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S. A. Walling , J. C. Hill
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PART ONE

ELEMENTARY ARITHMETIC

FACTORS AND LEAST COMMON MULTIPLE

Factors.

When a number divides exactly into another number, the first is said to be a *factor* of the second.

EXAMPLE. 3 is a factor of 15. So is 5 a factor of 15. Therefore the factors of 15 are 3 and 5.

Many numbers have more than two factors, such as

$$24 = 2 \times 12 = 2 \times 2 \times 6 = 2 \times 2 \times 2 \times 3.$$

Some numbers have no factors, other than the number itself and 1.

Thus the only factors of 7 are 7 and 1. Such numbers are called *prime numbers*.

So that it follows that any number expressed in factors can be expressed in prime numbers.

EXAMPLE. $182 = 2 \times 91 = 2 \times 7 \times 13$, each of the final factors being a prime number.

These factors are called *prime factors*.

EXERCISE I.

1. Which of the following are prime numbers: 1, 3, 7, 9, 11, 15, 17, 51, 53, 71, 73?

2. Find the prime factors of:

(*a*) 16.	(*b*) 32.	(*c*) 71.	(*d*) 85.
(*e*) 168.	(*f*) 211.	(*g*) 251.	(*h*) 484.
(*i*) 571.	(*j*) 9261.	(*k*) 11025.	(*l*) 1111.

Least Common Multiple (L.C.M.).

A number is said to be a *multiple* of each of its factors.

Thus 180, 120 and 60 are each multiples of 20. They are also multiples of 12 and are consequently *common multiples* of 20 and 12.

The *smallest* number which is a common multiple of any factors is called the *least common multiple* (L.C.M.).

EXERCISE II.

1. Find the L.C.M. of:

(*a*) 4 and 6.	(*b*) 9 and 18.	(*c*) 18 and 27.
(*d*) 7 and 21.	(*e*) 24 and 36.	(*f*) 3, 4 and 5.
(*g*) 6, 8 and 12.	(*h*) 2, 12, 6 and 18.	(*i*) 3, 6, 15 and 20.
(*j*) 3, 4, 12 and 18.	(*k*) 5, 10, 15 and 20.	(*l*) 1, 2, 3, 4 and 5.

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FRACTIONS

A fraction is always a part of something. For example: three farthings are written as $\frac{3}{4}d.$ to denote that they are three quarters of a penny.

In all fractions the number above the line is called the *numerator*, and that below the line is called the *denominator*.

All fractions should be expressed in their *lowest terms*. This can be done by dividing the numerator and denominator by any common factors:

$$\frac{\overset{3}{\cancel{9}}}{\underset{4}{\cancel{12}}}=\frac{3}{4}.$$

All fractions that have the numerator smaller than the denominator are termed *proper fractions*.

Occasionally you will meet with fractions having the numerator larger than the denominator, e.g. $\frac{21}{9}$.

Such fractions are called *improper fractions* and should never be left as such in your answer. They should be changed to a *mixed number* and reduced to their lowest terms. Thus

$$\frac{21}{9}=2\frac{3}{9}=2\frac{1}{3}.$$

It is often necessary when working with fractions to change mixed numbers into improper fractions, but the change back must be made in the final answer.

Exercise III.

1. Reduce the following fractions to their lowest terms:

(*a*) $\frac{2}{6}$. (*b*) $\frac{3}{6}$. (*c*) $\frac{6}{8}$. (*d*) $\frac{12}{16}$. (*e*) $\frac{10}{15}$. (*f*) $\frac{10}{25}$.
(*g*) $\frac{18}{30}$. (*h*) $\frac{25}{28}$. (*i*) $\frac{27}{81}$. (*j*) $\frac{64}{84}$. (*k*) $\frac{28}{49}$. (*l*) $\frac{45}{100}$.
(*m*) $\frac{242}{1111}$. (*n*) $\frac{370}{555}$. (*o*) $\frac{216}{243}$. (*p*) $\frac{220}{924}$. (*q*) $\frac{572}{1012}$. (*r*) $\frac{1617}{1815}$.
(*s*) $\frac{1008}{1728}$. (*t*) $\frac{2940}{4620}$. (*u*) $\frac{264}{1760}$. (*v*) $\frac{39}{169}$. (*w*) $\frac{465}{705}$. (*x*) $\frac{729}{945}$.

2. Express the following mixed numbers as improper fractions:

(*a*) $1\frac{3}{4}$. (*b*) $3\frac{1}{2}$. (*c*) $4\frac{3}{4}$. (*d*) $8\frac{1}{7}$. (*e*) $6\frac{4}{5}$. (*f*) $4\frac{3}{100}$.
(*g*) $4\frac{57}{100}$. (*h*) $5\frac{7}{22}$. (*i*) $20\frac{6}{13}$. (*j*) $41\frac{3}{11}$. (*k*) $13\frac{2}{15}$. (*l*) $17\frac{7}{31}$.
(*m*) $41\frac{11}{32}$. (*n*) $25\frac{2}{25}$. (*o*) $10\frac{17}{18}$. (*p*) 15.

3. Change these improper fractions into mixed numbers:

(*a*) $\frac{7}{4}$. (*b*) $\frac{8}{3}$. (*c*) $\frac{18}{5}$. (*d*) $\frac{31}{2}$. (*e*) $\frac{17}{12}$. (*f*) $\frac{22}{7}$.
(*g*) $\frac{507}{100}$. (*h*) $\frac{181}{17}$. (*i*) $\frac{630}{23}$. (*j*) $\frac{1143}{112}$. (*k*) $\frac{3764}{97}$. (*l*) $\frac{1141}{29}$.
(*m*) $\frac{9250}{157}$. (*n*) $\frac{4439}{47}$. (*o*) $\frac{1790}{101}$. (*p*) $\frac{7441}{89}$.

4. Fill in the gaps:

(*a*) $\frac{5}{6}=\frac{\ }{24}$. (*b*) $\frac{2}{3}=\frac{\ }{36}$. (*c*) $\frac{5}{9}=\frac{55}{\ }$.
(*d*) $\frac{6}{17}=\frac{18}{\ }$. (*e*) $\frac{3}{7}=\frac{\ }{21}=\frac{\ }{49}$. (*f*) $\frac{9}{10}=\frac{\ }{20}=\frac{\ }{100}$.
(*g*) $7=\frac{\ }{3}=\frac{63}{\ }$. (*h*) $13=\frac{\ }{2}=\frac{\ }{7}=\frac{117}{\ }$.

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Addition and Subtraction of Fractions.

When adding or subtracting fractions, first bring all fractions to a common denominator (L.C.M.), find the sum and/or difference of the numerators and reduce the answer, if necessary, to its lowest terms.

EXAMPLE. $\frac{1}{8}+\frac{1}{4}-\frac{1}{6}=\frac{3+6-4}{24}=\frac{5}{24}$.

When adding or subtracting mixed numbers *do not make improper fractions.* Merely find the total of the whole numbers and add this to the fractional answer, reduced to lowest terms.

EXAMPLE.

$$\begin{aligned} &3\tfrac{1}{4}+3\tfrac{5}{6}-1\tfrac{3}{8}\\ &=5+\tfrac{1}{4}+\tfrac{5}{6}-\tfrac{3}{8}\\ &=5+\frac{6+20-9}{24}\\ &=5+\tfrac{17}{24}=5\tfrac{17}{24}. \end{aligned}$$

EXERCISE IV.

1. Find the value of:

(*a*) $\frac{1}{2}+\frac{1}{4}$. (*b*) $\frac{2}{5}+\frac{3}{10}$. (*c*) $\frac{3}{14}+\frac{5}{21}$. (*d*) $\frac{4}{15}+\frac{3}{10}$.
(*e*) $\frac{5}{12}+\frac{7}{15}$. (*f*) $\frac{4}{11}+\frac{2}{33}+\frac{5}{22}$. (*g*) $2\frac{1}{2}+3\frac{1}{3}$. (*h*) $\frac{5}{6}+1\frac{5}{12}$.
(*i*) $4\frac{3}{8}+3\frac{5}{12}$. (*j*) $1\frac{2}{5}+1\frac{1}{4}+\frac{7}{10}$.
(*k*) $\frac{8}{9}+3\frac{5}{6}+1\frac{11}{12}$. (*l*) $2\frac{3}{10}+1\frac{61}{100}+3\frac{7}{1000}$.

2. Find the value of:

(*a*) $\frac{3}{4}-\frac{1}{4}$. (*b*) $\frac{1}{3}-\frac{1}{7}$. (*c*) $\frac{3}{4}-\frac{1}{6}$. (*d*) $\frac{7}{15}-\frac{3}{10}$.
(*e*) $\frac{7}{12}-\frac{7}{18}$. (*f*) $3\frac{5}{6}-2\frac{1}{3}$. (*g*) $3\frac{7}{8}-1\frac{3}{4}$. (*h*) $3\frac{5}{8}-1\frac{3}{4}$.
(*i*) $4\frac{3}{8}-2\frac{7}{12}$. (*j*) $7\frac{1}{2}-3\frac{3}{5}$. (*k*) $6\frac{4}{7}-5\frac{3}{5}$. (*l*) $5\frac{3}{7}-4\frac{1}{2}$.

3. Simplify:

(*a*) $\frac{1}{4}+\frac{1}{2}-\frac{2}{5}$. (*b*) $1\frac{1}{10}-1\frac{1}{100}+1\frac{1}{1000}$. (*c*) $4\frac{1}{2}+2\frac{1}{6}-2\frac{1}{3}$.
(*d*) $4\frac{1}{8}-2\frac{1}{4}+4\frac{3}{4}$. (*e*) $2\frac{1}{6}-1\frac{5}{6}+3\frac{1}{3}$. (*f*) $8\frac{7}{12}-2\frac{17}{18}+3\frac{1}{6}$.
(*g*) $3\frac{7}{15}-1\frac{13}{20}+\frac{17}{25}$. (*h*) $4\frac{3}{8}-4\frac{1}{2}-\frac{5}{8}+10$. (*i*) $6\frac{1}{2}-4\frac{1}{6}+3\frac{1}{12}-3\frac{3}{4}$.
(*j*) $11\frac{11}{21}+\frac{1}{14}-2\frac{12}{49}-2\frac{1}{7}$. (*k*) $6\frac{3}{22}-2\frac{17}{33}-1\frac{1}{2}$.
(*l*) $3\frac{5}{9}-2\frac{1}{3}+1\frac{5}{12}+1\frac{5}{6}$.

4. Take the smaller from the greater of:

(*a*) $\frac{5}{6}$ and $\frac{4}{7}$. (*b*) $\frac{77}{1000}$ and $\frac{8}{100}$. (*c*) $\frac{7}{8}$ and $\frac{7}{9}$.
(*d*) $7\frac{5}{6}$ and $7\frac{7}{8}$. (*e*) $\frac{8}{21}$ and $\frac{11}{28}$. (*f*) $\frac{15}{26}$ and $\frac{29}{39}$.

5. Arrange in order of magnitude, placing greatest first:

$$\tfrac{2}{3};\ \tfrac{5}{6};\ \tfrac{3}{4};\ \tfrac{4}{5};\ \tfrac{7}{10}.$$

6. What would bolts of the following diameters measure if tested with a vernier micrometer reading $\frac{1}{1000}$ths of an in.?

(*a*) $\frac{3}{8}$ in. (*b*) $\frac{1}{4}$ in. (*c*) $\frac{7}{8}$ in. (*d*) $\frac{9}{16}$ in.

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EXERCISE V.

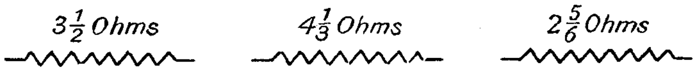
1. I fly $\frac{7}{8}$ of my journey and motor the remaining 25 miles. What is the total length of my journey?

2. A plane has to fly 630 miles from an aerodrome to Berlin. How much farther has it to go after reaching the Dutch coast, $\frac{2}{7}$ of its total journey?

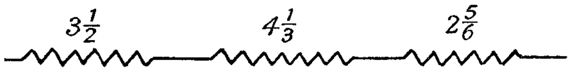
3. The resistance R which a conductor offers to the passage of electric current is measured in *ohms*.

If several wires are joined together in series—that is, end to end so as to form one long wire—the total resistance of such a wire is the sum of the separate resistances.

EXAMPLE. What would be the total resistance of the following three wires in series?



When in series we have:



$$\begin{aligned}\text{The total resistance } R &= 3\tfrac{1}{2}+4\tfrac{1}{3}+2\tfrac{5}{6}\\ &= 9\,\frac{3+2+5}{6}\\ &= 9\tfrac{10}{6}\\ &= 10\tfrac{2}{3}\text{ ohms.}\end{aligned}$$

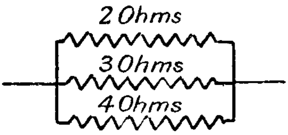
Find the total resistances of the following wires when joined in series:

(*a*) $2\frac{2}{3}$ ohms and $5\frac{3}{4}$ ohms.

(*b*) $1\frac{3}{5}$ ohms, $3\frac{1}{3}$ ohms and $20\frac{5}{6}$ ohms.

(*c*) $4\frac{1}{2}$ ohms, $3\frac{1}{7}$ ohms and $5\frac{5}{9}$ ohms.

4. When two or more wires are joined in parallel—or side by side—they afford alternative paths for the current. Thus



The total resistance is less than that of the smallest branch.
It is found in this way. The wire of resistance 2 ohms is said to have

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a conductance of $\frac{1}{2}$, i.e. the conductance is obtained by inverting the resistance.

Thus a resistance r has a conductance of $\frac{1}{r}$, where r may be any value.

To find the total resistance of a circuit in parallel, find the total of the separate conductances and invert this to find the total resistance.

In the above example, if R is the total resistance, then

$$\frac{1}{R}=\frac{1}{2}+\frac{1}{3}+\frac{1}{4}=\frac{6+4+3}{12}=\frac{13}{12}.$$

$$\therefore\ R=\tfrac{12}{13}\text{ ohms.}$$

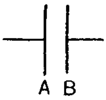
Find the resistances of the following wires in parallel:

(*a*) $1\frac{1}{2}$ ohms and $2\frac{1}{2}$ ohms. (*b*) 2, 4 and 8 ohms.

(*c*) $1\frac{1}{4}$, $2\frac{1}{2}$ and $3\frac{3}{4}$ ohms. (*d*) $1\frac{7}{8}$, 5 and $1\frac{2}{3}$ ohms.

5. A condenser is used in wireless telegraphy to store electrical energy. In its simplest form it consists of two parallel, oblong metal plates separated by a non-conducting substance called a "di-electric". Air, glass, paraffin wax and certain oils are all used as dielectrics.

In drawings of circuits a condenser is shown thus: where A and B are the plates viewed edgewise and the di-electric is in the space between.

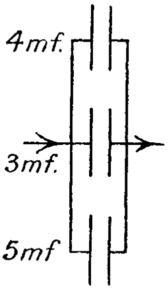


Large condenser capacities are measured in *Farads* and the capacity is a measure of the storing power.

Capacities of small condensers are expressed in microfarads, where

1 Farad $=1{,}000{,}000$ microfarads

or 1 microfarad (mf.) $=\frac{1}{\text{millionth}}$ of a Farad.



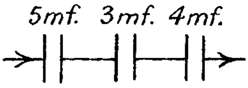
Condensers act oppositely to resistances.

When in *parallel* the total capacity is the sum of the separate capacities.

In the above circuit the total capacity

$=5+3+4=12$ microfarads.

When in *series* they are treated like resistances in parallel and the total capacity is found by adding the reciprocals and inverting.



Thus if S is the total capacity,

$$\frac{1}{S}=\frac{1}{5}+\frac{1}{3}+\frac{1}{4}=\frac{12+20+15}{60}=\frac{47}{60}.$$

$$\therefore\ S=\tfrac{60}{47}=1\tfrac{13}{47}\text{ microfarads.}$$

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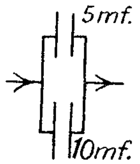
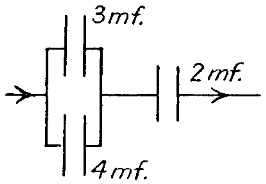
Find the total capacities in microfarads of the following circuits:

(*a*)

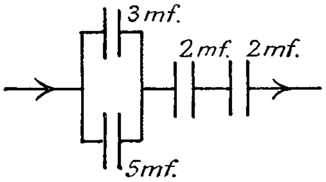


(*b*)

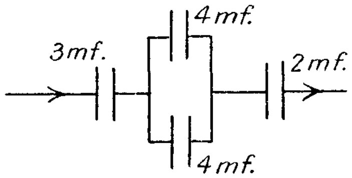


(Note. The 3 mf. and 4 mf. in parallel act as one single condenser of 7 mf. capacity. Thus we have 7 mf. and 2 mf. in series.)

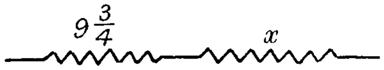
(*c*)



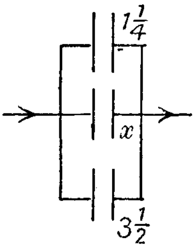
(*d*)



6. (*a*) If the total resistance of these wires is $12\frac{1}{8}$ ohms, what is the resistance of the part x?



(*b*) If the total capacity of these three condensers is $7\frac{1}{12}$ microfarads, what is the capacity of condenser x?



7. A pilot used $\frac{1}{4}$ of his petrol supply flying North. Then $\frac{1}{5}$ of his total supply flying East. What fraction of his tank capacity remained? If he was left with 99 gallons, what was his original supply in gallons?

8. Two petrol tanks are of equal capacity. From the first $\frac{2}{3}$ has been used and from the second $\frac{2}{5}$.

(*a*) How much petrol must be taken from the tank with the larger quantity so that what is left is equal to the lesser?

(*b*) How much petrol must be taken from the larger quantity and transferred to the lesser, to equalise the amounts in each tank?

Answer, in each case, as fraction of whole tank.

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Multiplication of Fractions.

Always change mixed numbers to improper fractions before multiplying. Thus

$$2\frac{2}{3}\times 5\frac{1}{4}=\frac{\overset{2}{\cancel{8}}}{\cancel{3}}\times\frac{\overset{7}{\cancel{21}}}{\cancel{4}}=14.$$

Exercise VI.

1. Find the value of:

(*a*) $\frac{3}{5}\times\frac{4}{7}$. (*b*) $\frac{3}{8}$ of $\frac{3}{5}$. (*c*) $\frac{5}{16}$ of 12. (*d*) $21\times\frac{3}{7}$.
(*e*) $\frac{15}{16}\times\frac{20}{21}$. (*f*) $\frac{33}{40}$ of $\frac{72}{121}$. (*g*) $\frac{63}{77}\times\frac{22}{35}$. (*h*) $\frac{51}{60}$ of $\frac{5}{68}$.

2. Find the value of:

(*a*) $1\frac{1}{4}\times\frac{2}{3}$. (*b*) $\frac{3}{5}$ of $2\frac{1}{2}$. (*c*) $2\frac{1}{4}\times 1\frac{1}{3}$. (*d*) $3\frac{3}{8}$ of $3\frac{1}{3}$.
(*e*) $5\frac{1}{3}\times 1\frac{1}{4}$. (*f*) $11\frac{4}{7}\times 5\frac{4}{9}$. (*g*) $1\frac{11}{25}$ of $1\frac{19}{36}$. (*h*) $2\frac{5}{12}\times 1\frac{7}{29}$.

3. Simplify:

(*a*) $\frac{9}{10}\times\frac{5}{8}\times\frac{4}{9}$. (*b*) $5\frac{1}{4}\times\frac{5}{7}\times 2\frac{2}{5}$. (*c*) $\frac{7}{12}$ of $9\frac{1}{3}\times 3\frac{3}{5}$.
(*d*) $2\frac{13}{16}\times 1\frac{1}{3}\times 1\frac{5}{9}$. (*e*) $2\frac{1}{10}\times\frac{5}{7}$ of 24. (*f*) $3\frac{3}{4}\times 1\frac{7}{8}\times 4\frac{4}{5}$.

4. Find the distances flown in the following cases:

	Speed	Flying hours	Distance (to nearest mile)
(*a*)	110 m.p.h.	$2\frac{1}{2}$	
(*b*)	$96\frac{1}{2}$,,	$1\frac{3}{4}$	
(*c*)	215 ,,	$2\frac{1}{3}$	
(*d*)	$172\frac{1}{2}$,,	$1\frac{3}{8}$	
(*e*)	$223\frac{1}{2}$,,	$1\frac{2}{3}$	

PROBLEMS

Exercise VII.

1. A watch gains $1\frac{2}{5}$ sec. per day. What will it gain in the following times (to nearest $\frac{1}{5}$ sec.)?

(*a*) $3\frac{1}{2}$ days. (*b*) 7 days. (*c*) $2\frac{3}{4}$ days.

2. A plane is climbing steadily at 142 m.p.h. If the plane's altitude changes at $\frac{2}{15}$ of this speed, at how many miles per hour is the altitude changing?

3. If petrol weighs $7\frac{1}{5}$ lb. per gallon and a plane flying at a certain speed uses 30 gal. per hour, by how much is the weight of the plane reduced after $3\frac{1}{4}$ hours flight at this speed?

4. $A=L\times B$.

This is a short way of expressing

$$\text{Area}=\text{Length}\times\text{Breadth}$$

for a rectangular (oblong) plate.

The length and breadth must *both* be in the same units; for example, (*a*) both in feet, or (*b*) both in inches, or (*c*) both in centimetres.

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The area is then expressed in (*a*) *square* feet, (*b*) *square* inches, or (*c*) *square* centimetres.

Find the areas of the following oblong plates and name the units of area in each case:

	L	B	Area
(*a*)	$2\frac{1}{2}$ ft.	$1\frac{3}{4}$ ft.	
(*b*)	$5\frac{2}{3}$ in.	$3\frac{1}{3}$ in.	
(*c*)	$6\frac{1}{4}$ in.	$4\frac{2}{3}$ in.	
(*d*)	$1\frac{1}{4}$ ft.	$2\frac{1}{12}$ ft.	

5. The area of a circle is $\pi \times r \times r$, where π is a fixed number, as nearly as possible $\frac{22}{7}$ when represented as a fraction, and r is the radius of the circle.

It is often more convenient to measure the diameter of a circle or of a wire, or rod, so that the formula becomes

$$\text{Area} = \frac{22}{7} \times \frac{D}{2} \times \frac{D}{2},$$

where D is the diameter, i.e. $\frac{11}{14} \times D \times D$.

Find the cross-sectional area of these circularly sectioned metal struts whose diameters are:

(*a*) $\frac{7}{8}$ in. (*b*) $\frac{7}{16}$ in. (*c*) $\frac{3}{4}$ in. (*d*) $\frac{5}{16}$ in.

6. Find the cross-sectional area of a seven-strand wire rope. Each strand is, in section, a circle of $D = \frac{1}{8}$ in.

7. From these details of a Bristol Beaufort: Wingspan 57 ft. 10 in.; Length 44 ft. 2 in.; Height 14 ft. 3 in., find the wingspan, length and height of a model. Scale: $\frac{1}{4}$ in. = 1 ft.

8. The fuselage of a certain monoplane contains in its construction: 4 longerons each $38\frac{1}{3}$ ft. long, and 14 struts each $7\frac{1}{8}$ ft. long. What total length (in feet) of Balsa wood strip would be needed to make these parts in a model $\frac{3}{32}$ full size?

9. Two of the various kinds of thermometer in use for measuring temperature are the Fahrenheit and the Centigrade thermometers. On the Fahrenheit thermometer the freezing point of water is 32° F. and the boiling point of water 212° F. (a difference of 180° F.). On the Centigrade thermometer the freezing point of water is 0° C. and the boiling point 100° C. (a difference of 100° C.).

To convert from ° C. to ° F. first multiply by $\frac{180}{100}$, i.e. $\frac{9}{5}$, and add 32°.

Example. Change 60° C. to ° F.

$$(60 \times \tfrac{9}{5}) + 32 = 108 + 32 = 140° \text{ F.}$$

To convert a temperature from ° F. to ° C. first subtract 32° and then multiply by $\frac{5}{9}$.

Example. What temperature in ° C. is the same as 104° F.?

$$(104 - 32)\,\tfrac{5}{9} = 72 \times \tfrac{5}{9} = 40° \text{ C.}$$

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Convert these ° F. into ° C.:

(*a*) 158° F. (*b*) 185° F. (*c*) 71° F. (*d*) 14° F.

Convert these ° C. into ° F.:

(*e*) 35° C. (*f*) $62\frac{1}{2}$° C. (*g*) 17° C. (*h*) −25° C.

10. In an aerial battle $\frac{1}{10}$ of the total attacking force is destroyed in the first encounter and $\frac{1}{9}$ of the remainder in a second engagement. If 16 machines return, how many started out?

Division of Fractions.

Always change mixed numbers to improper fractions. Then invert the divisor and multiply. Thus:

$$2\tfrac{3}{5} \div \frac{11}{15} = \frac{13}{\cancel{5}} \times \frac{\overset{3}{\cancel{15}}}{11} = \frac{39}{11} = 3\tfrac{6}{11}.$$

Exercise VIII.

1. Find the value of:

(*a*) $\frac{7}{8} \div 5$. (*b*) $\frac{3}{5} \div 4$. (*c*) $8 \div \frac{2}{3}$. (*d*) $25 \div \frac{5}{8}$.
(*e*) $\frac{9}{14} \div \frac{18}{35}$. (*f*) $\frac{3}{7} \div \frac{9}{49}$. (*g*) $\frac{25}{42} \div \frac{35}{36}$. (*h*) $1 \div \frac{17}{25}$.

2. Simplify:

(*a*) $33\frac{1}{3} \div 6\frac{1}{4}$. (*b*) $18\frac{3}{4} \div 3\frac{1}{8}$. (*c*) $23\frac{4}{5} \div 4\frac{1}{4}$.
(*d*) $8\frac{1}{10} \div 4\frac{1}{2}$. (*e*) $2\frac{1}{2} \div \frac{1}{10}$. (*f*) $21\frac{7}{11} \div \frac{17}{132}$.

3. $\text{Speed} = \dfrac{\text{Distance travelled}}{\text{Time taken}}$, i.e. Distance ÷ Time.

If the distance is in miles and the time in hours, the speed is in miles per hour. Solve the following:

	Distance	Time	Speed in m.p.h.
(*a*)	305 miles	$2\frac{1}{2}$ hours	
(*b*)	418 ,,	$2\frac{3}{4}$,,	
(*c*)	220 ,,	$1\frac{1}{5}$,,	
(*d*)	$20\frac{1}{2}$,,	$\frac{1}{12}$ hour	

4. $\text{Time taken} = \dfrac{\text{Distance travelled}}{\text{Speed}}$, i.e. Time taken = Distance ÷ Speed.

Find the flying time in hours (or fractions of an hour) in the following:

(*a*) 210 miles flown at 120 m.p.h.
(*b*) $287\frac{1}{2}$,, ,, 115 ,,
(*c*) 399 ,, ,, 126 ,,
(*d*) 738 ,, ,, 180 ,,

PROBLEMS

Exercise IX.

1. A photographic plate has an area of $13\frac{13}{16}$ sq. in. Its length is $4\frac{1}{4}$ in. Find its breadth.

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2. Sizes of wires for stays are usually expressed in terms of their circumferences. Thus a $3\frac{1}{2}$ in. wire is a little over 1 in. in diameter.

$$\text{Circumference of a circle} = \tfrac{22}{7} \times \text{Diameter}$$

i.e.
$$\text{Diameter} = \text{Circumference} \div \tfrac{22}{7}.$$

EXAMPLE. What is the diameter of a $2\frac{1}{2}$ in. wire?

$$\text{Diameter} = \text{Circumference} \div \tfrac{22}{7}$$
$$= 2\tfrac{1}{2} \div \tfrac{22}{7} = \tfrac{5}{2} \times \tfrac{7}{22} = \tfrac{35}{44} \text{ in.}$$

What are the diameters of the following wire stays?

(*a*) $3\frac{1}{2}$ in. (*b*) $1\frac{1}{4}$ in. (*c*) $2\frac{1}{4}$ in. (*d*) 1 in.

3. A watch was 20 sec. slow at noon on 10 March and $8\frac{4}{5}$ sec. slow at noon on 18 March. Find the daily rate of the watch and express it as gaining or losing.

4. A watch was $13\frac{4}{5}$ sec. fast at 8.30 p.m. on 5 April and $20\frac{1}{5}$ sec. fast at 9.30 p.m. on 8 April. Find the daily rate of the watch to the nearest $\frac{1}{5}$ sec.

5. If a watch has a daily rate of $2\frac{4}{5}$ sec. gain and at noon on 1 June it is $29\frac{2}{5}$ sec. slow, when will it show correct time?

6. There is a type of fractional problem in which the answer appears to be wrong, unless the process is clearly understood.

EXAMPLE. How many pieces of string $3\frac{1}{2}$ in. long can be cut from a length of $7\frac{1}{4}$ in. and how much remains?

The answer to this is obviously 2, with $\frac{1}{4}$ in. left over.

By working with division of fractions we have

$$\frac{7\frac{1}{4}}{3\frac{1}{2}} = \frac{29}{4} \div \frac{7}{2} = \frac{29}{\cancel{4}_{2}} \times \frac{\cancel{2}}{7} = \frac{29}{14} = 2\tfrac{1}{14}.$$

The $\frac{1}{14}$ left over does *not* mean that $\frac{1}{14}$th of an inch is left, but $\frac{1}{14}$th of the *length* that is being cut off (the divisor), i.e.

$$\frac{1}{14} \text{ of } 3\tfrac{1}{2} = \frac{1}{\cancel{14}_{2}} \times \frac{\cancel{7}}{2} = \frac{1}{4} \text{ in.}$$

How many strips of aluminium each $4\frac{5}{8}$ in. long can be cut from a strip $32\frac{1}{2}$ in. long and what length remains?

7. How many pieces of Balsa wood $3\frac{1}{2}$ in. long can be cut from a length 1 ft. 8 in. and how much will be left over? Allow in each cut $\frac{1}{16}$ in. for wastage due to saw-cut.

8. Given the capacity of a petrol tank in gallons, and the hourly consumption of petrol at a certain speed, to find the possible flying time while retaining a reserve of petrol.

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