

Mathematics

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(Chapter – 5) (Complex Numbers and Quadratic Equations)
(Class – XI)

Exercise 5.1

Question 1:

Express the given complex number in the form $a + ib$: $(5i)\left(-\frac{3}{5}i\right)$

Answer 1:

$$\begin{aligned}(5i)\left(-\frac{3}{5}i\right) &= -5 \times \frac{3}{5} \times i \times i \\ &= -3i^2 \\ &= -3(-1) \quad [i^2 = -1] \\ &= 3\end{aligned}$$

Question 2:

Express the given complex number in the form $a + ib$: $i^9 + i^{19}$

Answer 2:

$$\begin{aligned}i^9 + i^{19} &= i^{4 \times 2 + 1} + i^{4 \times 4 + 3} \\ &= (i^4)^2 \cdot i + (i^4)^4 \cdot i^3 \\ &= 1 \times i + 1 \times (-i) \quad [i^4 = 1, i^3 = -i] \\ &= i + (-i) \\ &= 0\end{aligned}$$

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Question 3:

Express the given complex number in the form $a + ib$: i^{-39}

Answer 3:

$$\begin{aligned}i^{-39} &= i^{-4 \times 9 - 3} = (i^4)^{-9} \cdot i^{-3} \\ &= (1)^{-9} \cdot i^{-3} \quad [i^4 = 1] \\ &= \frac{1}{i^3} = \frac{1}{-i} \quad [i^3 = -i] \\ &= \frac{-1}{i} \times \frac{i}{i} \\ &= \frac{-i}{i^2} = \frac{-i}{-1} = i \quad [i^2 = -1]\end{aligned}$$

Question 4:

Express the given complex number in the form $a + ib$:

$$3(7 + i7) + i(7 + i7)$$

Answer 4:

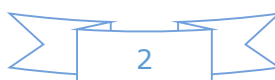
$$\begin{aligned}3(7 + i7) + i(7 + i7) &= 21 + 21i + 7i + 7i^2 \\ &= 21 + 28i + 7 \times (-1) \quad [\because i^2 = -1] \\ &= 14 + 28i\end{aligned}$$

Question 5:

Express the given complex number in the form $a + ib$: $(1 - i) - (-1 + i6)$

Answer 5:

$$\begin{aligned}(1 - i) - (-1 + i6) &= 1 - i + 1 - 6i \\ &= 2 - 7i\end{aligned}$$



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Question 6:

Express the given complex number in the form $a + ib$: $\left(\frac{1}{5} + i\frac{2}{5}\right) - \left(4 + i\frac{5}{2}\right)$

Answer 6:

$$\begin{aligned} & \left(\frac{1}{5} + i\frac{2}{5}\right) - \left(4 + i\frac{5}{2}\right) \\ &= \frac{1}{5} + \frac{2}{5}i - 4 - \frac{5}{2}i \\ &= \left(\frac{1}{5} - 4\right) + i\left(\frac{2}{5} - \frac{5}{2}\right) \\ &= \frac{-19}{5} + i\left(\frac{-21}{10}\right) \\ &= \frac{-19}{5} - \frac{21}{10}i \end{aligned}$$

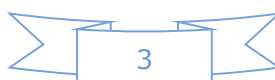
Question 7:

Express the given complex number in the form $a + ib$:

$$\left[\left(\frac{1}{3} + i\frac{7}{3}\right) + \left(4 + i\frac{1}{3}\right)\right] - \left(-\frac{4}{3} + i\right)$$

Answer 7:

$$\begin{aligned} & \left[\left(\frac{1}{3} + i\frac{7}{3}\right) + \left(4 + i\frac{1}{3}\right)\right] - \left(-\frac{4}{3} + i\right) \\ &= \frac{1}{3} + \frac{7}{3}i + 4 + \frac{1}{3}i + \frac{4}{3} - i \\ &= \left(\frac{1}{3} + 4 + \frac{4}{3}\right) + i\left(\frac{7}{3} + \frac{1}{3} - 1\right) \\ &= \frac{17}{3} + i\frac{5}{3} \end{aligned}$$



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Question 8:

Express the given complex number in the form $a + ib$: $(1 - i)^4$

Answer 8:

$$\begin{aligned}(1-i)^4 &= \left[(1-i)^2 \right]^2 \\ &= \left[1^2 + i^2 - 2i \right]^2 \\ &= \left[1 - 1 - 2i \right]^2 \\ &= (-2i)^2 \\ &= (-2i) \times (-2i) \\ &= 4i^2 = -4 \quad [i^2 = -1]\end{aligned}$$

Question 9:

Express the given complex number in the form $a + ib$: $\left(\frac{1}{3} + 3i\right)^3$

Answer 9:

$$\begin{aligned}\left(\frac{1}{3} + 3i\right)^3 &= \left(\frac{1}{3}\right)^3 + (3i)^3 + 3\left(\frac{1}{3}\right)(3i)\left(\frac{1}{3} + 3i\right) \\ &= \frac{1}{27} + 27i^3 + 3i\left(\frac{1}{3} + 3i\right) \\ &= \frac{1}{27} + 27(-i) + i + 9i^2 \quad [i^3 = -i] \\ &= \frac{1}{27} - 27i + i - 9 \quad [i^2 = -1] \\ &= \left(\frac{1}{27} - 9\right) + i(-27 + 1) \\ &= \frac{-242}{27} - 26i\end{aligned}$$

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Question 10:

Express the given complex number in the form $a + ib$: $\left(-2 - \frac{1}{3}i\right)^3$

Answer 10:

$$\begin{aligned}\left(-2 - \frac{1}{3}i\right)^3 &= (-1)^3 \left(2 + \frac{1}{3}i\right)^3 \\ &= - \left[2^3 + \left(\frac{i}{3}\right)^3 + 3(2)\left(\frac{i}{3}\right)\left(2 + \frac{i}{3}\right) \right] \\ &= - \left[8 + \frac{i^3}{27} + 2i\left(2 + \frac{i}{3}\right) \right] \\ &= - \left[8 - \frac{i}{27} + 4i + \frac{2i^2}{3} \right] \quad [i^3 = -i] \\ &= - \left[8 - \frac{i}{27} + 4i - \frac{2}{3} \right] \quad [i^2 = -1] \\ &= - \left[\frac{22}{3} + \frac{107i}{27} \right] \\ &= -\frac{22}{3} - \frac{107}{27}i\end{aligned}$$

Question 11:

Find the multiplicative inverse of the complex number $4 - 3i$.

Answer 11:

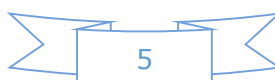
Let $z = 4 - 3i$

Then,

$$\bar{z} = 4 + 3i \text{ and } |z|^2 = 4^2 + (-3)^2 = 16 + 9 = 25$$

Therefore, the multiplicative inverse of $4 - 3i$ is given by

$$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{4 + 3i}{25} = \frac{4}{25} + \frac{3}{25}i$$



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Question 12:

Find the multiplicative inverse of the complex number $\sqrt{5} + 3i$

Answer 12:

Let $z = \sqrt{5} + 3i$

Then, $\bar{z} = \sqrt{5} - 3i$ and $|z|^2 = (\sqrt{5})^2 + 3^2 = 5 + 9 = 14$

Therefore, the multiplicative inverse of $\sqrt{5} + 3i$

$$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{\sqrt{5} - 3i}{14} = \frac{\sqrt{5}}{14} - \frac{3i}{14}$$

Question 13:

Find the multiplicative inverse of the complex number $-i$

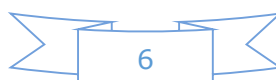
Answer 13:

Let $z = -i$

Then, $\bar{z} = i$ and $|z|^2 = 1^2 = 1$

Therefore, the multiplicative inverse of $-i$ is given by

$$z^{-1} = \frac{\bar{z}}{|z|^2} = \frac{i}{1} = i$$



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Question 14:

Express the following expression in the form of $a + ib$.

$$\frac{(3+i\sqrt{5})(3-i\sqrt{5})}{(\sqrt{3}+\sqrt{2}i)-(\sqrt{3}-i\sqrt{2})}$$

Answer 14:

$$\begin{aligned} & \frac{(3+i\sqrt{5})(3-i\sqrt{5})}{(\sqrt{3}+\sqrt{2}i)-(\sqrt{3}-i\sqrt{2})} \\ &= \frac{(3)^2 - (i\sqrt{5})^2}{\sqrt{3} + \sqrt{2}i - \sqrt{3} + \sqrt{2}i} \quad [(a+b)(a-b) = a^2 - b^2] \\ &= \frac{9 - 5i^2}{2\sqrt{2}i} \\ &= \frac{9 - 5(-1)}{2\sqrt{2}i} \quad [i^2 = -1] \\ &= \frac{9+5}{2\sqrt{2}i} \times \frac{i}{i} \\ &= \frac{14i}{2\sqrt{2}i^2} \\ &= \frac{14i}{2\sqrt{2}(-1)} \\ &= \frac{-7i}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} \\ &= \frac{-7\sqrt{2}i}{2} \end{aligned}$$