

# Fill in the Blanks

# Roots of Cubic Equations

| Quartic Equation                      | $\alpha$          | $\beta$           | $\gamma$ | $\delta$      | $\sum \alpha$   | $\sum \alpha\beta$ | $\sum \alpha\beta\gamma$ | $\sum \alpha\beta\gamma\delta$ |
|---------------------------------------|-------------------|-------------------|----------|---------------|-----------------|--------------------|--------------------------|--------------------------------|
| $z^4 + z^3 - 7z^2 - z + 6 = 0$        | -1                | 2                 | 1        | -3            | -1              | -7                 | 1                        | 6                              |
| $z^4 - 3z^3 - 8z^2 + 12z + 16 = 0$    | 4                 | -1                | -2       | 2             | 3               | -8                 | -12                      | 16                             |
| $6z^4 - 29z^3 - 9z^2 + 21z - 5 = 0$   | $\frac{1}{3}$     | 5                 | -1       | $\frac{1}{2}$ | $\frac{29}{6}$  | $-\frac{3}{2}$     | $-\frac{7}{2}$           | $-\frac{5}{6}$                 |
| $2z^4 - 3z^3 - 12z^2 + 7z + 6 = 0$    | $-\frac{1}{2}$    | 3                 | 1        | -2            | $\frac{3}{2}$   | -6                 | $-\frac{7}{2}$           | 3                              |
| $z^4 - 5z^3 + 10z^2 - 10z + 4 = 0$    | 1                 | 2                 | $1 + i$  | $1 - i$       | 5               | 10                 | 10                       | 4                              |
| $z^4 - 4z^3 + z^2 + 6z - 40 = 0$      | $1 + 2i$          | $1 - 2i$          | -2       | 4             | 4               | 1                  | -6                       | -40                            |
| $3z^4 - 11z^3 + 9z^2 + 13z - 10 = 0$  | $\frac{2}{3}$     | -1                | $2 - i$  | $2 + i$       | $\frac{11}{3}$  | 3                  | $-\frac{13}{3}$          | $-\frac{10}{3}$                |
| $z^4 - 8z^3 + 24z^2 - 32z + 20 = 0$   | $1 + i$           | $1 - i$           | $3 + i$  | $3 - i$       | 8               | 24                 | 32                       | 20                             |
| $9z^4 + 30z^3 + 23z^2 - 22z + 10 = 0$ | $\frac{1 - i}{3}$ | $\frac{1 + i}{3}$ | $-2 + i$ | $-2 - i$      | $-\frac{10}{3}$ | $\frac{23}{9}$     | $\frac{22}{9}$           | $\frac{10}{9}$                 |