N5 Indices

Expressions & Formulae

SPTA Mathematics – Topic Questions with Notes

Rules of Indices

Basic Rule 1: anything to the power 0 is equal to 1:

e.g. $5^0 = 1$, $17^0 = 1$, $35627658^0 = 1$, $x^0 = 1$

Basic Rule 2: anything to the power 1 is equal to itself:

e.g. $5^1 = 5$, $17^1 = 17$, $35627658^1 = 35627658$, $x^1 = x$

Key Rule 1: when you multiply two expressions involving powers, you add the numbers in the power: $a^m \times a^n = a^{m+n}$

e.g. $x^3 \times x^4 = \underline{x^7}$ $y^{-1} \times y^6 = y^{-1+6} = \underline{y^5}$

Key Rule 2: when you divide two expressions involving powers, you take away the numbers in the power: $\frac{a^m}{a^n} = a^{m-n}$

e.g. $a^8 \div a^3 = \underline{a^5}$ $\frac{m^{10}}{m^8} = \underline{m^2}$

Key Rule 3: when you take one power to the power of another (nested powers), you multiply the numbers in the power: $(a^m)^n = a^{mn}$

e.g. $(x^2)^3 = \underline{x^6}$ $(a^4)^{-2} = \underline{a^{-8}}$

Example 1

Simplify $\frac{3x^4 \times 8x^8}{6x^2}$

Solution

$$\frac{3x^4 \times 8x^8}{6x^2} = \frac{24x^{12}}{6x^2}$$ (add the powers when multiplying)

$$= 4x^{10}$$ (take away the powers when dividing)

Example 2

Simplify $(5x^{-3})^2 \times x^8$

Solution

$(5x^{-3})^2 \times x^8 = 25x^{-6} \times x^8$ (multiplying the nested powers)

$=25x^2$ (adding the powers when multiplying)

Example 3

Simplify $3x^2(x^{-2} + 2x^5)$

Solution

$$3x^2(x^{-2} + 2x^5) = 3x^2 \times x^{-2} + 3x^2 \times 2x^5$$
$$= 3x^{2+(-2)} + 6x^{2+5}$$
$$= 3x^0 + 6x^7$$
$$= \underline{3 + 6x^7}$$

Exercise 1

1. Write each of the following in its simplest index form.

a)	$3^4 \times 3^2$	**(b)**	2×2^3	**(c)**	$10^5 \times 10^2$	**(d)**	$8^3 \times 8^5$
e)	$7^6 \times 7$	**(f)**	$5^4 \times 5^4$	**(g)**	$9^6 \times 9^2$	**(h)**	$6^8 \times 6^5$
i)	$x^3 \times x^5$	**(j)**	$c^2 \times c^9$	**(k)**	$a^2 \times a^{12}$	**(l)**	$y^5 \times y^5$
m)	$b^{10} \times b^{30}$	**(n)**	$p \times p^9$	**(o)**	$d^2 \times d^4$	**(p)**	$q^{11} \times q^9$
q)	$t^3 \times t^7$	**(r)**	$f^4 \times f^3$	**(s)**	$k \times k^{12}$	**(t)**	$z^{50} \times z^{50}$
u)	$x^{30} \times x^{50}$	**(v)**	$y^{19} \times y$	**(w)**	$a^{25} \times a^{65}$	**(x)**	$b^1 \times b^0$

2. Write each of the following in its simplest index form.

a)	$2^8 \div 2^3$	**(b)**	$5^4 \div 5^2$	**(c)**	$12^9 \div 1\,2^6$	**(d)**	$7^{11} \div 7^4$
e)	$20^5 \div 20$	**(f)**	$8^8 \div 8^4$	**(g)**	$3^{18} \div 3^3$	**(h)**	$4^{15} \div 4^{13}$
i)	$x^7 \div x^2$	**(j)**	$a^9 \div a^5$	**(k)**	$y^{20} \div y^{10}$	**(l)**	$b^4 \div b^1$
m)	$p^{12} \div p^{11}$	**(n)**	$c^7 \div c^7$	**(o)**	$q^8 \div q^2$	**(p)**	$d^4 \div d$
q)	$\frac{x^9}{x^3}$	**(r)**	$\frac{a^8}{a^2}$	**(s)**	$\frac{m^{14}}{m}$	**(t)**	$\frac{s^7}{s^7}$
u)	$\frac{d^{20}}{d^{12}}$	**(v)**	$\frac{y^{100}}{y^{10}}$	**(w)**	$\frac{t^{100}}{t}$	**(x)**	$\frac{w^{10}}{w^0}$

3. Write each of the following in its simplest index form.

a) $(3^2)^4$ **(b)** $(8^2)^2$ **(c)** $(10^3)^2$ **(d)** $(2^2)^5$

e) $(4^5)^3$ **(f)** $(1^7)^2$ **(g)** $(12^3)^3$ **(h)** $(5^5)^5$

i) $(x^4)^2$ **(j)** $(y^8)^5$ **(k)** $(a^3)^7$ **(l)** $(m^4)^4$

m) $(b^3)^6$ **(n)** $(p^5)^3$ **(o)** $(k^5)^{20}$ **(p)** $(z^6)^0$

4. Write the following without brackets.

a) $(2b)^2$ **(b)** $(7a)^3$ **(c)** $(3x)^4$ **(d)** $(2y)^5$

e) $(ab)^4$ **(f)** $(xy)^7$ **(g)** $(wz)^5$ **(h)** $(st)^3$

i) $(pq^2)^3$ **(j)** $(x^4y)^2$ **(k)** $(a^2b^3)^5$ **(l)** $(6a^5)^2$

m) $(10x^2)^3$ **(n)** $(2c^4)^5$ **(o)** $(3ab^2)^3$ **(p)** $(4m^2k)^2$

5. Simplify these expressions.

a) $2a^3 \times 5a^5$ **(b)** $7x \times 9x^8$ **(c)** $12p^7 \div 4p^4$ **(d)** $50b^{12} \div 10b^6$

e) $3y \times (2y^2)^3$ **(f)** $(4q^3)^2 \times 5q^4$ **(g)** $(4c^3)^3 \div 8c^2$ **(h)** $72z^{12} \div (3z^4)^2$

i) $k^2(k^3 + k^5)$ **(j)** $m^5(m^2 - m^3)$ **(k)** $2x^4(x^3 + 3x^2)$ **(l)** $5a^5(2a^2 - 3a^3)$

m) $\dfrac{x^5 \times x^4}{x^6}$ **(n)** $\dfrac{(m^5)^4}{m^6}$ **(o)** $\dfrac{5c^3 \times 4c^7}{2c^6}$ **(p)** $\dfrac{(3q^3)^2 \times 4q^4}{6q^7}$

q) $\dfrac{(3xy^5)^3}{9x^2y}$ **(r)** $\dfrac{(2a^2b^5)^6}{(4ab)^2}$ **(s)** $\dfrac{(4p^4)^3}{2p^3 \times 8p^6}$ **(t)** $\dfrac{(2ab^3)^5}{3a^2b \times 4ab^2}$

6. Write down the value of

a) 5^0 **(b)** 2^0 **(c)** 100^0 **(d)** $(-3)^0$

e) 25^0 **(f)** $\frac{1}{2}{}^0$ **(g)** a^0 **(h)** k^0

i) $(mn)^0$ **(j)** $(ab^2)^0$ **k)** $(10x^3)^0$ **(l)** $(16y^2z^3)^0$

Negative Powers and Fractions in Powers

A negative power means dividing. In general, $a^{-m} = \frac{1}{a^m}$

e.g. $3^{-2} = \frac{1}{3^2} = \underline{\underline{\frac{1}{9}}}$ $\quad a^{-4} = \underline{\underline{\frac{1}{a^4}}}$ $\quad 5x^{-2} = 5 \times \frac{1}{x^2} = \underline{\underline{\frac{5}{x^2}}}$

Example 1 – negative power

Rewrite $3x^{-4}$ and $5y^{-7}$ using positive powers

Solution

$\underline{\underline{\frac{3}{x^4}}}$ and $\underline{\underline{\frac{5}{y^7}}}$

A fraction as a power means a root. In general, $a^{\frac{m}{n}} = \sqrt[n]{a^m}$

e.g. $15^{\frac{2}{3}} = \sqrt[3]{15^2}$, $\quad a^{\frac{4}{5}} = \sqrt[5]{a^4}$, $\quad x^{\frac{1}{3}} = \sqrt[3]{x}$

Example 2 – fraction power

Evaluate $9^{\frac{3}{2}}$ and $125^{\frac{4}{3}}$

Solution

$$9^{\frac{3}{2}} = \sqrt[2]{9^3} \qquad 125^{\frac{4}{3}} = \sqrt[3]{125^4}$$
$$= 3^3 \qquad = 5^4$$
$$= \underline{27} \qquad = \underline{625}$$

Hint: calculate the root first and the power second, or the sum may prove too hard for you

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Example 3 – negative and fractional powers

Simplify $25^{-\frac{1}{2}}$

Solution

$25^{-\frac{1}{2}} = \frac{1}{25^{\frac{1}{2}}}$ (moving negative power to the bottom)

$= \frac{1}{\sqrt{25}}$ (changing fractional power into surd)

$= \underline{\underline{\frac{1}{5}}}$ (simplifying the surd)

Exercise 2

1. Rewrite the following with positive indices.

a) 3^{-2} **(b)** 5^{-4} **(c)** 2^{-6} **(d)** 10^{-3} **(e)** 4^{-5} **(f)** 200^{-7}

g) a^{-5} **(h)** x^{-2} **(i)** p^{-7} **(j)** y^{-10} **(k)** $2b^{-3}$ **(l)** $10\,q^{-x}$

m) $\dfrac{1}{x^{-3}}$ **(n)** $\dfrac{1}{w^{-5}}$ **(o)** $\dfrac{3}{a^{-2}}$ **(p)** $\dfrac{10}{c^{-8}}$ **(q)** $\dfrac{2}{3t^{-1}}$ **(r)** $\dfrac{5}{4y^{-3}}$

2. Rewrite the following with negative indices.

a) $\dfrac{1}{3^2}$ **(b)** $\dfrac{1}{6^9}$ **(c)** $\dfrac{1}{5^4}$ **(d)** $\dfrac{1}{2^7}$ **(e)** $\dfrac{1}{10^3}$ **(f)** $\dfrac{1}{4^4}$

g) $\dfrac{1}{x^3}$ **(h)** $\dfrac{1}{a^5}$ **(i)** $\dfrac{1}{p^4}$ **(j)** $\dfrac{1}{y^{10}}$ **(k)** $\dfrac{1}{q^6}$ **(l)** $\dfrac{1}{c^8}$

3. Simplify the following expressions.

a) $m^3 \times m^{-5}$ **(b)** $x^7 \times x^{-2}$ **(c)** $p^{-8} \times p^5$ **(d)** $a^{-3} \times a^{-5}$ **(e)** $(y^3)^{-4}$

f) $(c^{-5})^3$ **(g)** $(q^3)^{-5}$ **(h)** $(w^{-2})^{-4}$ **(i)** $4b^{-4} \times 5b^5$ **(j)** $3x^6 \times 9x^{-6}$

k) $4k^3 \div 2k^{-2}$ **(l)** $18d \div 12d^4$ **(m)** $x^2(x^3 + x^{-1})$ **(n)** $p^{-3}(p^4 - p^{-8})$

o) $3a^5(2a + 3a^{-2})$ **(p)** $\frac{1}{2}\, m^{-2}(4m^{-3} - 10m^6)$ **(q)** $\dfrac{v^3 \times v^5}{v^{-2}}$

r) $\dfrac{4h^7 \times 3h^{-4}}{2h^4}$ **(s)** $\dfrac{4c^{-5} \times 9c^6}{6c^{-4}}$ **(t)** $\dfrac{5x^4 \times 6x^{-8}}{3x^{-4}}$

4. Find the value of

a) $16^{\frac{1}{4}}$ **(b)** $8^{\frac{1}{3}}$ **(c)** $36^{\frac{1}{2}}$ **(d)** $27^{\frac{2}{3}}$ **(e)** $64^{\frac{1}{3}}$ **(f)** $1000^{\frac{1}{3}}$

g) $25^{\frac{1}{2}}$ **(h)** $81^{\frac{3}{4}}$ **(i)** $125^{\frac{2}{3}}$ **(j)** $64^{\frac{1}{2}}$ **(k)** $216^{\frac{1}{3}}$ **(l)** $16^{-\frac{1}{4}}$

m) $4^{-\frac{1}{2}}$ **(n)** $16^{-\frac{1}{2}}$ **(o)** $9^{-\frac{1}{2}}$ **(p)** $27^{-\frac{2}{3}}$ **(q)** $256^{-\frac{3}{4}}$ **(r)** $1000^{-\frac{2}{3}}$

s) $16^{-\frac{3}{2}}$ **(t)** $8^{-\frac{4}{3}}$ **(u)** $8^{\frac{4}{3}}$ **(v)** $(-8)^{\frac{1}{3}}$ **(w)** $64^{\frac{2}{3}}$ **(x)** $100^{-\frac{3}{2}}$

y) $(\frac{1}{2})^{-1}$ **(z)** $(\frac{1}{8})^{\frac{4}{3}}$

5. Simplify the following expressions, giving your answers with positive indices.

a) $(x^{\frac{1}{2}})^6$ **(b)** $(p^{\frac{1}{3}})^6$ **(c)** $(a^{\frac{3}{4}})^8$ **(d)** $(y^{-\frac{2}{3}})^9$ **(e)** $(q^{-\frac{1}{5}})^{10}$ **(f)** $(k^{-\frac{2}{5}})^1$

g) $(g^4)^{\frac{1}{2}}$ **(h)** $(m^{12})^{-\frac{2}{3}}$ **i)** $(c^9)^{\frac{2}{3}}$ **(j)** $(h^5)^{-\frac{1}{2}}$ **(k)** $(z^4)^{-\frac{3}{4}}$ **(l)** $(b^{16})^{-\frac{3}{4}}$

m) $x^{\frac{1}{2}} \times x^{-\frac{1}{2}}$ **(n)** $y^{\frac{1}{3}} \times y^{\frac{2}{3}}$ **(o)** $d^{-\frac{1}{4}} \times d^{\frac{9}{4}}$ **(p)** $s^{\frac{7}{2}} \times s^{-\frac{1}{2}}$

q) $3x^{\frac{1}{2}} \times 4x^{\frac{1}{2}}$ **(r)** $6x^{\frac{1}{2}} \times 2x^{-\frac{1}{2}}$ **(s)** $2x^{\frac{1}{2}} \times 5x^{\frac{1}{2}}$ **(t)** $3x^{\frac{2}{3}} \times 2x^{-\frac{1}{3}}$

u) $x^{\frac{1}{2}} \div x^{\frac{1}{2}}$ **(v)** $2x^{\frac{1}{2}} \div x^{-\frac{1}{2}}$ **w)** $8x^{\frac{2}{3}} \div 2x^{\frac{1}{3}}$ **(x)** $6x^{\frac{1}{3}} \div 4x^{\frac{2}{3}}$

6. Write the following in surd form.

a) $x^{\frac{1}{2}}$ **(b)** $y^{\frac{1}{3}}$ **(c)** $a^{\frac{1}{4}}$ **(d)** $y^{\frac{2}{3}}$ **(e)** $b^{\frac{3}{4}}$ **(f)** $x^{\frac{5}{3}}$

g) $c^{\frac{3}{5}}$ **(h)** $a^{\frac{4}{5}}$ **(i)** $c^{-\frac{1}{3}}$ **(j)** $z^{-\frac{1}{2}}$ **(k)** $m^{-\frac{2}{3}}$ **(l)** $k^{-\frac{3}{5}}$

m) $p^{-\frac{4}{3}}$ **(n)** $x^{-\frac{5}{3}}$ **(o)** $w^{-\frac{4}{5}}$ **(p)** $d^{-\frac{2}{7}}$

7. Write the following in index form.

a) $\sqrt{x}$ **(b)** $\sqrt[3]{a}$ **(c)** $\sqrt{y^3}$ **(d)** $\sqrt[3]{z^2}$ **(e)** $\sqrt[3]{c^2}$ **(f)** $\sqrt[4]{x^3}$

g) $\sqrt[3]{p^5}$ **(h)** $\sqrt[5]{m^2}$ **(i)** $\frac{1}{\sqrt{a}}$ **(j)** $\frac{1}{\sqrt[3]{z}}$ **(k)** $\frac{1}{\sqrt[3]{x^4}}$ **(l)** $\frac{1}{\sqrt{a^5}}$

m) $\frac{1}{\sqrt[3]{b^2}}$ **(n)** $\frac{1}{\sqrt[5]{m^3}}$ **(o)** $\frac{1}{\sqrt[4]{y}}$ **(p)** $\frac{1}{\sqrt[3]{c^5}}$

8. Simplify each of the following by: (i) changing root signs to fractional powers;
(ii) moving x's onto the numerators;
(iii) expanding brackets where necessary.

a) $x^{\frac{1}{2}}(x^4+1)$ **(b)** $x^{-\frac{1}{2}}(x^{\frac{3}{2}}-x^2)$ **(c)** $\frac{1}{x^2}(x^{\frac{1}{2}}+x)$ **(d)** $\frac{2}{x^{-3}}(x^2+\frac{1}{x})$

e) $\frac{1}{\sqrt{x}}(x^2-\sqrt{x})$ **(f)** $\left(x^2+\frac{1}{x}\right)^2$ **(g)** $\frac{1}{x}(\sqrt{x}+x)$ **(h)** $\left(x+\frac{1}{\sqrt{x}}\right)^2$

i) $x^{-2}\left(\frac{1}{x}-\sqrt[3]{x}\right)$ **(j)** $\frac{x^2+3}{x}$ **(k)** $\frac{\sqrt{x}-x}{x^2}$ **(l)** $\frac{(2x+1)^2}{x^{\frac{3}{2}}}$

Mixed Exercise

1. **a)** Simplify $\dfrac{7a^3b^2}{a\sqrt{b}}$

b) If $a = -1$ and $b = 4$, find the value of the expression in part (a).

2. Given that $y = 2x^{-2/3}$, find y when $x = 8$.

3. Simplify $x^{\frac{2}{3}}(x^{\frac{2}{3}} + x^{-\frac{2}{3}})$

4. **a)** Simplify $\dfrac{m^5}{m^{-3}}$

b) Evaluate $125^{-\frac{2}{3}}$

5. Express $\dfrac{p^5 \times 8p}{2p^{-3}}$ in its simplest form.

6. Simplify, writing your answer with a positive index: $3a^4 \times a^{-6}$

7. Simplify the fraction, giving your answer in positive index form: $\dfrac{x^3 \times x^4}{x^9}$

8. Simplify $\dfrac{a^2 \times a^5}{a^{-3}}$.

9. **a)** Remove the brackets and simplify: $p^{\frac{1}{2}}(p^{\frac{5}{2}} - 2)$.

b) Hence, or otherwise, find the value of $p^{\frac{1}{2}}(p^{\frac{5}{2}} - 2)$ when $p = 4$.

Answers

Exercise 1

1. **a)** 3^6 **(b)** 2^4 **(c)** 10^7 **(d)** 8^8 **(e)** 7^7 **(f)** 5^8

g) 9^8 **(h)** 6^{13} **(i)** x^8 **(j)** c^{11} **(k)** a^{14} **(l)** y^{10}

m) b^{40} **(n)** p^{10} **(o)** d^6 **(p)** q^{20} **(q)** t^{10} **(r)** f^7

s) k^{13} **(t)** z^{100} **(u)** x^{80} **(v)** y^{20} **(w)** a^{90} **(x)** b^1

2. **a)** 2^5 **(b)** 5^2 **(c)** 12^3 **(d)** 7^7 **(e)** 20^4 **(f)** 8^4

g) 3^{15} **(h)** 4^2 **(i)** x^5 **(j)** a^4 **(k)** y^{10} **(l)** b^3

m) p **(n)** 1 **(o)** q^6 **(p)** d^3 **(q)** x^6 **(r)** a^6

s) m^{13} **(t)** 1 **(u)** d^8 **(v)** y^{90} **(w)** t^{99} **(x)** w^{10}

3. **a)** 3^8 **(b)** 8^4 **(c)** 10^6 **(d)** 2^{10} **(e)** 4^{15} **(f)** 1

g) 12^9 **(h)** 5^{25} **(i)** x^8 **(j)** y^{40} **(k)** a^{21} **(l)** m^{16}

m) b^{18} **(n)** p^{15} **(o)** k^{100} **(p)** 1

4. **a)** $4b^2$ **(b)** $343a^3$ **(c)** $81x^4$ **(d)** $32y^5$ **(e)** a^4b^4 **(f)** x^7y^7

g) w^5z^5 **(h)** s^3t^3 **(i)** p^3q^6 **(j)** x^8y^2 **(k)** $a^{10}b^{15}$ **(l)** $36a^{10}$

m) $1000x^6$ **(n)** $32c^{20}$ **(o)** $27a^3b^6$ **(p)** $16m^4k^2$

5. **a)** $10a^8$ **(b)** $63x^9$ **(c)** $3p^3$ **(d)** $5b^6$ **(e)** $24y^7$

f) $80q^{10}$ **(g)** $8c^7$ **(h)** $8z^4$ **(i)** $k^5 + k^7$ **(j)** $m^7 - m^8$

k) $2x^7 + 6x^6$ **(l)** $10a^7 - 15a^8$ **(m)** x^3 **(n)** m^{14} **(o)** $10c^4$

p) $6q^3$ **(q)** $3xy^{14}$ **(r)** $4a^{10}b^{28}$ **(s)** $4p^3$ **(t)** $\frac{8}{3}a^2b^{12}$

6. **a)** 1 **(b)** 1 **(c)** 1 **(d)** 1 **(e)** 1 **(f)** 1

g) 1 **(h)** 1 **(i)** 1 **(j)** 1 **(k)** 1 **(l)** 1

Exercise 2

1. **a)** $\frac{1}{3^2}$ **(b)** $\frac{1}{5^4}$ **(c)** $\frac{1}{2^6}$ **(d)** $\frac{1}{10^3}$ **(e)** $\frac{1}{4^5}$ **(f)** $\frac{1}{200^7}$

g) $\frac{1}{a^5}$ **(h)** $\frac{1}{x^2}$ **(i)** $\frac{1}{p^7}$ **(j)** $\frac{1}{y^{10}}$ **(k)** $\frac{2}{b^3}$ **(l)** $\frac{10}{q^x}$

m) x^3 **(n)** w^5 **(o)** $3a^2$ **(p)** $10c^8$ **(q)** $\frac{2}{3}t$ **(r)** $\frac{5}{4}y^3$

2. **a)** 3^{-2} **(b)** 6^{-9} **(c)** 5^{-4} **(d)** 2^{-7} **(e)** 10^{-3} **(f)** 4^{-4}

g) x^{-3} **(h)** a^{-5} **(i)** p^{-4} **(j)** y^{-10} **(k)** q^{-6} **(l)** c^{-8}

3. **a)** m^{-2} **(b)** x^5 **(c)** p^{-3} **(d)** a^{-8} **(e)** y^{-12}

f) c^{-15} **(g)** q^{-15} **(h)** w^8 **(i)** $20b$ **(j)** 27

k) $2k^5$ **(l)** $1{\cdot}5d^{-3}$ **(m)** $x^5 + x$ **(n)** $p - p^{-11}$ **(o)** $6a^6 + 9a^3$

p) $2m^{-5} - 5m^4$ **(q)** v^{10} **(r)** $6h^{-1}$ **(s)** $6c^5$ **(t)** 10

4. **a)** 2 **(b)** 2 **(c)** 6 **(d)** 9 **(e)** 4 **(f)** 10

g) 5 **(h)** 27 **(i)** 25 **(j)** 8 **(k)** 6 **(l)** $\frac{1}{2}$

m) $\frac{1}{2}$ **(n)** $\frac{1}{4}$ **(o)** $\frac{1}{3}$ **(p)** $\frac{1}{9}$ **(q)** $\frac{1}{64}$ **(r)** $\frac{1}{100}$

s) $\frac{1}{64}$ **(t)** $\frac{1}{16}$ **(u)** 16 **(v)** -2 **(w)** 16 **(x)** $\frac{1}{1000}$

y) 2 **(z)** $\frac{1}{16}$

5. **a)** x^3 **(b)** p^2 **(c)** a^6 **(d)** $\frac{1}{y^6}$ **(e)** $\frac{1}{q^2}$ **(f)** $\frac{1}{k^{\frac{2}{5}}}$

g) g^2 **(h)** $\frac{1}{m^8}$ **(i)** c^6 **(j)** $\frac{1}{h^{\frac{5}{2}}}$ **(k)** $\frac{1}{z^3}$ **(l)** $\frac{1}{b^{12}}$

m) 1 **(n)** y **(o)** d^2 **(p)** s^3 **(q)** $12x$ **(r)** 12

s) $10x$ **(t)** $6x^{\frac{1}{3}}$ **(u)** 1 **(v)** $2x$ **(w)** $4x^{\frac{1}{3}}$ **(x)** $\frac{3}{2x^{\frac{1}{3}}}$

6. **a)** $\sqrt{x}$ **(b)** $\sqrt[3]{x}$ **(c)** $\sqrt[4]{a}$ **(d)** $\sqrt[3]{y^2}$ **(e)** $\sqrt[4]{b^3}$ **(f)** $\sqrt[3]{x^5}$

g) $\sqrt[5]{c^3}$ **(h)** $\sqrt[5]{a^4}$ **(i)** $\frac{1}{\sqrt[3]{c}}$ **(j)** $\frac{1}{\sqrt{z}}$ **(k)** $\frac{1}{\sqrt[3]{m^2}}$ **(l)** $\frac{1}{\sqrt[5]{k^3}}$

m) $\frac{1}{\sqrt[3]{p^4}}$ **(n)** $\frac{1}{\sqrt[3]{x^5}}$ **(o)** $\frac{1}{\sqrt[5]{w^4}}$ **(p)** $\frac{1}{\sqrt[7]{d^2}}$

7. **a)** $x^{\frac{1}{2}}$ **(b)** $a^{\frac{1}{3}}$ **(c)** $y^{\frac{3}{2}}$ **(d)** $z^{\frac{2}{3}}$ **(e)** $c^{\frac{2}{3}}$ **(f)** $x^{\frac{3}{4}}$

g) $p^{\frac{5}{3}}$ **(h)** $m^{\frac{2}{5}}$ **(i)** $a^{-\frac{1}{2}}$ **(j)** $z^{-\frac{1}{3}}$ **(k)** $x^{-\frac{4}{3}}$ **(l)** $a^{-\frac{1}{5}}$

m) $b^{-\frac{2}{3}}$ **(n)** $m^{-\frac{3}{5}}$ **(o)** $y^{-\frac{1}{4}}$ **(p)** $c^{-\frac{5}{3}}$

8. **a)** $x^{\frac{9}{2}}+x^{\frac{1}{2}}$ **(b)** $x-x^{\frac{3}{2}}$ **(c)** $x^{-\frac{3}{2}}+x^{-1}$ **(d)** $2x^5+2x^2$

e) $x^{\frac{3}{2}}-1$ **(f)** $x^4+2x+\frac{1}{x^2}$ **(g)** $x^{-\frac{1}{2}}+1$ **(h)** $x^2+2x^{\frac{1}{2}}+x^{-1}$

(i) $x^{-3}-x^{-\frac{5}{3}}$ **(j)** $x+3x^{-1}$ **(k)** $x^{-\frac{3}{2}}-x^{-1}$ **(l)** $4x^{\frac{1}{2}}+4x^{-\frac{1}{2}}+x^{-\frac{3}{2}}$

Mixed Exercise

1. **a)** $7a^2b^{\frac{3}{2}}$ **(b)** 56 **2.** $\frac{1}{2}$ **3.** $x^{\frac{4}{3}}+1$

4. **a)** m^8 **(b)** $\frac{1}{25}$ **5.** $4p^9$ **6.** $\frac{3}{a^2}$

7. $\frac{1}{x^2}$ **8.** a^{10} **9.** **a)** $p^3-2p^{\frac{1}{2}}$ **(b)** 60