DIRECTIONS FOR USE OF THE MK SLIDE RULE

The slide rule consists of three basic parts, viz. "the fixed stock", the "slide" and the "cursor" upon which are engraved one main and a number of auxiliary indicator lines (red.)
The front of the rule contains the following scales:
1) Wavelength λ ; circle frequency ω ; frequency f
2) Capacity C (on slide)
3) Self inductance L (on green scale)
4) Reactance R_c
5) Self inductance L (green) and capacity C (on slide)
6) Reactance R_L (on green scale)
The back of the rule contains the following scales:
7) x^3
8) sin/cos
9) tan/cot
10) x^2 and $P_1 : P_2$ (green scale); x^2 on the slide
11) 1 : x (green scale on the slide)
12) x (white scale), thereunder in the green scale X; $U_1 : U_2$ and $I_1 : I_2$
13) ln x and neper
14) centimetre scale, dB and logarithms (log)

Values read off the x-scales (7, 10, 11, 12) ignore decimal punctuations, and thus a figure of 25 may be 0,25 – 2,5 – 25 – 250 – etc. The positioning of the decimal point is determined by mental calculation. When using scales 1, 3, 4, 8, 9 and 11, read off from right to left for the correct values.

THE FRONT OF THE RULE

Conversion of circle frequency into frequency and wavelength

Formula: $\omega = 2\pi f = \frac{2\pi C}{\lambda}$
Set the main indicator line on the cursor to the ω value.
The with ω interrelated values of λ and f can be read off the two scales above and below (1).

Calculating L or C of f_o of a tuned circuit

Formula: $f_o = \frac{1}{2\pi\sqrt{LC}}$

a) Where resonant frequency and capacity are known
Set the black triangle on scale 2 to the given frequency (1) f_o (ω_o or λ_o). Place the hairline at the given capacity on (2) and read off the bearing in Henry (L), given by the hairline on (3). All other values of L at that particular resonant frequency can be found by moving the hairline slide to each given capacity.
b) Where resonant frequency f_o and self inductance L are known
Set the triangle to f_o on scale 1 and place the hairline at the self induction L on (3); the capacity is read off from (2) at the hairline. Values which fall outside the scale can be calculated by using a multiplication factor of a power of 10 on f, so that e.g. 10 kHz indicated on the fixed stock becomes 1 MHz when multiplied by 10^2. The resulting value of L given on (2) must be diminished by 10^4 in this case. C is not altered.

Calculating the reactance of capacitors or selfinductions
Formula: $RC = \frac{1}{2\pi fC}$ and $RL = 2\pi fL$

Set triangle on scale 2 to frequency f on scale 1. Move the hairline to the capacity, respectively selfinductance both on (5). Read off the reactance Rc on (4) at the hairline, and the reactances RL on (6).
Conversely, where the resistance and capacity or selfinductance are known, the cut-off frequency can be determined.
For this the selfinductance on (5) is placed opposite the reactance Rl on (6); the cut-off frequency f is read off scale (1) (f) at the black triangle. The same procedure is taken with a capacitor and reactance on resp. scales (5) and (4).
Here a multiplication factor can also be used, viz. f x 10^{-3}, RC x 10^{-3} and C x 10^6; as well as f x 10^{-3} and L x 10^3.

THE REAR OF THE RULE

Multiplication (a x b, a x b x c etc.)

The letters a, b, c, etc represent fictious numbers to simplify the instructions.
Set the figure 1 on scale 12 to correspond with value a on the green x-scale and read off the result from the same scale at the point corresponding to value b.
This is known as multiplication to the right.
Should the product of a x b fall outside the scale, multiplication to the left must be used. For this the figure 10 on scale 12 is set above value on the green x-scale, the product is read off the same way.
When calculating the product of a x b x c etc, the main red indicator on the cursor should be set to the product of a x b. The slide (12) is shifted to place the 1 (shift to the right) or 10 (to the left), on the hairline; the end product is again read off the green x-scale, which is situated between scales (12) and (13) and below c on (12).

Division (a : b)

Shift number b on scale (12) opposite number a on the green x-scale. The quotient is read off this scale opposite either the 1 or 10 of scale (12). Thus divisions can be carried out to the right as well as to the left.
Multiplication and division can be achieved with the aid of both x^2 scales (10), but it must be held in mind the scale runs from 1 to 100.

Squaring (a^2)

Set the red indicator on the cursor to figure a on the green x-scale and read off a^2 from scale (10) as indicated at the hairline.

Cubing (a^3)

Set the red indicator on the cursor to figure a on the green x-scale and read off the cube from the indicated position on scale (7) at the hairline.

Square roots ($\sqrt{a}$ and $\sqrt[3]{a}$)

Adjust the hairline into a on (10). The square root of a is read off the green x-scale at the hairline.
Cube roots are found by placing the hairline at a on scale (7), and reading the answer off the green x-scale again at the hairline.
Where it is required to find the root of a figure with an even number of digits before the decimal point, figure a is set on the right-hand half of scale 10. Where there is a odd number of digits before the decimal point, the left-hand half of scale 10 is used.
Where figure a is less than 1, the decimal point is mentally shifted to the right, in steps of two for as many times as is necessary to permit the above rules to be observed.
When calculating cube roots, the decimal point must always be moved three places until one, two or three digits are in front of the decimal point.

Combined multiplication ($\frac{a \times b}{c}$)

This can be accomplished in a single operation provided that the division sum is carried out first; i.e. a : c, then the multiplication (a : c) b, Proceed as follows:
Place the number c (on 12) opposite a on the green x-scale, and shift the hairline to b, which is on (12). The answer is read off the green x-scale at the hairline.
In this operation it may be necessary to work to the left. The quotient of a : c need not be read off.

Reciprocate scale: $\frac{1}{a}$ and $\frac{a \times b}{c}$

On scale (11) the reciprocates of the values on (12) are marked. The former often allows a faster calculation of combination sums.

Use of the special marks "C" and "C_1" ($1/4\ \pi\ d^2$)

The purpose of the marks C and C_1 on scale 12 is to enable the area of a circle or the volume of a cylinder to be calculated at a single setting of the slide. The result will be the same whichever mark is used. however in practice the choice should be such that the slide remains as far in the stock as possible (thus not extended).

$(C = \sqrt{\frac{4}{\pi}})$ On the green x-scale, place the hairline on the diameter "d". Slide C or C 1 (on 12) to correspond with the hairline, and read off the answer from the white x^2 scale, and opposite 1, 10 or 100 of scale (10).
For the volume of a cylinder don't read off the answer opposite 1, 10 or 100, but opposite the number representing the height of the cylinder.

Use of the marks "R_A" and "R_{cu}"

The purpose of the marks R_A and R_{cu} is to enable calculation of the ohmic resistance of aluminium and copper conductors respectively of which diameter d and length l are known. The formula is:

$R = \frac{1 \times \rho}{q}$ in which ρ is the specific resistance in Ω/cm and q is equal to $1/4\pi d^2$, so that if d is given instead of q,

the formula becomes: $R = \frac{4 \times 1 \times \rho}{\pi d^2}$ or $R = \frac{L}{d^2} \times \frac{4\rho}{\pi}$

this last term is represented on the rule by R_A for aluminium, and R_{cu} for copper.
Place the hairline on the diameter on the green x-scale. The length, on the white x^2 scale, is shifted to coincide with the hairline. Now shift the cursor and place the hairline on either R_A or R_{cu}, depending on the metal.
Read off the answer at the hairline, on the white x^2 scale of the slide.
N.B. For the setting of l the rule applies that for an even number of digits before the decimal point, the movement must be to the left, and for an uneven number to the right (x^2-scale).

Weight of conductors

With the aid of the marks c_u for copper and A for aluminium it is possible with a single movement of the slide to calculate the weight of the conductor, provided that length l and diameter d are known.

The formula used is: $W = 1/4\pi d x l x RD$ or $W = 1/4\pi RDxd^2xl$: the former term ($1/4\pi RD$) is known and is indicated on the green x-scale C_u for copper or A for aluminium wires.
Place the hairline on C_u or A. The slide is shifted untill the length l on the white x^2 scale corresponds to the hairline. Move the hairline to the diameter "d" on scale (10). Read the weight (in decimal grams) off the white x^2 scale at the hairline. When finding the decimal point keep in mind that with a diameter in millimeters and length in meters, the indications C_u and A represent values of 10.

Use of the indications on the cursor

Hairline p – capacity in Watt
Hairline q – area circle
Hairline pk – capacity in horsepower (h.p.)
In the foregoing it was taken for granted that the large hairline was used for the calculations carried out.
$1/4\pi d^2$: Place the p.k. hairline at the diameter on the green x-scale. The area is read off at the hairline q, from scale (10).
Hp – Kw: Hairline p gives the capacity in KW, while the PK hairline simultaneously shows the same capacity in hp.
This applies to both scales (10) and (12). On (12) both short hairlines count.
"C": The distance between the centre and right pk hairlines equals $\sqrt{\frac{4}{\pi}}$, = "C" (also see the x-scales (12) so that a figure can be instantly multiplied by $\sqrt{\frac{4}{\pi}}$. Place the hairline on a figure: the product $\sqrt{\frac{4}{\pi}}$ is read off at the right (small) pk hairline, and only from the green x-scale.

Amplification

Where the relative voltages/currents or powers respectively are known, the ratio can be established (by division, using the slide if desired). The resulting value is then sought on the scale $U_1 : U_2$, $I_1 : I_2$ or $P_1 : P_2$ respectively, whereupon the corresponding number of dB or neper (14 or 13) can be read off from the relevant scale.
Conversely, knowledge of the number of dB or neper permits immediate reading-off of the ratio's $U_1 : U_2$, $I_1 : I_2$ or $P_1 : P_2$ respectively.
The rear of the rule also incorporates fixed calibrations for the conversion of voltage or current ratio's into decibel and neper, and vice versa, and for the conversion of the ratio between powers $P_1 : P_2$ into dB and vice versa.

dB and neper

The relationship and conversion of dB and neper can be obtained directly, by reading off with the aid of scales (13) and (14).

Angle functions

Scales 8 and 9 in conjunction with the green x-scale indicate trigonometrical functions.
Scale (8) gives the angles between approx. 6' to 90', while their sine values are read off the green x-scale at the hairline, if it is set on the value of the angle. To find the cosine of an angle place the hairline on the angle value, these values are bracketed. Scale (9) is used to set an angle of which the tangent and cotangent are sought. Read off the tangent from the green x-scales if using the normal value, but bracketed values have to be read off the reciprocate scale (11). To determine the cotangents, work the other way, viz. angles up to 45' are read from the reciprocate scale (11), angles over 45' are read from the x-scale.

Logarithms

The naturel logs of numbers are found by placing the hairline on the green x-scale at the known number. Read off the hairline on scale (13). Decimal logs are found by placing the hairline at the given number on scale (10). Read off at the hairline on scale (14). (Use the left part of the scale only).

Other marks

On scales (10, 11 and 12) π is indicated which is equal to 3.14159. On (10) the mark M is included which equals $0.3183 = \frac{1}{\pi}$.

Scale (12) includes a black triangle which indicates 1.593 ($\sqrt{2.54}$), which is the square root of 1 inch in centimeters.