



◇「콘텐츠산업 진흥법 시행령」제33조에 의한 표시

1) 제작연월일 : 2018-03-05

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3) 이 콘텐츠는 「콘텐츠산업 진흥법」에 따라 최초 제작일부터 5년간 보호됩니다.

◇「콘텐츠산업 진흥법」외에도「저작권법」에 의하여 보호되는 콘텐츠의 경우, 그 콘텐츠의 전부 또는 일부를 무단으로 복제하거나 전송하는 것은 콘텐츠산업 진흥법 외에도 저작권법에 의한 법적 책임을 질 수 있습니다.

## 01 음수의 제곱근

 $a > 0$ 일 때

(1)  $\sqrt{-a} = \sqrt{a}i$

(2)  $-a$ 의 제곱근은  $\pm \sqrt{a}i$

■ 허수단위  $i$ 를 사용하여 다음 수의 제곱근을 구하여라.

1.  $-1$

2.  $-3$

3.  $-4$

4.  $-5$

5.  $-8$

6.  $-18$

7.  $-25$

8.  $-\frac{1}{16}$

9.  $-\frac{1}{2}$

10.  $-\frac{2}{3}$

11.  $-\frac{3}{4}$

12.  $-\frac{1}{9}$

13.  $-\frac{1}{4}$

■ 다음 수를 허수단위  $i$ 를 사용하여 나타내어라.

14.  $\sqrt{-9}$

15.  $\sqrt{-12}$

16.  $-\sqrt{-8}$

17.  $-\sqrt{-\frac{9}{4}}$

■ 다음을 계산하여  $a+bi$  ( $a, b$ 는 실수)의 꼴로 나타내어라.

18.  $\sqrt{-2} + \sqrt{-8}$

19.  $\sqrt{-3} + \sqrt{-27}$

20.  $\sqrt{-9} + \sqrt{-16}$

21.  $\sqrt{-4} + \sqrt{-8}$

22.  $\sqrt{-32} - \sqrt{-8}$

23.  $4\sqrt{-12} - 2\sqrt{-27}$

24.  $3\sqrt{-2} - \sqrt{-8}$

25.  $\sqrt{-25} - \sqrt{-1}$

26.  $\sqrt{-16} + \sqrt{-4}$

27.  $\sqrt{-2} + \sqrt{-8} + \sqrt{-32}$

28.  $\sqrt{-7} + \sqrt{-49}$

29.  $\sqrt{-1} - \sqrt{-16}$

30.  $-5\sqrt{-16} + 2\sqrt{-9}$

31.  $3\sqrt{-2} - 4\sqrt{-8}$

32.  $4\sqrt{-1} - 6\sqrt{-36} + \sqrt{-12}$

33.  $\sqrt{-4} - \sqrt{-25}$

■ 다음 이차방정식의 해를 복소수 범위에서 구하여라.

34.  $x^2 = 2$

35.  $x^2 = -2$

36.  $x^2 = -3$

37.  $x^2 = -18$

38.  $x^2 = \frac{1}{2}$

39.  $x^2 = -\frac{1}{2}$

40.  $3x^2 = -9$

41.  $\frac{1}{2}x^2 = -2$

42.  $-\frac{1}{3}x^2 = 9$

43.  $x^2 = -9$

## 02 음수의 제곱근의 성질

(1)  $a < 0, b < 0$ 이면  $\sqrt{a}\sqrt{b} = -\sqrt{ab}$

(2)  $a > 0, b < 0$ 일 때,  $\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}$

$a > 0, b < 0$ 일 때를 제외하면  $a, b$ 의 부호에 관계없이

$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}} \quad (b \neq 0)$$

(참고) 위 성질의 역으로 다음이 성립한다.

(1)  $\sqrt{a}\sqrt{b} = -\sqrt{ab}$ 이면

$$a < 0, b < 0 \text{ 또는 } a = 0 \text{ 또는 } b = 0$$

(2)  $\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}$ 이면  $a > 0, b < 0$  또는  $a = 0, b \neq 0$

■ 다음을  $a+bi$  ( $a, b$ 는 실수) 꼴로 나타내어라.

44.  $\sqrt{-2}\sqrt{-8}$

45.  $\sqrt{3}\sqrt{-27}$

46.  $\sqrt{-2}\sqrt{8}$

47.  $\sqrt{-2}\sqrt{-3}$

48.  $\sqrt{-2}\sqrt{3}$

49.  $\sqrt{-4}\sqrt{-6}$

50.  $\sqrt{-5}\sqrt{-3}$

51.  $\sqrt{-8}\sqrt{-9}$

52.  $\frac{\sqrt{16}}{\sqrt{-4}}$

53.  $\frac{\sqrt{-30}}{\sqrt{-6}}$

54.  $\frac{\sqrt{-6}}{\sqrt{2}}$

55.  $\frac{\sqrt{5}}{\sqrt{-4}}$

56.  $\frac{\sqrt{-12}}{\sqrt{-3}}$

57.  $\frac{\sqrt{8}}{\sqrt{-2}}$

58.  $\frac{\sqrt{-10}}{\sqrt{2}}$

59.  $\frac{\sqrt{18}}{\sqrt{-3}}$

60.  $\frac{\sqrt{-8}}{\sqrt{-2}}$

61.  $\frac{1 - \sqrt{-12}}{2 + \sqrt{-3}}$

62.  $\frac{1 - \sqrt{-8}}{2 + \sqrt{-2}}$

63.  $\frac{2 - 2\sqrt{-1}}{1 + \sqrt{-1}}$

■ 다음을 계산하여  $a + bi$  꼴로 나타내어라.(단,  $a, b$ 는 실수,  $i = \sqrt{-1}$ )

64.  $2\sqrt{-8} - \sqrt{-18} + 2\sqrt{-50}$

65.  $\sqrt{-12} - \sqrt{-8} \sqrt{-2} + \frac{\sqrt{15}}{\sqrt{-5}}$

66.  $\frac{1 - \sqrt{-2}}{2 + \sqrt{-2}} + \frac{3 + \sqrt{-2}}{2 - \sqrt{-2}}$

67.  $3\sqrt{-12} - \sqrt{-48} - 6\sqrt{-3}$

68.  $\sqrt{-2} - \sqrt{-8} - \sqrt{-3} \sqrt{6} - \frac{\sqrt{16}}{\sqrt{-2}}$

69.  $\sqrt{4} \sqrt{-9} + \sqrt{-4} \sqrt{-9} + \frac{\sqrt{9}}{\sqrt{-4}} + \frac{\sqrt{-9}}{\sqrt{-4}}$

70.  $\sqrt{-9} \sqrt{-25} + \frac{\sqrt{9}}{\sqrt{-25}}$

71.  $\sqrt{-2} + \sqrt{-32} - \sqrt{-8}$

72.  $2\sqrt{-25} - 3\sqrt{-9} + 5\sqrt{-36}$

73.  $\sqrt{8} \sqrt{-2} + \sqrt{-8} \sqrt{-2} + \frac{\sqrt{8}}{\sqrt{-2}} + \frac{\sqrt{-8}}{\sqrt{-2}}$

74.  $\frac{\sqrt{32}}{\sqrt{-2}} + \frac{\sqrt{-48}}{\sqrt{-4}} + \sqrt{-2} \sqrt{-6}$

75.  $\frac{1 - \sqrt{-2}}{1 + \sqrt{-2}} + \frac{1 + \sqrt{-2}}{1 - \sqrt{-2}}$

76.  $\sqrt{-4} \sqrt{-9} + \frac{\sqrt{-8}}{\sqrt{-2}} - \sqrt{(-4)^2} - \sqrt{-2^2}$

77.  $\left( \sqrt{-15} \sqrt{5} + \frac{\sqrt{-27}}{\sqrt{-3}} \right) (\sqrt{-3} \sqrt{-1} + \sqrt{-9})$

■ 다음 물음에 답하여라.

78. 0이 아닌 두 실수  $a, b$ 에 대하여  $\sqrt{a} \sqrt{b} = -\sqrt{ab}$  일 때,  $|a| - |b| + \sqrt{(a+b)^2}$ 를 간단히 나타내어라.

79. 0이 아닌 두 실수  $a, b$ 에 대하여  $\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}$  일 때,  $|a-b| - |a| + |b|$ 를 간단히 나타내어라.

80. 0이 아닌 두 실수  $a, b$ 에 대하여  $\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}$  일 때,  $\sqrt{a^2} \sqrt{b^2}$ 을 간단히 나타내어라.

81. 실수  $a, b$ 에 대하여  $\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}$  일 때,  $\sqrt{(a-b)^2} - \sqrt{b^2} + (\sqrt{b})^2 + (\sqrt{a})^2$ 을 간단히 나타내어라.

82. 0이 아닌 실수  $a, b, c, d$ 에 대하여  $\sqrt{a} \sqrt{b} = -\sqrt{ab}$ ,  $\sqrt{\frac{d}{c}} = -\sqrt{\frac{d}{c}}$ 가 성립할 때,  $\sqrt{(a+b+c)^2} - 2|a-d|$ 를 간단히 나타내어라.

83. 0이 아닌 세 실수  $a, b, c$ 가  $\sqrt{a} \sqrt{b} = \sqrt{ab}$ 와  $\frac{\sqrt{c}}{\sqrt{b}} = -\sqrt{\frac{c}{b}}$ 를 동시에 만족할 때,  $|a-b| - \sqrt{(b-c)^2} - |a+c|$ 를 간단히 나타내어라.

84. 0이 아닌 실수  $a, b, c, d$ 에 대하여

$$\sqrt{ab} = -\sqrt{a}\sqrt{b}, \quad \sqrt{\frac{c}{d}} = -\frac{\sqrt{c}}{\sqrt{d}} \text{ 일 때,}$$

$|a| + |b+d| - \sqrt{c^2} - \sqrt{(a-c)^2}$  을 간단히 하여라.

85. 0이 아닌 네 실수  $a, b, c, d$ 에 대하여

$$\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}}, \quad \sqrt{c}\sqrt{d} = -\sqrt{cd} \text{ 일 때,}$$

$\sqrt{a^2} + \sqrt{b^2} - \sqrt{(c-a)^2} - |b+d| + |d|$  를 간단히 나타내어라.



## 정답 및 해설

1)  $\pm i$

2)  $\pm \sqrt{3}i$

$\Rightarrow \pm \sqrt{-3} = \pm \sqrt{3}i$

3)  $\pm 2i$

$\Rightarrow \pm \sqrt{4}i = \pm 2i$

4)  $\pm \sqrt{5}i$

5)  $\pm 2\sqrt{2}i$

$\Rightarrow \pm \sqrt{8}i = \pm 2\sqrt{2}i$

6)  $\pm 3\sqrt{2}i$

$\Rightarrow \pm \sqrt{-18} = \pm \sqrt{18}i = \pm 3\sqrt{2}i$

7)  $\pm 5i$

$\Rightarrow \pm \sqrt{-25} = \pm \sqrt{25}i = \pm 5i$

8)  $\pm \frac{1}{4}i$

$\Rightarrow \pm \sqrt{-\frac{1}{16}} = \pm \sqrt{\frac{1}{16}}i = \pm \frac{1}{4}i$

9)  $\pm \frac{\sqrt{2}}{2}i$

10)  $\pm \frac{\sqrt{6}}{3}i$

$\Rightarrow \pm \sqrt{\frac{2}{3}}i = \pm \frac{\sqrt{6}}{3}i$

11)  $\pm \frac{\sqrt{3}}{2}i$

12)  $\pm \frac{1}{3}i$

13)  $\pm \frac{1}{2}i$

$\Rightarrow \pm \sqrt{\frac{1}{4}}i = \pm \frac{1}{2}i$

14)  $3i$

$\Rightarrow \sqrt{-9} = \sqrt{9}i = 3i$

15)  $2\sqrt{3}i$

$\Rightarrow \sqrt{-12} = \sqrt{12}i = 2\sqrt{3}i$

16)  $-2\sqrt{2}i$

$\Rightarrow -\sqrt{-8} = -\sqrt{8}i = -2\sqrt{2}i$

17)  $-\frac{3}{2}i$

$\Rightarrow -\sqrt{-\frac{9}{4}} = -\sqrt{\frac{9}{4}}i = -\frac{3}{2}i$

18)  $3\sqrt{2}i$

$\Rightarrow$

$$\begin{aligned}\sqrt{-2} + \sqrt{-8} &= \sqrt{2}i + \sqrt{2^3}i = \sqrt{2}i + 2\sqrt{2}i \\ &= (\sqrt{2} + 2\sqrt{2})i = 3\sqrt{2}i\end{aligned}$$

19)  $4\sqrt{3}i$

$\Rightarrow$

$$\sqrt{-3} + \sqrt{-27} = \sqrt{3}i + 3\sqrt{3}i = 4\sqrt{3}i$$

20)  $7i$

$\Rightarrow$

$$\sqrt{-9} + \sqrt{-16} = 3i + 4i = 7i$$

21)  $2(1 + \sqrt{2})i$

$$\Rightarrow \sqrt{-4} + \sqrt{-8} = 2i + 2\sqrt{2}i = 2(1 + \sqrt{2})i$$

22)  $2\sqrt{2}i$

$\Rightarrow$

$$\sqrt{-32} - \sqrt{-8} = 4\sqrt{2}i - 2\sqrt{2}i = 2\sqrt{2}i$$

23)  $2\sqrt{3}i$

$\Rightarrow$

$$\begin{aligned}4\sqrt{-12} - 2\sqrt{-27} &= 4 \cdot 2\sqrt{3}i - 2 \cdot 3\sqrt{3}i \\ &= 8\sqrt{3}i - 6\sqrt{3}i = 2\sqrt{3}i\end{aligned}$$

24)  $\sqrt{2}i$

$\Rightarrow$

$$3\sqrt{-2} - \sqrt{-8} = 3\sqrt{2}i - 2\sqrt{2}i = \sqrt{2}i$$

25)  $4i$

$\Rightarrow$

$$\sqrt{-25} - \sqrt{-1} = 5i - i = 4i$$

26)  $6i$

$$\Rightarrow \sqrt{-16} + \sqrt{-4} = 4i + 2i = 6i$$

27)  $7\sqrt{2}i$

$\Rightarrow$

$$\sqrt{-2} + \sqrt{-8} + \sqrt{-32} = \sqrt{2}i + 2\sqrt{2}i + 4\sqrt{2}i = 7\sqrt{2}i$$

28)  $(7 + \sqrt{7})i$

$$\Rightarrow \sqrt{-7} + \sqrt{-49} = \sqrt{7}i + 7i = (7 + \sqrt{7})i$$

29)  $-3i$

$$\Rightarrow \sqrt{-1} - \sqrt{-16} = i - 4i = -3i$$

30)  $-14i$

$\Rightarrow$

$$-5\sqrt{-16} + 2\sqrt{-9} = -5 \cdot 4i + 2 \cdot 3i = -20i + 6i = -14i$$

31)  $-5\sqrt{2}i$

$$\Rightarrow 3\sqrt{-2} - 4\sqrt{-8} = 3\sqrt{2}i - 8\sqrt{2}i = -5\sqrt{2}i$$

32)  $-2(16 - \sqrt{3})i$

$$\Rightarrow 4\sqrt{-1} - 6\sqrt{-36} + \sqrt{-12}$$

$$= 4i - 6 \cdot 6i + 2\sqrt{3}i$$

$$= 4i - 36i + 2\sqrt{3}i = -32i + 2\sqrt{3}i$$

$$= -2(16 - \sqrt{3})i$$

33)  $-3i$

$$\Rightarrow \sqrt{-4} - \sqrt{-25} = 2i - 5i = -3i$$

34)  $x = \pm \sqrt{2}$

35)  $x = \pm \sqrt{2}i$

36)  $x = \pm \sqrt{3}i$

37)  $x = \pm 3\sqrt{2}i$

$$\Rightarrow x = \pm \sqrt{18}i \quad \therefore x = \pm 3\sqrt{2}i$$

38)  $x = \pm \frac{\sqrt{2}}{2}$

39)  $x = \pm \frac{\sqrt{2}}{2}i$

40)  $x = \pm \sqrt{3}i$

$$\Rightarrow x^2 = -3 \quad \therefore x = \pm \sqrt{3}i$$

41)  $x = \pm 2i$

$$\Rightarrow x^2 = -4 \quad \therefore x = \pm 2i$$

42)  $x = \pm 3\sqrt{3}i$

$$\Rightarrow x^2 = -27, x = \pm \sqrt{27}i \quad \therefore x = \pm 3\sqrt{3}i$$

43)  $x = \pm 3i$

$$\Rightarrow -9\text{의 제곱근은 } \pm \sqrt{9}i = \pm 3i\text{이므로}$$

$$x^2 = -9\text{의 해는 } x = \pm 3i$$

44)  $-4$

$$\Rightarrow \sqrt{-2} \sqrt{-8} = \sqrt{2}i \cdot \sqrt{8}i = \sqrt{16}i^2 = -4$$

45)  $9i$

$$\Rightarrow \sqrt{3} \sqrt{-27} = \sqrt{3} \sqrt{27}i = \sqrt{81}i = 9i$$

46)  $4i$

$$\Rightarrow \sqrt{-2} \sqrt{8} = \sqrt{2}i \times 2\sqrt{2} = 4i$$

47)  $-\sqrt{6}$

$$\Rightarrow \sqrt{-2} \sqrt{-3} = \sqrt{2}i \times \sqrt{3}i = -\sqrt{6}$$

48)  $\sqrt{6}i$

$$\Rightarrow \sqrt{-2} \sqrt{3} = \sqrt{2}i \times \sqrt{3} = \sqrt{6}i$$

49)  $-2\sqrt{6}$

$$\Rightarrow \sqrt{-4} \sqrt{-6} = 2i \times \sqrt{6}i = -2\sqrt{6}$$

50)  $-\sqrt{15}$

$$\Rightarrow \sqrt{-5} \sqrt{-3} = \sqrt{5}i \times \sqrt{3}i = -\sqrt{15}$$

51)  $-6\sqrt{2}$

$$\Rightarrow$$

$$\sqrt{-8} \sqrt{-9} = 2\sqrt{2}i \cdot 3i = -6\sqrt{2}$$

52)  $-2i$

$$\Rightarrow \frac{\sqrt{16}}{\sqrt{-4}} = \frac{4}{\sqrt{4}i} = \frac{4i}{2i^2} = \frac{4i}{-2} = -2i$$

53)  $\sqrt{5}$

$$\Rightarrow \frac{\sqrt{-30}}{\sqrt{-6}} = \frac{\sqrt{30}i}{\sqrt{6}i} = \sqrt{5}$$

54)  $\sqrt{3}i$

$$\Rightarrow \frac{\sqrt{-6}}{\sqrt{2}} = \frac{\sqrt{6}i}{\sqrt{2}} = \sqrt{3}i$$

55)  $-\frac{\sqrt{5}}{2}i$

$$\Rightarrow \frac{\sqrt{5}}{\sqrt{-4}} = \frac{\sqrt{5}}{2i} = \frac{\sqrt{5}i}{2i^2} = -\frac{\sqrt{5}}{2}i$$

56)  $2$

$$\Rightarrow \frac{\sqrt{-12}}{\sqrt{-3}} = \frac{2\sqrt{3}i}{\sqrt{3}i} = 2$$

57)  $-2i$

$$\Rightarrow \frac{\sqrt{8}}{\sqrt{-2}} = \frac{2\sqrt{2}}{\sqrt{2}i} = \frac{2\sqrt{2}i}{\sqrt{2}i^2} = -2i$$

58)  $\sqrt{5}i$

$$\Rightarrow$$

$$\frac{\sqrt{-10}}{\sqrt{2}} = \frac{\sqrt{10}i}{\sqrt{2}} = \sqrt{5}i$$

59)  $-\sqrt{6}i$

$$\Rightarrow$$

$$\frac{\sqrt{18}}{\sqrt{-3}} = \frac{3\sqrt{2}}{\sqrt{3}i} = \frac{3\sqrt{2} \cdot \sqrt{3}i}{3i^2} = -\sqrt{6}i$$

60)  $2$

$$\Rightarrow$$

$$\frac{\sqrt{-8}}{\sqrt{-2}} = \frac{2\sqrt{2}i}{\sqrt{2}i} = 2$$

61)  $-\frac{4}{7} - \frac{5\sqrt{3}}{7}i$

$$\Rightarrow$$



$$\begin{aligned}\frac{1-\sqrt{-12}}{2+\sqrt{-3}} &= \frac{1-2\sqrt{3}i}{2+\sqrt{3}i} = \frac{(1-2\sqrt{3}i)(2-\sqrt{3}i)}{(2+\sqrt{3}i)(2-\sqrt{3}i)} \\ &= \frac{2-\sqrt{3}i-4\sqrt{3}i+6i^2}{4-3i^2} \\ &= \frac{-4-5\sqrt{3}i}{7} = -\frac{4}{7} - \frac{5\sqrt{3}}{7}i\end{aligned}$$

$$62) -\frac{1}{3} - \frac{5\sqrt{2}}{6}i$$

⇒

$$\begin{aligned}\frac{1-\sqrt{-8}}{2+\sqrt{-2}} &= \frac{1-2\sqrt{2}i}{2+\sqrt{2}i} \\ &= \frac{(1-2\sqrt{2}i)(2-\sqrt{2}i)}{(2+\sqrt{2}i)(2-\sqrt{2}i)} \\ &= \frac{2-\sqrt{2}i-4\sqrt{2}i+4i^2}{4-2i^2} \\ &= \frac{-2-5\sqrt{2}i}{6} = -\frac{1}{3} - \frac{5\sqrt{2}}{6}i\end{aligned}$$

$$63) -2i$$

⇒

$$\frac{2-2\sqrt{-1}}{1+\sqrt{-1}} = \frac{2-2i}{1+i} = \frac{2(1-i)^2}{(1+i)(1-i)} = \frac{2(1-i)^2}{2} = -2i$$

$$64) 11\sqrt{2}i$$

⇒

$$\begin{aligned}2\sqrt{-8} - \sqrt{-18} + 2\sqrt{-50} &= 2\cdot 2\sqrt{2}i - 3\sqrt{2}i + 2\cdot 5\sqrt{2}i \\ &= 4\sqrt{2}i - 3\sqrt{2}i + 10\sqrt{2}i \\ &= 11\sqrt{2}i\end{aligned}$$

$$65) 4 + \sqrt{3}i$$

⇒

$$\begin{aligned}\sqrt{-12} - \sqrt{-8} \sqrt{-2} + \frac{\sqrt{15}}{\sqrt{-5}} &= 2\sqrt{3}i - 2\sqrt{2}i \cdot \sqrt{2}i + \frac{\sqrt{15}}{\sqrt{5}i} \\ &= 2\sqrt{3}i + 4 + \frac{\sqrt{3}i}{i^2} \\ &= 2\sqrt{3}i + 4 - \sqrt{3}i \\ &= 4 + \sqrt{3}i\end{aligned}$$

$$66) \frac{2}{3} + \frac{\sqrt{2}}{3}i$$

⇒

$$\begin{aligned}\frac{1-\sqrt{-2}}{2+\sqrt{-2}} + \frac{3+\sqrt{-2}}{2-\sqrt{-2}} \\ &= \frac{1-\sqrt{2}i}{2+\sqrt{2}i} + \frac{3+\sqrt{2}i}{2-\sqrt{2}i} \\ &= \frac{(1-\sqrt{2}i)(2-\sqrt{2}i) + (3+\sqrt{2}i)(2+\sqrt{2}i)}{(2+\sqrt{2}i)(2-\sqrt{2}i)} \\ &= \frac{-3\sqrt{2}i + (4+5\sqrt{2}i)}{4-2i^2} \\ &= \frac{4+2\sqrt{2}i}{6} = \frac{2}{3} + \frac{\sqrt{2}}{3}i\end{aligned}$$

$$67) -4\sqrt{3}i$$

⇒

$$\begin{aligned}3\sqrt{-12} - \sqrt{-48} - 6\sqrt{-3} &= 3\cdot 2\sqrt{3}i - 4\sqrt{3}i - 6\sqrt{3}i \\ &= -4\sqrt{3}i\end{aligned}$$

$$68) -2\sqrt{2}i$$

⇒

$$\begin{aligned}\sqrt{-2} - \sqrt{-8} - \sqrt{-3} \sqrt{6} - \frac{\sqrt{16}}{\sqrt{-2}} \\ &= \sqrt{2}i - 2\sqrt{2}i - \sqrt{3}i \cdot \sqrt{6} - \frac{4}{\sqrt{2}i} \\ &= \sqrt{2}i - 2\sqrt{2}i - 3\sqrt{2}i + 2\sqrt{2}i \\ &= -2\sqrt{2}i\end{aligned}$$

$$69) -\frac{9}{2} + \frac{9}{2}i$$

⇒

$$\begin{aligned}\sqrt{4} \sqrt{-9} + \sqrt{-4} \sqrt{-9} + \frac{\sqrt{9}}{\sqrt{-4}} + \frac{\sqrt{-9}}{\sqrt{-4}} \\ &= 2\cdot 3i + 2i\cdot 3i + \frac{3}{2i} + \frac{3i}{2i} \\ &= 6i - 6 - \frac{3}{2}i + \frac{3}{2} = -\frac{9}{2} + \frac{9}{2}i\end{aligned}$$

$$70) -15 - \frac{3}{5}i$$

$$\Rightarrow \sqrt{-9} \sqrt{-25} + \frac{\sqrt{9}}{\sqrt{-25}} = 3i\cdot 5i + \frac{3}{5i} = -15 - \frac{3}{5}i$$

$$71) 3\sqrt{2}i$$

⇒

$$\begin{aligned}\sqrt{-2} + \sqrt{-32} - \sqrt{-8} &= \sqrt{2}i + 4\sqrt{2}i - 2\sqrt{2}i \\ &= (1+4-2)\sqrt{2}i = 3\sqrt{2}i\end{aligned}$$

$$72) 31i$$

⇒

$$\begin{aligned}2\sqrt{-25} - 3\sqrt{-9} + 5\sqrt{-36} &= 2\cdot 5i - 3\cdot 3i + 5\cdot 6i \\ &= 10i - 9i + 30i = 31i\end{aligned}$$

$$73) -2+2i$$

⇒

$$\begin{aligned}\sqrt{8} \sqrt{-2} + \sqrt{-8} \sqrt{-2} + \frac{\sqrt{8}}{\sqrt{-2}} + \frac{\sqrt{-8}}{\sqrt{-2}} \\ &= 2\sqrt{2} \cdot \sqrt{2}i + 2\sqrt{2}i \cdot \sqrt{2}i + \frac{2\sqrt{2}}{\sqrt{2}i} + \frac{2\sqrt{2}i}{\sqrt{2}i} \\ &= 4i - 4 - 2i + 2 = -2 + 2i\end{aligned}$$

$$74) -4i$$

⇒

$$\begin{aligned}\frac{\sqrt{32}}{\sqrt{-2}} + \frac{\sqrt{-48}}{\sqrt{-4}} + \sqrt{-2} \sqrt{-6} &= \frac{\sqrt{32}}{\sqrt{2}i} + \frac{\sqrt{48}i}{\sqrt{4}i} + \sqrt{2}i \sqrt{6}i \\ &= \frac{4}{i} + \sqrt{12} - \sqrt{12} = \frac{4i}{i^2} = -4i\end{aligned}$$

$$75) -\frac{2}{3}$$

⇒

$$\begin{aligned}\frac{1-\sqrt{-2}}{1+\sqrt{-2}} + \frac{1+\sqrt{-2}}{1-\sqrt{-2}} &= \frac{1-\sqrt{2}i}{1+\sqrt{2}i} + \frac{1+\sqrt{2}i}{1-\sqrt{2}i} \\ &= \frac{(1-\sqrt{2}i)^2 + (1+\sqrt{2}i)^2}{(1+\sqrt{2}i)(1-\sqrt{2}i)}\end{aligned}$$

$$= \frac{1-2\sqrt{2}i-2+1+2\sqrt{2}i-2}{3} = -\frac{2}{3}$$

$$76) -8-2i$$

$$\Rightarrow \sqrt{-4}\sqrt{-9} + \frac{\sqrt{-8}}{\sqrt{-2}} - \sqrt{(-4)^2} - \sqrt{-2^2}$$

$$= 2i \cdot 3i + \frac{2\sqrt{2}i}{\sqrt{2}i} - 4 - 2i = -6 + 2 - 4 - 2i = -8 - 2i$$

$$77) -18\sqrt{3}-6i$$

$\Rightarrow$

$$\sqrt{-15}\sqrt{5} + \frac{\sqrt{-27}}{\sqrt{-3}} = \sqrt{15}i\sqrt{5} + \frac{\sqrt{27}i}{\sqrt{3}i}$$

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

$$\text{또, } \sqrt{-3}\sqrt{-1} + \sqrt{-9} = \sqrt{3}i\sqrt{1}i + \sqrt{9}i$$

$$= -\sqrt{3} + 3i$$

$$\therefore (\text{준식}) = (3+5\sqrt{3}i)(-\sqrt{3}+3i)$$

$$= -3\sqrt{3} + 9i - 15i - 15\sqrt{3}$$

$$= -18\sqrt{3} - 6i$$

$$78) -2a$$

$\Rightarrow$

$$\sqrt{a}\sqrt{b} = -\sqrt{ab} \text{ 일 때, } a < 0, b < 0 \text{ 이므로}$$

$$|a| - |b| + \sqrt{(a+b)^2} = -a - (-b) - (a+b) = -2a$$

$$79) -2b$$

$\Rightarrow$

$$\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}} \text{ 일 때, } a > 0, b < 0 \text{ 이므로}$$

$$|a-b| - |a| + |b| = a-b-a+(-b) = -2b$$

$$80) -ab$$

$\Rightarrow$

$$\frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}} \text{ 일 때, } a > 0, b < 0 \text{ 이므로}$$

$$\sqrt{a^2}\sqrt{b^2} = a \cdot (-b) = -ab$$

$$81) 2a+b$$

$$\Rightarrow \frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}} \text{ 가 성립할 때의 조건은 } b < 0, a \geq 0$$

이다.

$$\sqrt{(a-b)^2} - \sqrt{b^2} + (\sqrt{b})^2 + (\sqrt{a})^2$$

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

$$82) a-b-c-2d$$

$\Rightarrow$

$$\sqrt{a}\sqrt{b} = -\sqrt{ab} \text{ 에서 } a < 0, b < 0 \text{ 이고}$$

$$\sqrt{\frac{d}{c}} = -\frac{\sqrt{d}}{\sqrt{c}} \text{ 에서 } c < 0, d > 0 \text{ 이다.}$$

$$\sqrt{(a+b+c)^2} - 2|a-d|$$

$$= -(a+b+c) + 2(a-d)$$

$$= a-b-c-2d$$

$$83) -2c$$

$$\Rightarrow \frac{\sqrt{c}}{\sqrt{b}} = -\sqrt{\frac{c}{b}} \text{ 이므로 } c > 0, b < 0 \text{ 이고,}$$

$$\text{이 때 } \sqrt{a}\sqrt{b} = \sqrt{ab} \text{ 이므로 } b < 0 \text{ 이면 } a > 0 \text{ 이다.}$$

$$|a-b| - \sqrt{(b-c)^2} - |a+c|$$

$$= (a-b) - (-b+c) - (a+c)$$

$$= -2c$$

$$84) -b-2c-d$$

$\Rightarrow$

$$\sqrt{ab} = -\sqrt{a}\sqrt{b} \text{ 이므로 } a < 0, b < 0$$

$$\sqrt{\frac{c}{d}} = -\frac{\sqrt{c}}{\sqrt{d}} \text{ 이므로 } c > 0, d < 0$$

$$\therefore |a| + |b+d| - \sqrt{c^2} - \sqrt{(a-c)^2}$$

$$= |a| + |b+d| - |c| - |a-c|$$

$$= -a-b-d-c+a-c$$

$$= -b-2c-d$$

$$85) c$$

$$\Rightarrow \frac{\sqrt{a}}{\sqrt{b}} = -\sqrt{\frac{a}{b}} \text{ 이므로 } a > 0, b < 0$$

$$\sqrt{c}\sqrt{d} = -\sqrt{cd} \text{ 이므로 } c < 0, d < 0$$

$$\therefore \sqrt{a^2} + \sqrt{b^2} - \sqrt{(c-a)^2} - |b+d| + |d|$$

$$= a-b-(a-c)-(-b-d)+(-d)$$

$$= c$$