1) $9b^2 + 4b + 4 = 0$

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

$$x = \frac{-4 \pm \sqrt{16 - 4(36)}}{18}$$

$$x = \frac{-4 \pm \sqrt{-128}}{18}$$

$$\boxed{x = \frac{-2 \pm 4i\sqrt{2}}{9}} \Leftarrow x = \frac{-4 \pm 8i\sqrt{2}}{18}$$

2) $(-5 - 3i) - (-3 - 6i) + (-1 - 6i)$

$-5 - 3i + 3 + 6i - 1 - 6i$

$\boxed{-3 - 3i}$

3) $(-2 + 8i)(8 + 6i)(-7 - 6i)$

$-16 \boxed{-12i + 64i} + 48i^2$ $\quad -16 - 48$

$\boxed{-64 + 52i}$

$(-64 + 52i)(-7 - 6i)$

$448 + 384i - 364i \boxed{-312i^2}$ $+312$

$\boxed{760 + 20i}$

7) $(3x^3+22x^2-7x+63)\div(x+8)$

$$\begin{array}{r|rrrr} -8 & 3 & 22 & -7 & 63 \\ & \downarrow & -24 & 16 & -72 \\ \hline & 3 & -2 & 9 & -9 \end{array}$$

$x+8=0$
$x=-8$

Not 0

Therefor $x+8$ is
NOT a Factor

$f(x)=3x^3+22x^2-7x+63$

$f(-8)=-9$

-8 is NOT a zero of $f(x)$

8) $(x^3-7x^2+x+9)\div(x+1)$

$$\begin{array}{r|rrrrl} -1 & 1 & -7 & 1 & 9 & D3 \\ & \downarrow & -1 & +8 & -9 & \\ \hline D2 & 1 & -8 & 9 & 0 & \end{array}$$

Yes!! $x+1$ is a factor!

"Factor completely" given $x+1$ is a factor
given $x=-1$ is a zero...

x^2-8x+9 (Doesn't Factor)

$$\frac{x^3-7x^2+x+9}{x+1}=x^2-8x+9$$

9) $x^3 - 3x^2 - 6x + 8$

$x = -2$

$\downarrow$

$x+2$ is a factor

$$\begin{array}{r|rrrr} -2 & 1 & -3 & -6 & 8 \\ & \downarrow & -2 & 10 & -8 \\ \hline & 1 & -5 & 4 & 0 \end{array}$$

D3

D2

$x^2 - 5x + 4$

$(x-4)(x-1)$

Factors: $(x-4)(x-1)(x+2)$

Zeros: $x = 4, 1, -2$

10) $x^4 + 7x^3 + 16x^2 + 8x - 32 = 0$

$x = -2 + 2i$

$(x+2)^2 = (2i)^2$ -2

$x^2 + 4x + 4 = \boxed{2i^2}$

$x^2 + 4x + 6 = 0$

$x^2 + 4x + 4 = -4$

$x^2 + 4x + 8 = 0$

$$\begin{array}{r|l} & x^2 + 3x - 2 \\ \hline \boxed{x^2} + 4x + 6 & \boxed{x^4} + 7x^3 + 16x^2 + 8x - 32 \\ & -x^4 - 4x^3 - 6x^2 \\ \hline & \boxed{3x^3} + 10x^2 + 8x \\ & -3x^3 - 12x^2 - 18x \\ \hline & -2x^2 - 10x - 32 \\ & +2x^2 + 8x + 12 \\ \hline & -2x - 20 \end{array}$$

$(x+4)(x-1)$

$$\begin{array}{r|l} & x^2 + 3x - 4 \\ \hline x^2 + 4x + 8 & x^4 + 7x^3 + 16x^2 + 8x - 32 \\ & -x^4 - 4x^3 \ 8x^2 \\ \hline & 3x^3 + 8x^2 + 8x \\ & -3x^3 - 12x^2 - 24x \\ \hline & -4x^2 - 16x - 32 \\ & +4x^2 + 16x + 32 \\ \hline & 0 \end{array}$$

11) $-1+2i$, $2\sqrt{2}$ additional
$-1-2i$ $-2\sqrt{2}$

Irrational & complex zeros → conjugate pairs

Rational No i's No √'s
dec. ... w/no pattern Irrational √
Complex i's
Integers

Classify by degree : Quartic

$x = -1+2i$
$x+1 = 2i$
$x^2+2x+1 = -4$
$x^2+2x+5 = 0$
factor

$(x)^2 = (2\sqrt{2})^2$
$x^2 = 8$
$x^2 - 8 = 0$
factor

$f(x) = (x^2+2x+5)(x^2-8)$ (mult.)

12) $2, -2+\sqrt{3}$

$x-2$

$x = -2+\sqrt{3}$
$x+2 = \sqrt{3}$
$x^2+4x+4 = 3$
$x^2+4x+1 = 0$

$f(x) = (x-2)(x^2+4x+1)$

13) $\sqrt{3}$ mult. of 2

even Bounce
odd Snake
1 Through

$\sqrt{3}$
$\sqrt{3}$

$x = \sqrt{3}$
$x^2 = 3$
$x^2 - 3 = 0$
$(x^2-3)(x^2-3) = 0$

EB

Leading term

$a\,x^{b}$ ← even or odd?

↑ + or − ?

	(same) even	(opposite) odd
a +	$\nwarrow \;\; \nearrow^{+}$	$\swarrow \;\; \nearrow^{+}$
a −	$\swarrow \;\; \searrow_{-}$	$\nwarrow \;\; \searrow_{-}$

15) $1x^5$ ← odd

\+

$\swarrow \quad \nearrow$

$x \to -\infty,\ f(x) \to -\infty$

$x \to \infty,\ f(x) \to \infty$

16) $-x^3$

$\nwarrow \quad \searrow_{-}$

$x \to -\infty,\ f(x) \to \underline{\infty}$

$x \to \infty,\ f(x) \to \underline{-\infty}$

17) Find all roots!

$x^2+8x+1=0$ $\boxed{\text{QF + solve}}$

19) $f(x)=x^3+3x^2-x-3$

table ; $x=\pm 1, -3$

21) $f(x) = \boxed{2}x^3 - 7x^2 + 7x \boxed{-2}$

Rational Root Thm $\quad \dfrac{\text{factors of constant}}{\text{factors of L.C.}}$

$$\frac{\pm 1, \pm 2}{\pm 1, \pm 2} = \pm\left(1, 2, \tfrac{1}{2}\right)$$

30) $\dfrac{\cancel{n+3}}{\cancel{(n+3)}\cancel{(n+6)}} \cdot \dfrac{7\cancel{(n+6)}}{n+4} \quad \dfrac{7}{n+4}$

oops

31) $\dfrac{7m^2\cancel{(m-4)}}{(m+9)\cancel{(m-4)}} \cdot \dfrac{\cancel{(m-9)}\cancel{(m-1)}}{\cancel{m-1}}$

$$\frac{7m^2(m-9)}{m+9}$$