Fractions.   idea. $\dfrac{1}{3} + \dfrac{1}{5} = \dfrac{8}{15}$ ①
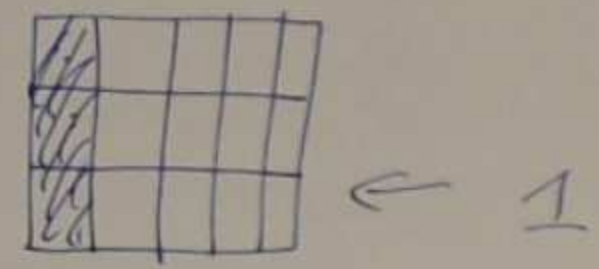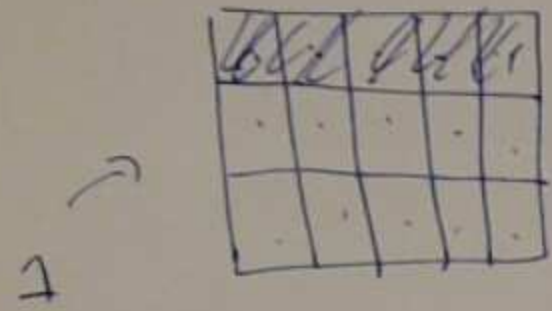

$\dfrac{1}{3} = \dfrac{5}{15}$ $\dfrac{1}{5} = \dfrac{3}{15}$

$\dfrac{1\times5}{3\times5} + \dfrac{1\times3}{5\times3}$ $\dfrac{5}{15} + \dfrac{3}{15}$

$= \dfrac{8}{15}$

complications.   ⊛ negative numbers.
              ⊕ whole numbers.
              ⊗ multiplication and division.
              ⊛ letters.

$$\frac{1}{-2} + \frac{1}{3}. \leftrightarrow \frac{1}{3} - \frac{1}{2}$$

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

$$\frac{-1 \times 3}{2 \times 3} + \frac{1 \times 2}{3 \times 2} = \frac{-3}{6} + \frac{2}{6} =$$

$$\frac{-3 + 2}{6} = \frac{-1}{6}.$$

whole numbers.

$$7 = \frac{7}{1}$$

$$\frac{2}{3} - 1 = \frac{2}{3} - \frac{1 \times 3}{1 \times 3}$$

letter $\boxed{x \quad \times}$

letters aim.   multiplication $\frac{2}{3} - \frac{3}{3} = \frac{2-3}{3}$

$$\frac{1}{x} + \frac{1}{y}$$ common

$$= \frac{-1}{3}$$

denominator

xy

$$\frac{1 \times y}{x \times y} + \frac{1 \times x}{y \times x} = \frac{y}{xy} + \frac{x}{xy} = \frac{y+x}{xy}$$

multiplication

$$\frac{4}{5} \times \frac{11}{2} = \frac{44}{10} \quad 5 \quad \text{common factor.}$$

$$\frac{44/2}{10/2} = \frac{22}{5}$$

⑤ can simplify.

division $\quad \frac{4}{5} \div \frac{11}{2} \qquad \frac{4}{5} \Big/ \frac{11}{2} \qquad \frac{4/5}{11/2}$

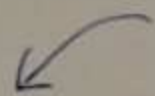to divide, multiply by 1/fraction.

$$\frac{4}{5} \div \frac{11}{2} = \frac{4}{5} \times \frac{2}{11} = \frac{8}{55}$$

Quiz.   Q2

$$\frac{5}{3/4} + 2$$

$$\frac{5}{1} \times \frac{4}{3} + 2$$

$$\frac{20}{3} + 2 = \frac{20}{3} + \frac{2 \times 3}{1 \times 3}$$

$$= \frac{20}{3} + \frac{6}{3} = \frac{26}{3}$$

$$\frac{2/3}{3} \qquad\qquad 3 = \frac{3}{1}$$

$$\frac{2/3}{3/1} = \frac{2}{3} \times \frac{1}{3} = \frac{2}{9}$$

$$\frac{5}{3} \diagdown \frac{1}{2}$$

$$\frac{5 \times 7}{3 \times 7} + \frac{1 \times 3}{7 \times 3} = \frac{35}{21} + \frac{3}{21} = \frac{38}{21}$$

$$\left(\frac{x^9 y^{-3}}{8 y^{3/2}} \right)^{-1/3} \quad \text{④}$$

$$\left(\frac{36 \, s^4 t^4}{s^3 t^{9/2}} \right)^{-\frac{1}{2}}$$

recall powers

① $x^2 \cdot x^3 = x$

$\underbrace{x \cdot x}_{2} \cdot \underbrace{x \cdot x \cdot x}_{3} = x^{5}$

② $(x^2)^3 = x^6$

$(x x)(x x)(x \cdot x) = x^6 \quad \text{④}$

③ $x^{-1} = \frac{1}{x}$

$x^3 \cdot x^{-1} = x^2$

$x x x \frac{1}{x} = x \cdot x$

$$\left(\frac{x^9 y^{-3}}{8y^{3/2}}\right)^{-1/3} \cdot$$

$$\left(\left(\frac{x^9 y^{-3}}{8 y^{3/2}}\right)^{-1}\right)^{1/3} \cdot$$

cube
root

$z^{-1} = \frac{1}{z}$

$\left(\frac{z}{w}\right)^{-1} = \frac{1}{z/w} = $

$\frac{1}{1} \times \frac{w}{z} = \frac{w}{z}$

rule

$\boxed{x^1 = x}$

rule

$(x^9)^b = x^{ab}$

$$\left(\frac{8y^{3/2}}{x^9 y^{-3}}\right)^{1/3}$$

$$= \frac{(2^3)^{1/3} (y^{3/2})^{1/3}}{(x^9)^{1/3}(y^{-3})^{1/3}} = \frac{2\, y^{1/2}}{x^3 y^{-1}}$$

$x^{1/3} = \sqrt[3]{x}$

rule

$(xy)^a$
$= x^a y^a$

$$\frac{2y^{1/2}}{x\,y^{-1}}$$

$$y^{-1} = \frac{1}{y}$$

$$\frac{2y^{1/2} \times y}{x \cdot \frac{1}{y} \times y} = \frac{2y^{1/2}\,y^{1}}{x} = \frac{2y^{3/2}}{x}$$

$$\frac{1}{2} + 1 = \frac{1}{2} + \frac{2}{2}$$
$$= \frac{3}{2}$$

$$\left(\frac{36 \, s^4 t^4}{s^3 t^{9/2}}\right)^{-\frac{1}{2}} \qquad \text{rule} \qquad \boxed{z^{-1} = \frac{1}{z}}$$

$$\left(\frac{s^3 \, t^{9/2}}{36 \, s^4 t^4}\right)^{1/2} \qquad\qquad t^{9/2} \cdot t^{-4}$$

$$\frac{t^{9/2}}{t^4} = \frac{1}{t^4 \cdot t^{-9/2}} = \frac{4^{\times 2}}{1 \times 2} \frac{9}{2}$$

$$\frac{s^3}{s^4}$$

$$s^3 \cdot s^{-4} = s^{-1} = \frac{1}{s} \qquad\qquad \frac{8}{2} - \frac{9}{2} = \frac{-1}{2}$$

$$\frac{1}{t^{-1/2}} \overset{=}{=} t^{1/2}$$

$$\left(\frac{t^{1/2}}{36 \, s}\right)^{1/2} \qquad (1/t)^{1/2} = 1/1/t^{1/2} = t^{1/2}$$

$$\left(\frac{t^{1/2}}{36s}\right)^{1/2} = \frac{\left(t^{1/2}\right)^{1/2}}{(36)^{1/2} \; s^{1/2}}$$

$$\sqrt{36} = 6.$$

$$= \frac{t^{1/4}}{6 \; s^{1/2}}.$$

$$(ab)^{P} = a^{P} b^{P}$$

$$\left(\frac{a}{b}\right)^{P} = \frac{a^{P}}{b^{P}}.$$

$$\left(\frac{x \, y^{-4} \, z^{-2}}{x^4 \, y^5 \, z^{-3}} \right)^{-3}$$

$$\frac{x^{-3} \left(y^{-4}\right)^{-3} \left(z^{-2}\right)^{-3}}{\left(x^4\right)^{-3} \left(y^5\right)^{-3} \left(z^{-3}\right)^{-3}}$$

$$\frac{x^{-3} \, y^{12} \, z^{6}}{x^{-12} \, y^{-15} \, z^{9}} = x^{-3} \cdot x^{12} \cdot y^{12} \cdot y^{+15} \, z^{6} \cdot z^{-9}$$

$$= x^{9} \, y^{27} \, z^{-3} = \frac{x^{9} y^{27}}{z^{3}}$$

rule

$$(xy)^{a} = x^{a} y^{a}$$

$$\left(\frac{x}{y}\right)^{a} = \frac{x^{a}}{y^{a}}$$

rule

$$\left(x^{a}\right)^{b} = x^{ab}$$

rule

$$x^{a} x^{b} = x^{a+b}$$

$$\left(\frac{x \, y^{-4} \, z^{-2}}{x^4 \, y^5 \, z^{-3}} \right)^{-3}$$

$$\frac{1}{z^9 \, z^{-6}} = \frac{1}{z^3}$$

rule

$$(xy)^a = x^a \, y^a$$

$$\left(\frac{x}{y} \right)^a = \frac{x^a}{y^a}$$

$$\frac{x^{-3} \, (y^{-4})^{-3} \, (z^{-2})^{-3}}{(x^4)^{-3} \, (y^5)^{-3} \, (z^{-3})^{-3}}$$

rule

$$(x^a)^b = x^{ab}$$

rule

$$x^a x^b = x^{a+b}$$

$$\frac{x^{-3} \; y^{12} \; z^6}{x^{-12} \; y^{-15} \; z^9} = \frac{x^{-3} \cdot x^{12} \cdot y^{12} \cdot y^{+15} \; z^6 \cdot z^{-9}}{}$$

$$= x^9 \, y^{27} \, z^{-3} = \boxed{\frac{x^9 y^{27}}{z^3}}$$

$$\left(8w^2z^{-2}\right)^2 z^3.$$

$$8^2\left(w^2\right)^2\left(z^{-2}\right)^2 z^3.$$

$$64\, w^4\, z^{-4}\, z^3.$$

$$64\, w^4\, z^{-1}$$

$$\frac{64\, w^4}{z}$$

① $(xy)^a$
$= x^a y^a.$

② $(x^a)^b = x^{ab}.$

③ $x^a x^b = x^{a+b}.$

Classwork

$$\frac{1\times5}{3\times5} + \frac{1\times3}{5\times3} = \frac{5}{15} + \frac{3}{15} = \frac{8}{15}.$$

$$\frac{2/3}{5/1} = \frac{2}{3} \times \frac{1}{5} = \frac{2}{15}.$$

$$\frac{5\times7}{3\times\frac{9}{7}} + \frac{1\times3}{7\times3} = \frac{19}{6} + \frac{3}{6} = \frac{7}{6} \quad 38$$

$$\frac{7}{3/4} = \frac{7}{1} \times \frac{4}{3} = \frac{28}{3}.$$

$$\frac{35}{21} + \frac{3\frac{14}{4}}{21} = \frac{114}{21}$$

$$\frac{1}{3} - \frac{7\times3}{1\times3} = \frac{1}{3} - \frac{21}{3} = \frac{-20}{3}$$

$$\frac{4/5}{6/7} = \frac{4}{5} \times \frac{7}{6} = \frac{28}{30}.$$

$$= \frac{14}{15}.$$

$$\frac{2\times7}{3\times7} - \frac{4\times3}{7\times3} = \frac{14}{21} - \frac{12}{21}$$

$$= \frac{2}{21}.$$

$$\frac{8/9}{-10/11} = \frac{8}{9} \times \frac{11}{10} = \frac{88}{90}$$

$$\frac{44}{45}.$$

Q8

$$\frac{\dfrac{6\times2}{11\times2}+\dfrac{1\times11}{2\times11}}{\dfrac{4\times2}{7\times2}-\dfrac{3\times7}{2\times7}} = \left(\frac{6}{11}+\frac{1}{2}\right)\times\frac{1}{\left(\dfrac{4}{7}-\dfrac{3}{2}\right)}$$

$$\frac{\dfrac{12}{22}+\dfrac{11}{22}}{\dfrac{8}{14}-\dfrac{21}{14}} = \frac{\dfrac{23}{22}}{\dfrac{-13}{14}} = \frac{23}{22}\times\frac{-14}{13}$$

$$= \frac{-23\times14}{22\times13}$$

Q8

$$\frac{\dfrac{6\times2}{11\times2}+\dfrac{1\times11}{2\times11}}{\dfrac{4\times2}{7\times2}-\dfrac{3\times7}{2\times7}} = \left(\frac{6}{11}+\frac{1}{2}\right)\times\frac{1}{\left(\dfrac{4}{7}-\dfrac{3}{2}\right)}$$

$$\frac{\dfrac{12}{22}+\dfrac{11}{22}}{\dfrac{8}{14}-\dfrac{21}{14}} = \frac{\dfrac{23}{22}}{\dfrac{-13}{14}} = \frac{23}{22}\times\frac{-14}{13}$$

$$= \frac{-23\times14}{22\times13}$$

$$= \frac{-322}{286} = \frac{161}{143}$$