

tip:  $ax^2 + bx + c$

$$= a(x^2 + \frac{b}{a}x) + c$$

$$= a(x + \frac{b}{2a})^2 - (\frac{b}{2a})^2 + c$$

$$= a(x + p)^2 + q$$

$$(1) 4x^2 - 8x + 6$$

$$= 4(x^2 - 2x) + 6$$

$$= 4(x - 1)^2 - 4 + 6$$

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

$$(2) -3x^2 + 30x - 80$$

$$= -3(x^2 - 10x) - 80$$

$$= -3(x - 5)^2 + 75 - 80$$

$$= -3(x - 5)^2 - 5$$

$$(3) -3x^2 + 6x - 2$$

$$= -3(x^2 - 2x) - 2$$

$$= -3(x - 1)^2 + 3 - 2$$

$$= -3(x - 1)^2 + 1$$

$$(4) 3x^2 - 36x + 107$$

$$= 3(x^2 - 12x) + 107$$

$$= 3(x - 6)^2 - 108 + 107$$

$$= 3(x - 6)^2 - 1$$

$$(5) 4x^2 - 16x + 19$$

$$= 4(x^2 - 4x) + 19$$

$$= 4(x - 2)^2 - 16 + 19$$

$$= 4(x - 2)^2 + 3$$

$$(6) -2x^2 - 16x - 29$$

$$= -2(x^2 + 8x) - 29$$

$$= -2(x + 4)^2 + 32 - 29$$

$$= -2(x + 4)^2 + 3$$

$$(7) -4x^2 - 24x - 38$$

$$= -4(x^2 + 6x) - 38$$

$$= -4(x + 3)^2 + 36 - 38$$

$$= -4(x + 3)^2 - 2$$

$$(8) -4x^2 + 24x - 34$$

$$= -4(x^2 - 6x) - 34$$

$$= -4(x - 3)^2 + 36 - 34$$

$$= -4(x - 3)^2 + 2$$

$$(9) 4x^2 - 40x + 101$$

$$= 4(x^2 - 10x) + 101$$

$$= 4(x - 5)^2 - 100 + 101$$

$$= 4(x - 5)^2 + 1$$

$$(10) 3x^2 + 36x + 107$$

$$= 3(x^2 + 12x) + 107$$

$$= 3(x + 6)^2 - 108 + 107$$

$$= 3(x + 6)^2 - 1$$

$$(11) 3x^2 - 18x + 22$$

$$= 3(x^2 - 6x) + 22$$

$$= 3(x - 3)^2 - 27 + 22$$

$$= 3(x - 3)^2 - 5$$

$$(12) -2x^2 - 20x - 52$$

$$= -2(x^2 + 10x) - 52$$

$$= -2(x + 5)^2 + 50 - 52$$

$$= -2(x + 5)^2 - 2$$

$$(13) -2x^2 - 12x - 21$$

$$= -2(x^2 + 6x) - 21$$

$$= -2(x + 3)^2 + 18 - 21$$

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

$$(14) 4x^2 + 56x + 197$$

$$= 4(x^2 + 14x) + 197$$

$$= 4(x + 7)^2 - 196 + 197$$

$$= 4(x + 7)^2 + 1$$

$$(15) -x^2 + 20x - 103$$

$$= -(x^2 - 20x) - 103$$

$$= -(x - 10)^2 + 100 - 103$$

$$= -(x - 10)^2 - 3$$

$$(16) x^2 - 2x + 2$$

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

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

$$(17) x^2 + 16x + 60$$

$$= (x + 8)^2 - 64 + 60$$

$$= (x + 8)^2 - 4$$

$$(18) 3x^2 - 24x + 45$$

$$= 3(x^2 - 8x) + 45$$

$$= 3(x - 4)^2 - 48 + 45$$

$$= 3(x - 4)^2 - 3$$

$$(19) -2x^2 - 32x - 129$$

$$= -2(x^2 + 16x) - 129$$

$$= -2(x + 8)^2 + 128 - 129$$

$$= -2(x + 8)^2 - 1$$

$$(20) -x^2 + 18x - 82$$

$$= -(x^2 - 18x) - 82$$

$$= -(x - 9)^2 + 81 - 82$$

$$= -(x - 9)^2 - 1$$

$$(21) 4x^2 - 56x + 193$$

$$= 4(x^2 - 14x) + 193$$

$$= 4(x - 7)^2 - 196 + 193$$

$$= 4(x - 7)^2 - 3$$

$$\begin{aligned}
(22) \quad & 4x^2 - 8x + 1 \\
& = 4(x^2 - 2x) + 1 \\
& = 4(x - 1)^2 - 4 + 1 \\
& = 4(x - 1)^2 - 3 \\
(23) \quad & -5x^2 + 100x - 497 \\
& = -5(x^2 - 20x) - 497 \\
& = -5(x - 10)^2 + 500 - 497 \\
& = -5(x - 10)^2 + 3 \\
(24) \quad & -3x^2 + 36x - 111 \\
& = -3(x^2 - 12x) - 111 \\
& = -3(x - 6)^2 + 108 - 111 \\
& = -3(x - 6)^2 - 3 \\
(25) \quad & -4x^2 + 16x - 20 \\
& = -4(x^2 - 4x) - 20 \\
& = -4(x - 2)^2 + 16 - 20 \\
& = -4(x - 2)^2 - 4 \\
(26) \quad & 2x^2 + 28x + 100 \\
& = 2(x^2 + 14x) + 100 \\
& = 2(x + 7)^2 - 98 + 100 \\
& = 2(x + 7)^2 + 2 \\
(27) \quad & 4x^2 - 40x + 96 \\
& = 4(x^2 - 10x) + 96 \\
& = 4(x - 5)^2 - 100 + 96 \\
& = 4(x - 5)^2 - 4 \\
(28) \quad & 4x^2 + 24x + 35 \\
& = 4(x^2 + 6x) + 35 \\
& = 4(x + 3)^2 - 36 + 35 \\
& = 4(x + 3)^2 - 1 \\
(29) \quad & -4x^2 + 72x - 329 \\
& = -4(x^2 - 18x) - 329 \\
& = -4(x - 9)^2 + 324 - 329 \\
& = -4(x - 9)^2 - 5 \\
(30) \quad & -x^2 + 4x - 5 \\
& = -(x^2 - 4x) - 5 \\
& = -(x - 2)^2 + 4 - 5 \\
& = -(x - 2)^2 - 1 \\
(31) \quad & -5x^2 + 30x - 41 \\
& = -5(x^2 - 6x) - 41 \\
& = -5(x - 3)^2 + 45 - 41 \\
& = -5(x - 3)^2 + 4 \\
(32) \quad & -5x^2 + 60x - 182 \\
& = -5(x^2 - 12x) - 182 \\
& = -5(x - 6)^2 + 180 - 182 \\
& = -5(x - 6)^2 - 2 \\
(33) \quad & 4x^2 + 8x + 7 \\
& = 4(x^2 + 2x) + 7 \\
& = 4(x + 1)^2 - 4 + 7 \\
& = 4(x + 1)^2 + 3 \\
(34) \quad & x^2 - 2x + 5 \\
& = (x - 1)^2 - 1 + 5 \\
& = (x - 1)^2 + 4 \\
(35) \quad & -4x^2 + 64x - 254 \\
& = -4(x^2 - 16x) - 254 \\
& = -4(x - 8)^2 + 256 - 254 \\
& = -4(x - 8)^2 + 2 \\
(36) \quad & -x^2 - 8x - 20 \\
& = -(x^2 + 8x) - 20 \\
& = -(x + 4)^2 + 16 - 20 \\
& = -(x + 4)^2 - 4 \\
(37) \quad & -3x^2 + 6x - 8 \\
& = -3(x^2 - 2x) - 8 \\
& = -3(x - 1)^2 + 3 - 8 \\
& = -3(x - 1)^2 - 5 \\
(38) \quad & -2x^2 + 24x - 74 \\
& = -2(x^2 - 12x) - 74 \\
& = -2(x - 6)^2 + 72 - 74 \\
& = -2(x - 6)^2 - 2 \\
(39) \quad & 3x^2 - 24x + 46 \\
& = 3(x^2 - 8x) + 46 \\
& = 3(x - 4)^2 - 48 + 46 \\
& = 3(x - 4)^2 - 2 \\
(40) \quad & -x^2 + 16x - 63 \\
& = -(x^2 - 16x) - 63 \\
& = -(x - 8)^2 + 64 - 63 \\
& = -(x - 8)^2 + 1 \\
(41) \quad & -4x^2 - 24x - 40 \\
& = -4(x^2 + 6x) - 40 \\
& = -4(x + 3)^2 + 36 - 40 \\
& = -4(x + 3)^2 - 4 \\
(42) \quad & x^2 + 10x + 28 \\
& = (x + 5)^2 - 25 + 28 \\
& = (x + 5)^2 + 3 \\
(43) \quad & -3x^2 - 30x - 72 \\
& = -3(x^2 + 10x) - 72 \\
& = -3(x + 5)^2 + 75 - 72 \\
& = -3(x + 5)^2 + 3
\end{aligned}$$

$$\begin{aligned}
(44) \quad & 4x^2 + 8x \\
&= 4(x^2 + 2x) \\
&= 4(x + 1)^2 - 4 \\
(45) \quad & -x^2 + 18x - 83 \\
&= -(x^2 - 18x) - 83 \\
&= -(x - 9)^2 + 81 - 83 \\
&= -(x - 9)^2 - 2 \\
(46) \quad & x^2 - 12x + 38 \\
&= (x - 6)^2 - 36 + 38 \\
&= (x - 6)^2 + 2 \\
(47) \quad & 2x^2 - 4x - 3 \\
&= 2(x^2 - 2x) - 3 \\
&= 2(x - 1)^2 - 2 - 3 \\
&= 2(x - 1)^2 - 5 \\
(48) \quad & x^2 + 14x + 53 \\
&= (x + 7)^2 - 49 + 53 \\
&= (x + 7)^2 + 4 \\
(49) \quad & -2x^2 + 24x - 68 \\
&= -2(x^2 - 12x) - 68 \\
&= -2(x - 6)^2 + 72 - 68 \\
&= -2(x - 6)^2 + 4 \\
(50) \quad & -5x^2 + 20x - 21 \\
&= -5(x^2 - 4x) - 21 \\
&= -5(x - 2)^2 + 20 - 21 \\
&= -5(x - 2)^2 - 1
\end{aligned}$$