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für metalltechnische Berufe

Lösungsbuch

TECHNISCHES ENGLISCH zur FACHKUNDE METALL

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Autoren:

Dr. Eckhard Ignatowitz	Dr.-Ing., Dipl.-Ing.	StR. a. D.	Waldbronn
Christina Murphy	Dipl.-Berufspäd. (Univ.)	StDin	Wolfratshausen
Falko Wieneke	Dipl.-Ing.	StD	Essen

Bei der Übersetzung war behilflich:

Heinz Bernhardt	Gymnasiallehrer	OStR a. D.	Waldbronn
Wolfgang Peter-Michel			Overath

Leitung des Arbeitskreises und Lektorat:

Dr. Eckhard Ignatowitz

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Vorwort

Dss **Lösungsbuch Technisches Englisch für die Fachkunde Metall** dient zur Erarbeitung und Überprüfung der **Exercices** (Übungen) im Lehrbuch **Technisches Englisch für die Fachkunde Metall.**

Es enthält die **Fragen bzw. Aufgaben der Exercises** aus dem Lehrbuch und die dazu gehörenden **Antworten bzw. Lösungen.**

Die Antworten/Lösungen sind in Blau gedruckt und heben sich dadurch deutlich von den in Schwarz gedruckten Fragen/Aufgaben ab.

Die Exercises sind in derselben Reihenfolge und Kapitelnummerierung wie im Lehrbuch **Technisches Englisch für die Fachkunde Metall** angeordnet. Eine zusätzliche Seitenangabe lässt die jeweiligen Exercises im Lehrbuch rasch auffinden.

Nach jedem Kapitel bietet das **Lösungsbuch** eine Seite mit einer **Übungseinheit** (Test unit) zur Leistungsüberprüfung an.

Die **Übungseinheit** kann vom Lernenden als selbstgestellte Überprüfung seines Wissensstandes genutzt werden oder kann vom Lehrer durch Kopieren als Klassensatz zur Leistungsüberprüfung der Klasse verwendet werden.

Autorisierte Lehrkräfte können die Lösungen der Übungseinheiten auf der Website des Verlags Europa-Lehrmittel einsehen. Internetadresse: www.europa-lehrmittel.de

Sollten Sie Verbesserungsvorschläge zum **Lösungsbuch** haben, so freuen wir uns auf Ihre Zuschrift. Bitte senden Sie Ihre Hinweise und Vorschläge per E-Mail an: lektorat@europa-lehrmittel.de

Sommer 2021 Die Autoren, der Verlag

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Answers to the questions in the book TECHNISCHES ENGLISCH zur FACHKUNDE METALL

1 Measuring technique

1.1 Physical quantities and units

Exercises page 6

1. Working with words. Which words from the text are described here?

a) Every material has certain physical quantities, for example it has a special density.

b) In order to find out the correct diameter of a workpiece, you need to measure it with an instrument.

c) The speed of a car is also called velocity.

2. Define physical quantities in German by using the information from the text above.

Die an einem Objekt (z. B. bei einem bestimmten Werkstoff) messbaren Eigenschaften, Vorgänge oder Zustände werden physikalische Größen genannt.

3. Answer the following questions in English.

a) Which two elements does a physical quantity have? Find an example to explain it.

It consists of a numerical value and a unit.

For example: A workpiece has a *length l* of 330 mm:

330 represents the numerical value and **mm** the unit.

b) Which 7 base quantities does the International System of Units SI define?

The 7 base quantities defined by the International System of Units SI are length, mass, time, electric current, temperature, amount of substance and luminous intensity.

c) What is the difference between base quantities and derived quantities?

The base quantities cannot be transferred into another quantity, whereas the derived quantities can always be transferred back into the base quantities.

Exercises page 7

1. Write down the formula and explain the correct derived units. (Use your Metal Trades Handbook)

a) pressure p

$p = F : a$; Pressure p is defined as the effect of a force F applied to a surface a. The SI unit of pressure is Pascal (Pa), defined as a force of one Newton per square meter.

b) velocity v

$v = s : t$; Velocity v is defined as the distance s divided by time t. The SI unit for velocity is meter per second (m/s), defined as a distance measured in meter which is covered in the duration of one second.

c) density ϱ

$\varrho = m : V$; Density ϱ is defined as mass m per volume V. The SI unit for density is kilogram per cubic meter (kg/m^3), defined as a mass m measured in kilograms per volume V in cubic meters.

d) tension σ

$\sigma = F : S$; Tension σ is defined as a force F acting on a defined cross section S of a specimen in order to elongate him. The unit for tension in engineering is Newton per Millimeter N/mm^2.

e) electrical energy W

$W = P \cdot t$; Electrical energy W is defined as the electrical power P multiplied by the time t. The SI unit for electrical energy is Watt (W), defined as the power which gives rise to energy of one Joule in one second.

f) frequency f

$f = 1 : T$; Frequency f represents the number of occurrences of a repeating event per peroid time T. The SI unit for frequency is Hertz (Hz), defined as the rate of repetition per duration of one second.

2. Convert the measurements from imperial units into metric units. (Use your Handbook)

a) 120 miles in km

$120 \cdot 1.609$ km = 193.08 km

b) 3.300 ft in metres

$3.300 \cdot 0.3048$ m = 1.00584 m

c) 1 ½ pints in litres

$1.5 \cdot 0.5683$ l = 0.8525 l

d) 4.5 ounces in kilogram

$4.5 \cdot 0.02835$ kg = 0.1276 kg

e) 1/8 inch in mm

$0.125 \cdot 25.4$ mm = 3.175 mm

f) 22.5 pounds in kg

$22.5 \cdot 0.4536$ kg = 10.2060 kg

3. Calculate the physical quantities by using SI-Units.

a) A compact disc (CD) has a diameter of 120 mm. Calculate the area in mm².

$A = \pi \cdot r^2$;

$A_{CD} = \pi \cdot (60\ \text{mm})^2 = 11309.724\ \text{mm}^2$

b) The volume of a steel rod is 0.50 dm³ and has a density of 7.85 kg/dm³. Calculate the mass in kg.

$m = \varrho \cdot V$;

$m_{rod} = 7.85\ \text{kg/dm}^3 \cdot 0.50\ \text{dm}^3 = 3.925\ \text{kg}$

c) A turning tool moves 9.3 cm in a time of 3 seconds. Calculate the feed velocity in mm/s.

$v = m : t$; $v_{ftool} = 93\ \text{mm} : 3\ \text{s} = 31\ \text{mm/s}$

1.2 Fundamentals of measuring technique

Exercises page 8

1. Translate the following inspection aids and name the main group of these devices.

a) plug limit gauge
Grenzlehrdorn – Lehren (gauges)

b) prism block
Prisma – Hilfsmittel (auxiliary aids)

c) folding rule
Gliedermaßstab – Messtechnik (measuring devices)

d) micrometer
Bügelmessschraube – Messtechnik (measuring devices)

e) snap gauge
Rachenlehre – Lehren (gauges)

f) vernier calliper
Messschieber – Messtechnik (measuring devices)

2. Name the correct inspection aid to find out these measurements.

a) the diameter of a shaft of 22 mm
vernier calliper

b) the length of a rail of 1.80 m
folding rule

c) the angle of 120°
protractor

d) the bore of ∅ 20 mm
vernier calliper

e) the depth of 10 mm of a groove
vernier calliper

f) the radius R5
radius gauge

3. Answer the questions in English.

a) What are dimensional representatives?
Dimensional representatives are measuring devices allowing certain dimensions to be compared with a measuring scale.

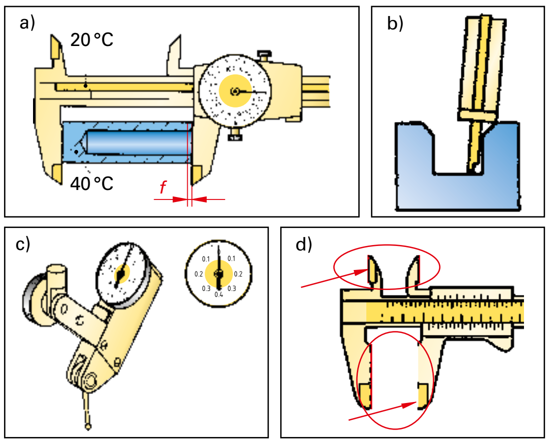
b) Which result do you get when you use a gauge? Give an example.
A gauge is used to check whether a dimension corresponds to the given standard. For example a plug limit gauge can be used to check whether the diameter of a hole is within specified limits and therefore accurate.

c) Which result do you get when you use an indicative measuring device? Give an example.
With an indicative measuring device, a numerical result is achieved. For example, when a shaft is measured with a vernier calliper.

d) When do you need an auxiliary aid? Give an example.
Auxiliary aids are used to fix objects in order to be able to measure them using measuring tools. For example to fix a shaft in a prism block and finally check it with a dial indicator.

Exercises page 9

1. Match the pictures a)–d) to the type of measuring error (1)–(4). Explain if it is a systematic or a random error.



Type of measuring error: (1) parallax error (2) wear of measuring surfaces (3) bad positioning of device (4) temperature too high

a) – 4 = systematic error
b) – 3 = random error
c) – 1 = random error
d) – 2 = systematic error

2. Make a list of six common measuring devices (e. g. steel rule, vernier calliper, gauge block, dial gauge protractor, etc.) and find out their type of inspection aid/range/accuracy. (Use a webpage of a company for measuring devices e. g. www.mitutoyo.com; www.mahr.de; www.hoffmann.de).

Measuring device	Type of inspection aid	Measuring Range	Accuracy
steel rule	dimensional representative	150–1000 mm	0.5/1 mm
vernier calliper	indicative measuring device	150 mm	0.01/0.2 mm
protractor	indicative measuring device	180°	0.1°/0.5°
micrometer	indicative measuring device	0–300 mm	0.005/0.01 mm
plug limit gauge	gauge	0.5–500 mm	0.01 mm/0.02 mm
dial indicator	indicative measuring device	50 µm–100 µm	0.001 mm
folding meter	dimensional representative	2000 mm	0.5/1 mm

1.3 Length Measuring Instruments

Exercises page 10

1. Match the correct expression of the following measuring devices to the pictures at the right.

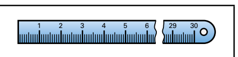
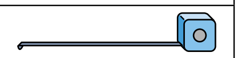
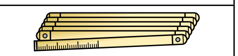
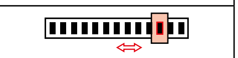
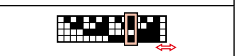
a) absolute scale

b) flexible steel rule

c) tape rule

d) folding rule

e) impulse scale

1	
2	
3	
4	
5	

a) – 5
b) – 1
c) – 2
d) – 3
e) – 4

2. Answer the following questions in English.

a) What is the difference between measuring instruments and gauges?

Measuring instruments provide a numerical value for the quantity, size, weight, distance or capacity of an object, whereas gauges are geometrical representations of certain dimensions or forms.

b) Why do straight edges and engineer's squares have lapped test blades?

Lapped test blades guarantee a high grade of flatness. Thus they enable the naked eye to realize different tiny light gaps between the blade and the tested object. These light gaps reveal inaccuracies concerning straightness and flatness of the workpiece.

c) What can you check with straight edges?

Straight edges are used to check the straightness and flatness of an object`s surfaces.

d) What is the light gap method?

The test blades are laid upon the surface of the object to be tested. If any tiny light gaps between the blade and the tested object are visible, they reveal inaccuracies in the surface.

e) Mention 3 different types of gauges and choose a certain measurement of a workpiece which can be checked by them.

Plug gauge – internal diameter of bores

Snap gauge – external diameter of cylindrical objects

Gauge block – external dimension of any three-dimensional object.

Exercises page 11

1. Find the correct answer of the questions and tick it in the table below.

a) A tolerance is a ...	clearance between a shaft/mating bore	measurement error	variation in manufacturing ✓
b) Which of the following statement of plug gauges is true (only 1)?	The Go side is smaller than the No Go side of the plug gauge. ✓	Only slight pressure is needed to slide the Go member into the bore.	The No Go member is designated with the minimum limit size.
c) Which of the following statements of snap gauges is true (only 1)?	The Go member should fail to slide into the bore.	The Go member is marked in red.	The Go member doesn't represent the minimum limit size. ✓

2. Create a stack of gauge blocks and write down the combination of blocks.

a) 42.123 mm		b) 74.357 mm		c) 81.685 mm	
	1.003		1.000		1.005
	1.020		1.007		1.080
	1.100		1.050		1.600
	9.000		1.300		8.000
	30.000		70.000		70.000

1.4 Vernier calliper

Exercises page 12

1. Some of the following six statements are wrong. Find these statements and correct them.

a) A vernier calliper is the least frequently used measuring device in the workshop.
⇒ Wrong
A vernier calliper is the **most** frequently used measuring device in the workshop.

b) A calliper can measure diameters of bores and shafts, the width and thickness of a part.
⇒ Correct

c) There are three different types of callipers: manual, digital and CNC callipers.
⇒ Wrong
There are **two** different types of callipers: manual and digital.

d) With the aid of a 1/20 nonius a measuring of 0.02 mm is possible.
⇒ Wrong
With the aid of a 1/20 nonius an accuracy of **0.05 mm** is possible.

e) Measurements of 0.001 inch, 0.01, 0.02 and 0.05 mm are also possible.
⇒ Correct

f) Digital callipers are easier to read, cheaper and more often used nowadays.
⇒ Wrong
Digital callipers are easier to read and more often used nowadays, but **not** cheaper.

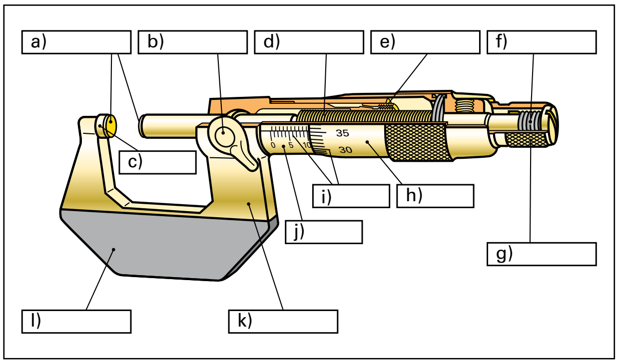
2. Translate the example of reading a mechanical calliper above into German.

Bei einer Messung wird als erstes der Nullstrich des Nonius als Komma abgelesen. Links vom Nullstrich liest man auf der Strichskala die vollen Millimeter ab.
Nun muss ermittelt werden, welcher der weiter rechts stehenden Striche der unteren Skala mit einem der oberen Skala übereinstimmt – dieser gibt den Zehntelmillimeterwert an. Das Addieren der beiden Werte ergibt das zu ermittelnde Maß.

1.5 Micrometer (screw gauge)

Exercises page 13

1. Label the sketch of the mechanical micrometer a) to l) by reading the text above.



a) measuring faces b) lock
c) anvil d) spindle
e) screw f) spring

g) ratchet h) rotary thimble

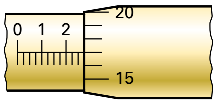
i) main scale and auxiliary scale

j) sleeve k) frame

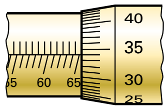
l) insulation plate

2. Read the correct measurements of the micrometers shown below.

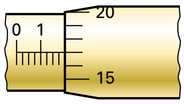
a) in inch



b) in mm



c) in inch



a) 0.267 inch

b) 65.34 mm

c) 0.192 inch

1.6 Surface testing

Exercises page 14

1. Complete the missing information about form deviations in the table.

Degrees of form deviation	Examples	Possible cause
1st degree: form deviation	straightness or roundness, other than the required form	Clamping marks, wear in the guides of the machine tool
2nd degree: waviness	waves	Vibrations of machine tool
3rd degree: roughness	grooves	Geometry of the cutting tool, feed or depth of cut of the tool during fabrication of the part
4th degree: roughness	scoring, scales, bumps	Sequence of chip formation, surface deformation during fabrication of the part

2. Answer the questions in English.

a) Which surface testing instrument is very quick and easy to use? Why?

Surface roughness comparators, because they can be used during the manufacturing process, without having to place the workpiece in a measuring apparatus.

b) Explain why you can compare the surface roughness visually and by touching.

Because both methods make roughness comprehensible through senses.

c) Describe how a stylus instrument works.

Stylus instruments are surface roughness testers, which record the peaks and valleys by a diamond stylus. It is drawn at a constant speed across the workpiece. The amount to which the stylus is raised or lowered is printed in a diagram. It shows the increased surface profile.

Exercises page 15

1. Answer the questions in English.

a) Which surface texture parameters are often used in USA and which in Germany?

The surface parameter *Rz* is widely used in Europe, *Ra* is the most specified U.S. parameter.

b) Explain the difference between the surface parameter *Rmax* and *Rz*.

Rz considers the five highest peaks and the five deepest valleys. The complete evaluation length is divided into five cut-offs. In each of these the highest distance between peak and valley is a value (Rz_{1-5}). *Rmax* represents the maximum height of the five values in the sampling length.

c) Why is the surface texture parameter *Rmax* not a very reliable value?

Because it represents only an extreme and not the average surface texture. This means one scratch could give a false impression about the surface quality.

d) Explain the surface texture parameter *Ra*.

Ra (arithmetic average roughness) considers all peaks and valleys of the roughness profile. Thus, extremes are neutralised and have no significant influence on the final result.

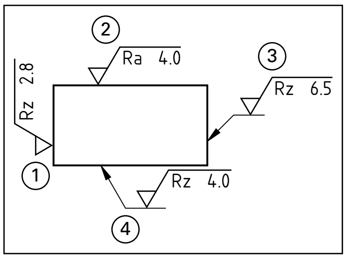
2. Name the type of surface parameters and its value of the positions (1) to (4) shown in the figure.

(1) Rz = 2.8 µm (average peak to valley height)

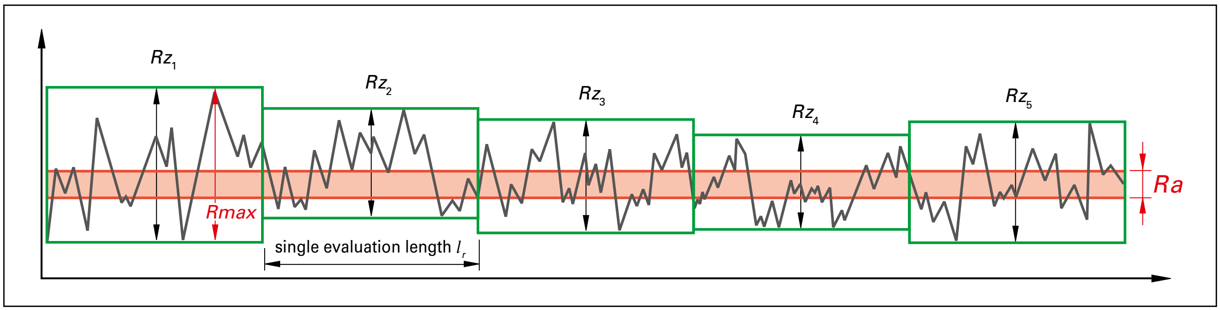
(2) Ra = 4.0 µm (arithmetic average roughness)

(3) Rz = 6.5 µm (average peak to valley height)

(4) Rz = 4.0 µm (average peak to valley height)



3. Copy a roughness profile from your own test or from a book and add the three parameters: *Rmax*, Rz_1–z_5 and *Ra*.



1.7 Fits

Exercises page 16

1. Answer the following questions in English.

a) What is a fit?

A fit is the dimensional relationship of two mating construction components.

b) Which two criteria are given to select the type of fit?

The choice of the different fit is determined either by the use or by the production of the parts.

c) What are the dimensions of the hole and shaft, when a clearance fit is given?

The lower limit size of the hole is greater or at least equal to the upper limit size of the shaft.

d) Which three types of fits are possible? Explain!

Clearance fit always enables some space between the hole and shaft. The lower limit size of the hole is greater or at least equal to the upper limit size of the shaft.

Interference fit always has some excess material between the hole and shaft. The upper limit size of the hole is smaller or at least equal to the lower limit size of the shaft.

Transition fit is a fit where both types of fit may occur. The tolerance zones of the hole and shaft partly or completely interfere. There can be a clearance fit or an interference fit.

2. Find the correct expressions and match them to the abbreviation.

a) F_{Imin}/F_{Imax} – minimum interference/maximum interference

b) G_{IH}/G_{UH} – hole minimum dimension/hole maximum dimension

c) T_H/T_S – hole tolerance/shaft tolerance

d) G_{IS}/G_{US} – shaft minimum dimension/shaft maximum dimension

e) F_{Cmin}/F_{Cmax} – minimum clearance/maximum clearance

1.8 Fit Systems

Exercises page 17

1. Answer the questions in German.

a) Which difference do the basic hole system and the basic shaft system have?

Beim **System Einheitsbohrung** wird die maximale Abweichung vom Nennmaß der Bohrung festgelegt. Die gewünschte Passung wird durch Auswahl einer Welle mit entsprechender Toleranz erreicht.

Beim **System Einheitswelle** wird die maximale Abweichung vom Nennmaß der Welle festgelegt. Die gewünschte Passung wird durch Auswahl einer Bohrung mit entsprechender Toleranz erreicht.

b) Where is the basic hole system used?
Das System Einheitsbohrung wird hauptsächlich im Maschinenbau und in dem Fahrzeugbau verwendet.

c) Which letters are used in the basic hole system for interference fits?
H/n or p…z

2. Determine the type of fit of the following fits:

a) 8H9/d9 – clearance fit

b) 24H7/s6 – interference fit

c) 9K7/h6 – transition fit

d) 153 H11/c11 – clearance fit

3.

a) Read the required values for the fit of Nr. 2 a) to d) from a Metal Trades Handbook.

a)
8H9: 8.000 mm + IT9 = 8.000 mm + 0.036 mm = 8.036 mm
8d9: 8.000 mm – 0.040 mm = 7.960 mm (upper specification limit)
7.960 mm – 0.036 mm (IT9) = 7.924 mm (lower specification limit)

b)
24H7: 24.000 mm + IT7 = 24.000 mm + 0.021 mm = 24.021 mm
24s6: 24.000 mm + 0.048 mm = 24.048 (upper specification limit)
24.048 mm – 0.013 mm = 24.035 mm (lower specification limit)

c)
9K7: 9.000 mm + K-value (table) = 9.000 mm + 0.005 mm = 9.005 mm (lower specification limit)
9.005 mm + IT7 = 9.005 mm – 0.015 mm = 8.990 mm (lower specification limit)
9h6: 9.000 mm (upper specification limit)
9.000 mm + IT6 = 9.000 mm – 0.009 mm = 8.991 mm (upper specification limit)

d)
153H11: 153.000 mm (lower specification limit)
153.000 mm + IT11 = 153.000 mm + 0.250 mm = 153.250 mm (upper specification limit)
153c11: 153.000 mm – 0.210 mm = 152.790 mm (upper specification limit)
152.790 mm – IT11 = 152.790 mm – 0.250 mm = 152.540 mm (lower specification limit)

b) Calculate the maximum and minimum clearance or interference, by using your Metal Trade Handbook.

a)
hole limits:
max. = 8.036 mm; min. = 8.000 mm
shaft limits:
max. = 8.000 mm – d9
= 8.000 mm – 0.040 mm = 7.960 mm
min. = 7.960 mm – 0.036 mm = 7.924 mm
Maximum clearance
= max. hole – min. shaft
= 8.036 mm – 7.924 mm = 0.112 mm
Minimum clearance
= min. hole – max. shaft
= 8.000 mm – 7.960 mm = 0.040 mm

b)
hole limits:
max. = 24.021 mm; min. = 24.000 mm
shaft limits:
max. = 24.048 mm; min. = 24.035 mm
Maximum clearance
= max. hole – min. shaft
= 24.021 mm – 24.035 mm = –0.014 mm
Minimum clearance
= min. hole – max. shaft
= 24.000 mm – 24.048 mm = –0.048 mm

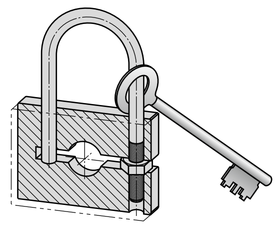
c)
hole limits:
max. = 9.005 mm; min. = 8.990 mm
shaft limits:
max. = 9.000 mm; min. = 8.991 mm
Maximum clearance
= max. hole + min. shaft
= 9.005 mm – 8.991 mm = 0.014 mm
Minimum clearance
= min. hole + max. shaft
= 8.990 mm – 9.000 mm = –0.010 mm

d)
hole limits:
max. = 153.250 mm; min. = 153.000 mm
shaft limits:
max. = 152.790 mm; min. = 152.540 mm
Maximum clearance
= max. hole – min. shaft
= 153.250 mm – 152.540 mm = 0.710 mm
Minimum clearance
= min. hole – max. shaft
= 153.000 mm – 152.790 mm = 0.210 mm

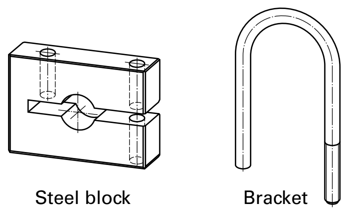
Test unit for Measuring technique

Übungseinheit zur Messtechnik

You are an **exchange student** in Manchester, Great Britain, and work at a metal processing company for three weeks. Your **instructor** has given you a demonstration copy of **a key fob** and forwarded you the order to produce one of it.



You have milled and drilled the steel blocks and you have bent the brackets. So all of the parts are on your workbench in front of you.



1. In order to **check all relevant dimensions** and to **test if all parts can be assembled** you have to **make an inspection plan** of the steel block (part 1) and the bracket (part 2).

The tolerances are according to **General tolerances, class m.** (Use the Metal Trades Handbook for looking up the tolerances)

Inspection plan **Key Fob**
Identification number: **18012** Drawing number: **24107**
Designation: **steel block** Inspection plan no.: **81**

Serial No.	Inspection characteristic	Tolerance (GTm)	Measuring instrument
1	length l_1 = 65 mm	?	?
2	width w_1 = 12 mm	?	?
3	height h_1 = 40 mm	?	?
4	groove, lenght l_2 = 50 mm	?	?
5	groove, height h_1 = 8 mm	?	?
6	internal diameter groove d_1 = 16 mm	?	?
7	diameter hole$_2$ d_2 = 8.1 mm	?	?
8	depth of hole$_2$ d_{h2} = 12 mm	?	?
9	distance from center of holes $d_{h1}/_{h2}$ = 40 mm	?	?
10	diameter hole$_3$ d_3 = 8.1 mm	?	?

Inspection plan **Key Fob**
Identification number: **18012** Drawing number: **24108**
Designation: **bracket** Inspection plan no.: **82**

Serial No.	Inspection characteristic	Tolerance (GTm)	Measuring instrument
1	length l_1 = 50 mm	?	?
2	diameter bracket d = 8 mm	?	?
3	external diameter d_{ex} = 48 mm	?	?
4	length l_2 = 65 mm	?	?
5	metric thread M8	?	?
6	depth of metric thread d_{mt} = 20 mm	?	?

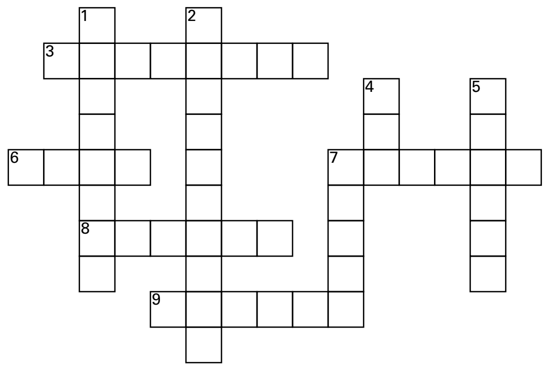
2. Your are back in your training workshop and **present your manufactured key fob.** Your instructor would like to **display this key fob** on the special event of the open house.

Therefore he asked you to **translate the inspection plan** of the **steel block** and the **bracket** into German. Here is the beginning. Translate it completely.

Prüfplan des **Schlüsselanhängers**
xx: xx:
xx: xx:

Ldf. Nr.	xx	xx	xx
1	Länge l_1 = 50 mm	?	?
2	...	?	?

3. Now **check your knowledge** about **measuring techniques and equipments** with the crossword puzzle below.



ACROSS

3 A general measuring device used to find out smaller distances and measure workpieces
6 A prefix for units for a multiple of thousand
7 With this instrument you can record the roughness of a surface
8 The most commonly used unit for electric current
9 The common unit for a force

DOWN

1 If you have an incorrect eye position when reading the scale, these errors can occur
2 The right instrument for very accurate measurements
4 A relationship between a bore and a matching shaft is called:
5 The measuring devices represent certain dimensions or geometric forms e.g. radii
7 Number of base quantities in technology

2 Quality management

2.1 Basics of quality management

Exercises page 18

1. Working with words. Which words from the text are described here?

a) If the product looks really good, the design is very appealing.

b) If the device runs without a problem for a long time, it is very reliable.

c) If the product can be used in many different ways, the performance is very high.

2. Translate the definition of quantitative and qualitative characteristics.

Quantitative Merkmale sind messbar oder können gezählt werden, beispielsweise die Länge eines Werkstücks oder der Durchmesser einer Welle.

Qualitative Merkmale beschreiben eine Beschaffenheit, wie beispielsweise die Qualität der Lackierung eines Fahrzeugs.

3. Answer the following questions in English.

a) Which 3 quality characteristics (= requirements of the customer) should your next smart phone have?
It should have an appealing design, good performance, diverse functions and be very reliable.

b) Which system supports the quality process in companies?
A quality management system according to ISO 9000 standards.

c) What does the 1-10-100 rule describe?
The 1-10-100 rule states that when a product moves through a production sequence, the cost of correcting an error multiplies by 10 from stage to stage.

d) Which different stages appear in a product circle?
Construction, development – Production planning – Quality planning – Inspection e.g. supplied parts – Quality control – Quality improvement – Production – Assembly – Product – Final testing – Delivery

2.2 Quality tools

Exercises page 19

1. Answer the questions:

a) Which two type of graphs are used in a Pareto chart?
Bars and a line. The bars indicate the type and the frequency of the defects. The line displays the cumulative total of the errors.

b) Why is the Ishikawa diagram also called fishbone diagram?
Because both terms name the same kind of diagram – a cause-and-effect diagram.
The fishbone represents the skeleton (cause) of the 6 effects.

c) What is meant by the 6 Ms?
manpower, machine, method, material, milieu, measurement

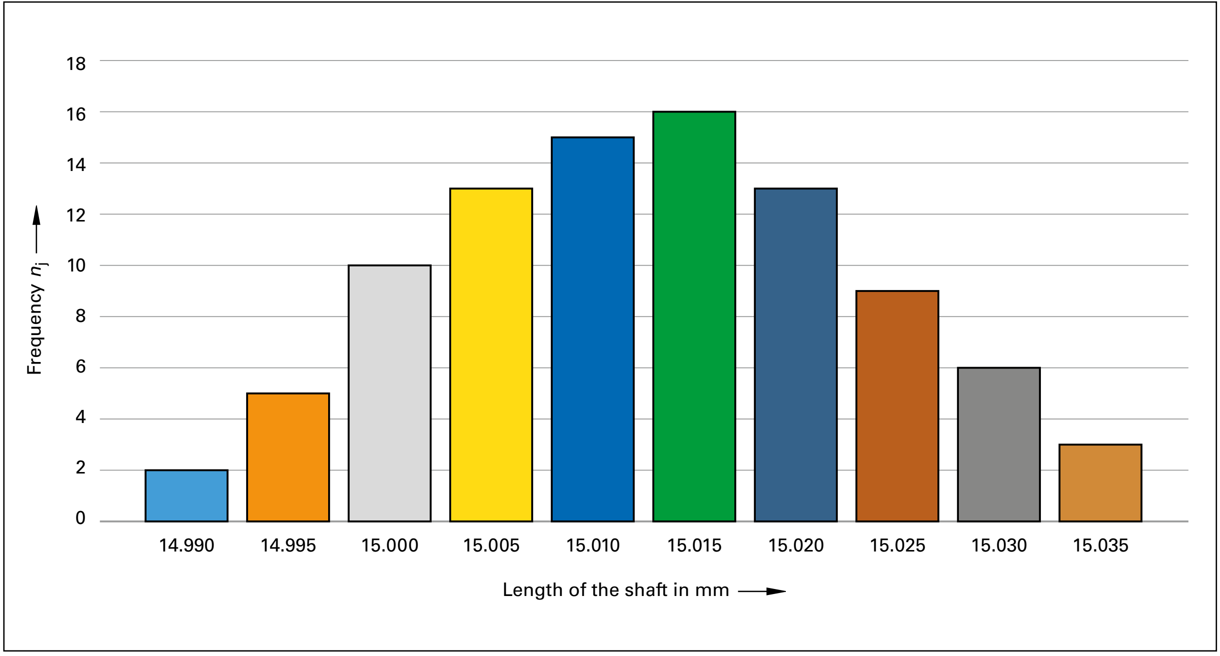
d) Which function has a tally sheet?
A tally sheet is used to summarize data in order to draw a histogram.

e) What is shown in a histogram?
A histogram shows the distribution of measured results. It indicates the frequency of data within a range of values, called a class.

f) What does the height of a bar in a histogram show?
The height of a bar in a histogram indicates the frequency of the data that falls in each class.

2. Draw a histogram on an extra sheet of paper by using the data below.

Length of the shaft in mm										
Measured values	14.990	14.995	15.000	15.005	15.010	15.015	15.020	15.025	15.030	15.035
Frequency n_j	2	5	10	13	15	16	13	9	6	3



2.3 Normal distribution

Exercises page 20

1. Give three examples of nature or technology in which data can be normally distributed.

- Intelligence of humans
- Body height of people
- Deviations from the diameter of turned shafts.

2. Explain the experimental principle of a Galton board in German. Use the following structure:

a) Construction of the board

Das Galton-Brett besteht aus einer vertikalen Fläche, auf der Stiftreihen in gestaffelter Reihenfolge so angeordnet sind, dass herunterfallende Kugeln nach links oder rechts daran abprallen können. Die Vorderseite des Geräts besteht aus Glas, damit der Weg der Kugeln beobachtet werden kann. Unterhalb der Hindernisse werden die Kugeln in Fächern aufgefangen.

b) Experimental procedure

Eine Anzahl Kugeln wird auf die Hindernisreihen fallen gelassen und anschließend ihre Verteilung auf die Fächer im unteren Teil des Apparats überprüft.

c) Experimental result

Die unterschiedlichen Höhen der Säulen bilden in allen Fällen eine Kurve in der Form einer Glocke. Diese wird Glockenkurve, Gaußsche Verteilungskurve oder Normalverteilungskurve genannt.

3. Translate the sentences according the normal distribution into English:

a) Die Normalverteilung entsteht, wenn viele zufallsbedingte Einflüsse wirksam sind.

A normal distribution occurs when many random influences are effective.

b) Sie zeigt eine typische Glockenkurve der Häufigkeit über dem Merkmal $\bar{x}$.

It shows a typical bell-shaped curve of frequency around the mean $\bar{x}$.

c) Der Mittelwert $\bar{x}$ liegt beim Kurvenmaximum und zeigt die Lage der Verteilung.

The mean $\bar{x}$ is located at the peak of the curve and shows the position of the distribution.

d) Die Standardabweichung kennzeichnet die Streuung, d.h. die Verteilung um den Mittelwert.
The standard deviation indicates the variation, i. e. the distribution around the mean value.

2.4 Statistical characteristics of data quantities

Exercises page 21

1. Translate the definition in German of

a) the arithmetic mean
Der arithmetische Mittelwert $\overline{x}$ einer Reihe von Daten wird als Summe der einzelnen Daten geteilt durch die Anzahl der Daten errechnet.

b) the median
Der Medianwert $\tilde{x}$ ist der mittlere Wert einer Datenreihe, die in aufsteigender Reihenfolge sortiert ist. Bei ungerader Anzahl von Daten ist er identisch mit dem Wert, der in der Mitte der Sequenz liegt.

c) the range
Die Spannweite R bezeichnet die Differenz zwischen dem höchsten (x_{max}) und dem niedrigsten Einzelwert (x_{min}).

2. Your company inspects the diameter of produced shafts. The nominal value = 19+/–0.001 mm. The result of a sampling test is presented in the following table:

Diameter of shafts	
Measured value in mm	Number of values
18.999	3
19.000	6
19.001	8
19.002	5
19.003	2
19.998	4

Calculate the following values by using an electronic calculator:

a) the mean value $\overline{x}$
$\overline{x}$ = 19.143 mm

b) the range R
R = 0.999 mm

c) the standard deviation s
s = 0.030 mm

d) the median $\tilde{x}$
$\tilde{x}$ = 0.126 mm

2.5 Machine capability

Exercises page 22

1. Translate the following sentences into English:

a) Maschinenfähigkeitsuntersuchungen (MFU) werden vor dem Einsatz von Maschinen, bei Maschinenabnahme sowie nach umfangreichen Wartungsarbeiten und Reparaturen eingesetzt.
Machine capability tests (MCT) are applied before machine use, during machine acceptance and after extensive maintenance and repairs.

b) Die MFU wird über einen längeren Zeitraum durchgeführt.
The MCT is applied over a longer period of time.

c) Bei der MFU werden in einem Vorlauf zur Fertigung mindestens 25 Teile gefertigt und ihre Maße geprüft.
During an MCT, at least 25 parts are manufactured in a lead-up to production and their dimensions are checked.

d) Der Mittelwert, die Spannweite und Toleranz sind wichtige Werte zur Auswertung der MFU.
The mean value, the range and the tolerance are important values for the evaluation of the MCT.

e) Zur Auswertung der MFU werden die gemessenen Maße der gefertigten Teile als Normalverteilungskurve in ein Koordinatensystem gezeichnet und der Mittelwert $\overline{x}$, die Spannweite R, die Standardabweichung s und die Toleranz T eingetragen.
To evaluate the MCT, the measured dimensions of the manufactured parts are drawn as a normal distribution curve into a coordinate system and the mean value $\overline{x}$, the range R, the standard deviation s and the tolerance T are marked.

2. In the sentences of exercise 1 are three wrong statements. Find and correct them.

The wrong statements and corrections are:

b) The MCT is a short term study.

c) During an MCT at least 50 parts are manufactured in a test run.

e) The range R is not marked in the coordinate system of an MCT.

2.6 Process capability

Exercises page 23

1. Find the missing word from the text above:

a) The "*C*" in the process capability indexes C_p and C_{pk} stands for capability.

b) The process capability is carried out within a long-term period.

c) The difference between the upper limit value (*ULV*) and the lower limit value (*LLV*) is called the tolerance.

d) If parts are produced in the required quality without faulty ones in a long term the process is consistent.

e) The process capability C_p doesn't consider if the curve is off-centre.

2. Explain, why the curve (4) in the figure above is capable but not consistent.

Because it reaches outside of the tolerance limits.

2.7 Statistical process control with quality control chart

Exercises page 24

1. Translate the purpose of using control charts in series production into German.

Mit der Darstellung von Messwerten in einer Qualitätsregelkarte kann beurteilt werden, ob der Fertigungsprozess stabil oder instabil ist und die Produkte die Spezifikationen im Rahmen der Toleranzen erfüllen.

2. Your company produces shafts at a CNC turning machine. The diameter of the shaft can be taken out of the technical drawing: 30 ± 0.05 mm. Besides you have the following limits given below:

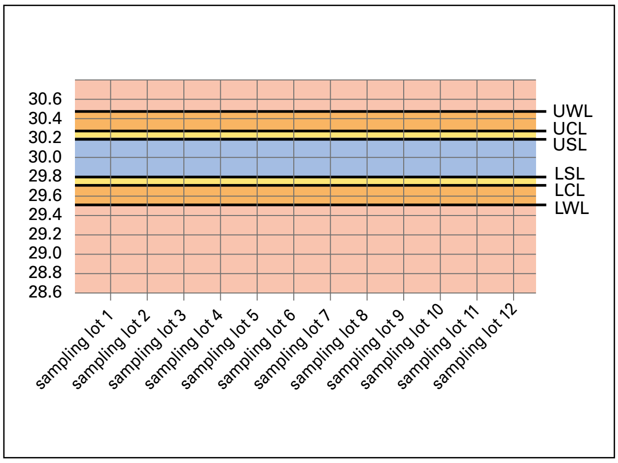
Upper control limit: 29.07 mm
Upper warning limit: 29.08 mm

Lower control limit: 30.03 mm
Lower warning limit: 30.02 mm

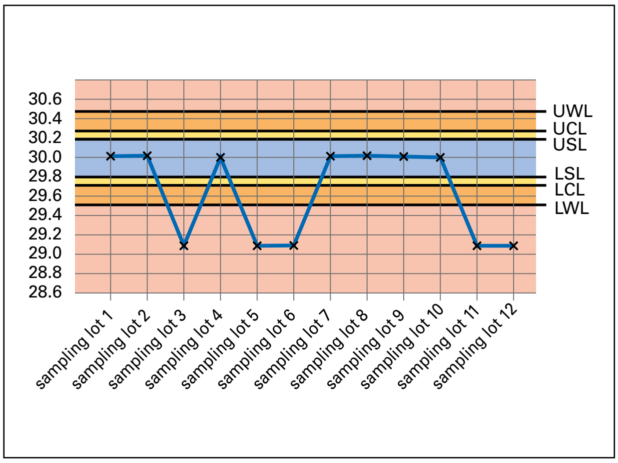
The mean diameter from each sampling lot can be taken out of the table below:

sampling lot	mean diameter
1	30.01
2	30.02
3	29.08
4	30.00
5	29.08
6	29.09
7	30.01
8	30.02
9	30.01
10	30.00
11	29.09
12	29.09

a) Draw a mean chart (see figure in text above) and label the different axis and limits.



b) Add the measured values of the table into the chart and connect them by lines.



Exercises page 25

1. Answer the following questions in English.

a) Why are two-track charts, showing two different statistical values, used in control charts?

They provide two aids to describe the same process. This increases the chance to check if the process is out of control or to mark the causes of variations.

b) When do you use a $\tilde{x}$–R-chart and when are $\bar{x}$–s-charts used? Explain!

$\tilde{x}$–R-charts are used in many industries to examine the stability of processes and can be used for manual control chart management.

$\bar{x}$–s-charts exhibits more sensitivity than the $\tilde{x}$–R-charts.

$\bar{x}$–s-charts are more complex to calculate and therefore used for computer-aided control chart management.

2. Explain three typical courses in control charts in German by using the information in the table above.

Run: 7 oder mehr aufeinander folgende Werte liegen auf einer Seite der Mittellinie.

Trend: 7 oder mehr aufeinander folgende Werte zeigen eine steigende oder fallende Tendenz.

Middle Third: Mindestens 15 Werte liegen aufeinander folgend innerhalb ± Standardabweichung s.

Test unit for Quality management

Übungseinheit zur Qualitätssicherung

1. 10-minutes quiz to check your knowledge about quality management!

a) What is meant by the expression "quality"?

b) Why is quality management essential for companies?

c) In which areas of a company is quality management necessary? Mention 3 different ones and explain.

d) What is the 1-10-100 rule? Explain.

e) Which quality tools are used in industry?

f) Explain Pareto´s principle!

g) What is the content of a tally sheet?

h) What can you do with it?

i) What is the name of a common bar chart showing the frequency of data within a certain range?

j) Which values can be calculated from this chart?

2. Your company *Metallix* produces shafts for E-bikes by turning. You recieve a raw data list of a sample of 56 different measurements of the nominal length of the shaft l = 56 mm +/–0.2 mm.

Measured value no.	Measured values in mm									
1…10	39.89	40.03	40.10	40.02	40.09	39.97	40.04	39.99	39.98	40.10
11…20	40.00	39.99	40.00	40.04	40.00	40.01	40.02	40.01	40.03	40.07
21…30	40.02	40.02	40.07	40.02	40.02	40.14	40.07	40.03	40.03	39.94
31…40	40.03	40.06	40.03	40.04	40.07	40.04	40.04	40.00	40.04	40.05
41…50	40.05	40.05	40.06	40.05	40.06	40.05	39.96	40.06	40.03	40.03
51…56	40.07	40.03	40.08	40.08	40.10	40.02				

Calculate the statistical characteristics of the data series and draw a histogram according to the calculation scheme of the adjacent form.

a) Enlarge the page on the right to DIN A4 size. To do this, use the print function in the top line of the computer keyboard, for example.

b) Calculate the statistical parameters using the formulas given and enter them in the calculation scheme.

c) Calculate the characteristic values for creating a histogram.

d) Create the data collection list (tally sheet).

e) Draw the histogram in the form.

Evaluation form

evaluation: sample:	part no: 1234567	measuring scope: $n = 56$	characteristics: length l	inspected dimension: 40 ± 0,2 mm		measuring device: digital micrometer	responsible employee: LR	date:

Measured value no.	Measured values in mm									
1…10	39.89	40.03	40.10	40.02	40.09	39.97	40.04	39.99	39.98	40.10
11…20	40.00	39.99	40.00	40.04	40.00	40.01	40.02	40.01	40.03	40.07
21…30	40.02	40.02	40.07	40.02	40.02	40.14	40.07	40.03	40.03	39.94
31…40	40.03	40.06	40.03	40.04	40.07	40.04	40.04	40.00	40.04	40.05
41…50	40.05	40.05	40.06	40.05	40.06	40.05	39.96	40.06	40.03	40.03
51…56	40.07	40.03	40.08	40.08	40.10	40.02				

Data and calculations

nominal value	***N*** =	
upper shaft tolerance	***Ao*** =	
lower shaft tolerance	***Au*** =	
tolerance	***T*** =	
shaft maximal dimension	G_{US} =	
shaft minimum dimension	G_{IS} =	
centre of tolerance	***M*** =	

Statistical characteristics

number of measured values	***n*** =	

Limit values

maximum value	x_{max} =	
minimum value	x_{min} =	

Range of variance $R = x_{max} - x_{min}$

range	***R*** =	

Median value

median value	$\tilde{x}$ =	

Mean value

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \dots x_n}{n}$$

mean value	$\bar{x}$ =	

Creating a histogram:

Calculations

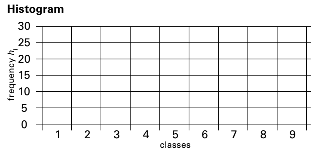
$k = \sqrt{n}$; $b = \frac{R}{k}$; $x_W = \frac{n_c}{n}$

number of classes:	***k*** ≈		rounded:	
class interval:	***b*** ≈		rounded:	
frequency of a class interval:	x_w			

Tally sheet $h_j = \frac{n_j}{n}$

class no.	measured value ≥	measured value ≤	tally list	n_j	h_j in %
1					
2					
3					
4					
5					
6					
7					
8					
9					

Histogram



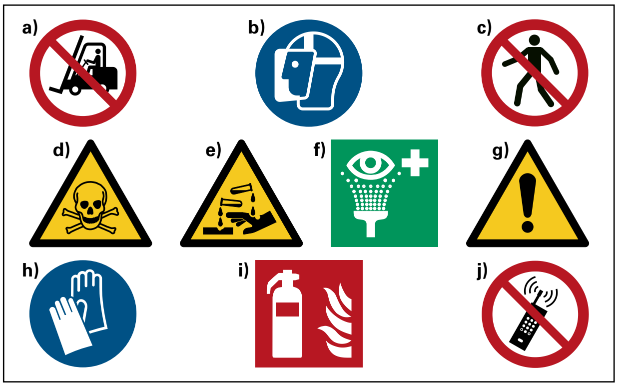
3 Production engineering

3.1 Safety at work

Exercises page 26

1. Translate the descriptions.

Then match it to the signs, e. g. 1 → h. (Use your *Metal Trades Handbook* if necessary)



(1) Wear protective gloves
Handschutz benutzen → h

(2) Eye rinsing equipment
Augenspüleinrichtung → f

(3) Fire extinguisher
Feuerlöscher → i

(4) Warning: Hazardous area
Achtung: Gefahrenbereich → g

(5) No cell phones
Keine Mobiltelefone → j

(6) Warning: Corrosive substances
Achtung: Ätzende Substanzen → e

(7) Wear face protection
Gesichtsschutz tragen → b

(8) Pedestrian access prohibited
Zutritt für Fußgänger verboten → c

(9) No forklifts
Keine Gabelstapler/Flurförderfahrzeuge → a

(10) Warning: Toxic substances
Achtung: Giftige Substanzen → d

2. Complete the table and describe the safety signs. Give one example of each category.

Safety sign	Geometrical form	Colour	Meaning	Example
Mandatory sign	round/circular	blue/white	You must wear the item.	Wear gloves
Prohibitive sign	round/circular	red/white/black	It is forbidden to...	No forklifts
Warning sign	triangular	yellow/black	Warning: ...	Warning: Corrosive substances
Escape and rescue sign	square or rectangular	green/white	Escape route or rescue equipment	Eye rinsing equipment