an irrational number between 1 and 2.

34. M/J/14/11/15
(a) Find value of s which makes $8s + 2$ a prime number.

(b) Write down an irrational number b/w 7 and 8.

Set Language & notation

Subject Contents:

- Use language, notation and Venn diagrams to describe sets represent relationships between sets
- Definition of sets: e.g.

$A = \{x : x \text{ is a natural number}\}$
$B = \{(x, y): y = mx + c\}$
$C = \{x : a \leq x \leq b\}$
$D = \{a, b, c\ldots\}$

Notes & examples:

- Includes using Venn diagrams to solve problems.

Notation:

Number of elements in set A	$n(A)$
"… is an element of …"	ϵ
"… is not an element of …"	$\notin$
Complement of set A	A'
The empty set	φ
Universal set	ε
A is a subset of B	$A \subseteq B$
A is a proper subset of B	$A \subset B$
A is not a subset of B	$A \nsubseteq B$
A is not a proper subset of B	$A \not\subset B$
Union of A and B	$A \cup B$
Intersection of A and B	$A \cap B$

1. O/N/20/ 12/13

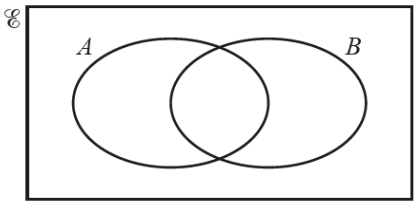
(a) $P = \{1,2,3,4,5,6,7,8\}$ $Q = \{1,3,5,7,9,11\}$ **(i)** Find n($P \cup Q$). [1]

(b) $p \in A \cap B$

$q \in (A \cup B)'$

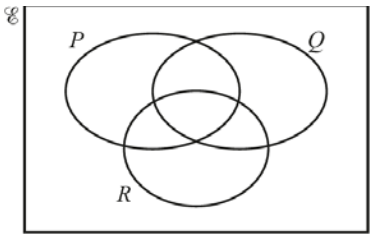
$r \in A \cap B'$

On the Venn diagram below, write each of the letters p, q and r in its appropriate subset.



[3]

2. O/N/20/11/14(a)



In the Venn diagram, shade the subset $(P \cup Q) \cap R'$. [1]

(b) In a group of 42 people,

- 30 people speak Spanish
- 20 people speak French.

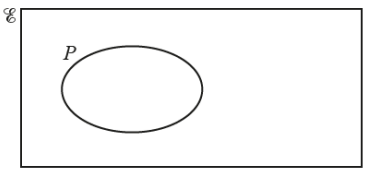
(i) Find the smallest possible number of people who speak both Spanish and French. [1]

(ii) Find the largest possible number of people who speak neither Spanish nor French. [1]

3. M/J/20/ 12/16

$$Q \subset P : \; P \cap R = \emptyset$$

Complete the Venn diagram to show sets Q and R. [2]



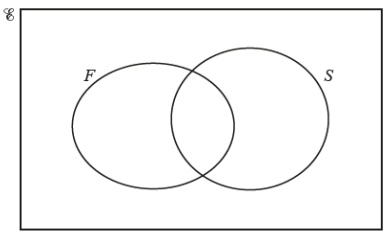
4. M/J/20/ 11/15

$\varepsilon = \{x : x \text{ is an integer } 1 \leq x \leq 10\}$,

$F = \{x : x \text{ is a factor of } 24\}$,

$S = \{x : x \text{ is a square no.}\}$

(i) Complete the Venn diagram. [2]

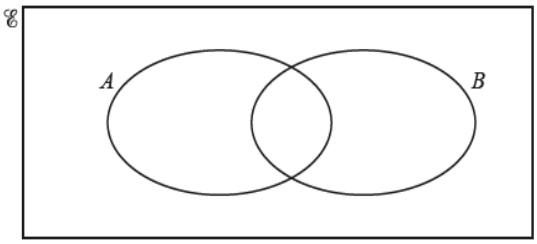


(ii) Find n($F \cup S$)′ [1]

5. O/N/18/21/4

(a) ε= {x :x is an integer $1 \leq x \leq 10$} ,
A = {x :x is a factor of 20} ,
B = {x :x is a multiple of 4}
(i) Complete the Venn diagram. [2]
(ii) State n($A \cup B$).

(iii) Describe in words the set $A \cap B'$.



6. M/J/19/12/10b

ε= { x :x is a positive number } , A = {x : 9 < x < 10 } , B = { x : x is an irrational number}
Write down an element of $A \cap B$.

7. O/N/18/12/22 ε = {0,1, 2, 3, 4, 5, 6}, P= {x : x = 0, 1, 2}, Q= {y : y = 0, 2}
(a) List the members of $P \cap Q$.

(b) Find n($P' \cup Q$).

(c) R = { z: $z = 2x + y$, $x \in P$, $y \in Q$ }List the members of R.

8. M/J/12/22/

ε = { x: x is an integer, $2 \leq x \leq 14$}, A = { x: x is a prime number } , B = { x: x is a multiple of 3 }
List the members of $(AUB)'$

9. M/J/10/22/

ε ={1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}, A= {x :x is a multiple of 3}, B = {x : x is a factor of 24}
C = {x :x is an odd number}

(i) Find n(B) **(ii)** $(A \cup B \cup C)'$