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Operating instructions

CE The unit complies with the corresponding EU guidelines

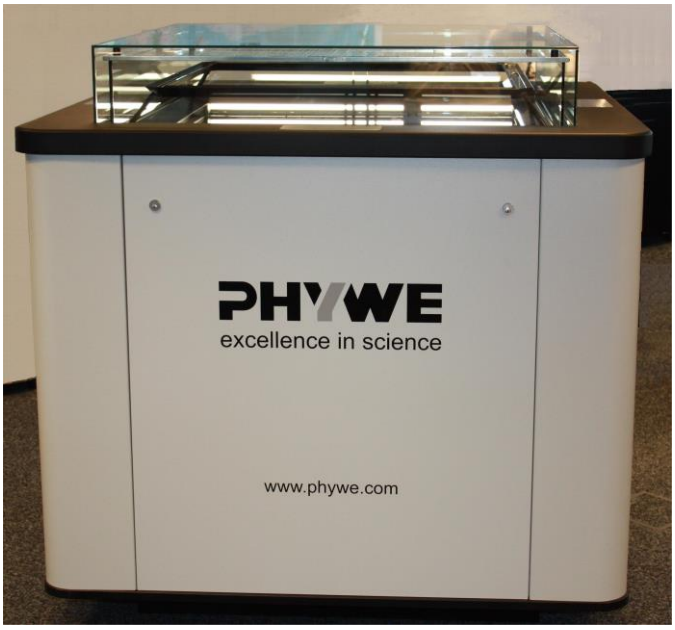


Fig. 1: Diffusion Cloud Chamber PJ 80, 09043-93.

TABLE OF CONTENTS

1 SAFETY PRECAUTIONS

Attention!

- Carefully read these operating instructions completely before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.
- Only use the instrument for the purpose for which it was designed.
- Check that your mains supply voltage corresponds to that given on the type plate fixed to the instrument.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Do not start up the instrument when there is visible damage to it or when it leaks.
- Do not cover or block the chamber base as there would then be an insufficient passage of fresh air into it.
- Only use an extension cable or a multiple socket when absolutely necessary.
- Wait at least 2 hours before putting the cloud chamber into operation to check that no faults have occurred to the refrigeration system during transport.
- Always unplug the mains plug before carrying out cleaning or maintenance work.

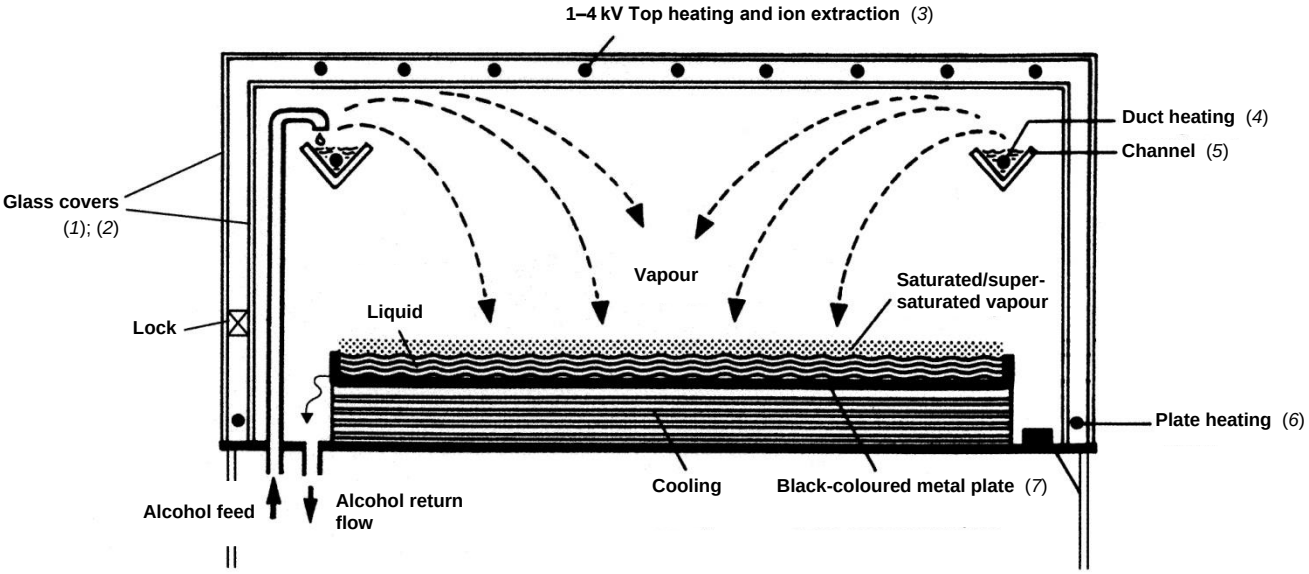


Fig. 2: Diffusion cloud chamber (cutaway view).

2 DESCRIPTION OF THE DIFFUSION CLOUD CHAMBER

The body of the instrument is encased by lacquered metal sheets. The observation chamber that is positioned on top of it consists of two glass covers (*1*) and (*2*) placed one over the other. A heating grid at the top of the inner glass cover serves both as top heating (*3*) and as a high-voltage grid (ion extraction). With this construction, the high-voltage is outside of the chamber that is filled with alcohol vapour, so that the possibility of deflagration is eliminated.

The alcohol channel (*5*) can also be clearly seen under the glass covers. The alcohol that is evaporated here by an electric heater (duct heating) (*4*) is continually replaced by a small pump. A quadratic, black-coloured anodized metal plate (*7*) is the actual observation plate. Beneath this aluminium plate there is a thick-walled brass plate with a copper tube spiral that is cast-in in tin, which serves as evaporator for the refrigeration unit installed in the lower part of the body.

To open any one of the 4 body covers, first unlock the lock of it then unhook the safety chain and lift the cover up and outwards. Do this to take off the front body cover (Fig. 3). The instrument panel (*10*) with the operating elements can now be seen. The electrical equipment is situated behind this instrument panel. The alcohol reservoir (*12*) stands on the bottom of the compartment, the membrane pump for the pumping of alcohol (*13*) is higher up to the left of it and a housing that holds three automatic fuses (*11*) is higher up to the right of it.

Four large Allen screws (*15*) in the bottom plate of the body serve for lifting the diffusion cloud chamber up and levelling it.

Replace the front body cover, hook the safety chain back on and lock the cover.

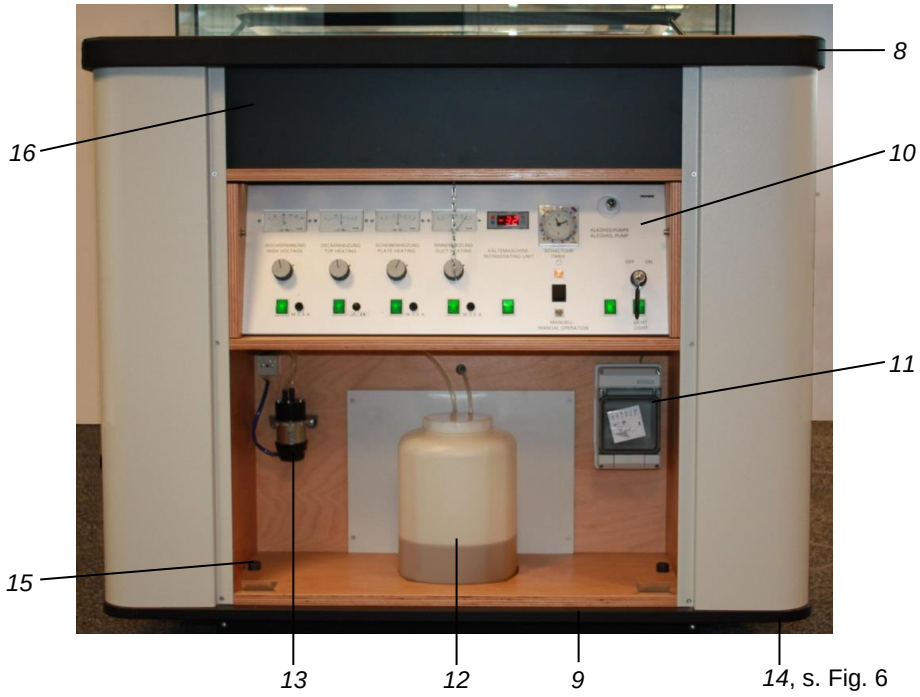
Now open the back body cover (Fig. 4) to gain access to the refrigeration unit. This is contained in a further closed housing made of wood for sound proofing. The main switch (*19*) of the instrument is on the left outer wall. The electrical socket (*18*) below it is directly connected to current, so that the hand-held lamp (230 V) that is supplied can be used even with the instrument switched off. The cover frame (*8*) can be removed by undoing the star knobs (*14*) when the fluorescent lamps (*16*) are to be replaced.

3 FUNCTIONALITY OF THE CHAMBER

A logarithmic temperature gradient is built up between the only slightly heated cover and the strongly cooled bottom of the observation chamber, so that alcohol vapour falls in the top to bottom direction (settling velocity approx: 1–5 mm/s), whereby a horizontal supersaturated area is formed at an approximate height of from 1 mm to 20 mm above the bottom plate. In this supersaturated area, condensation nuclei that are created along their paths of alpha particles, protons, beta particles etc. by their ionizing effect result in their tracks being made visible by the appearance of condensed vapour trails. After their creation, these trails fall at about the same rate as the settling velocity of the alcohol vapour. The strength of each of these trails is a measure of the specific ionization of the particular particle or the radiation quantum that caused it.

The light that is incident all around the cooled observation plate makes the trails clearly visible, so that they can also be photographed against the dark background of the bottom of the chamber. If the trails are very weak after switching on and correct adjustment of the voltage of the high-voltage system, this generally indicates an insufficient supply of vapour. Increase the supply by carefully increasing the duct heating.

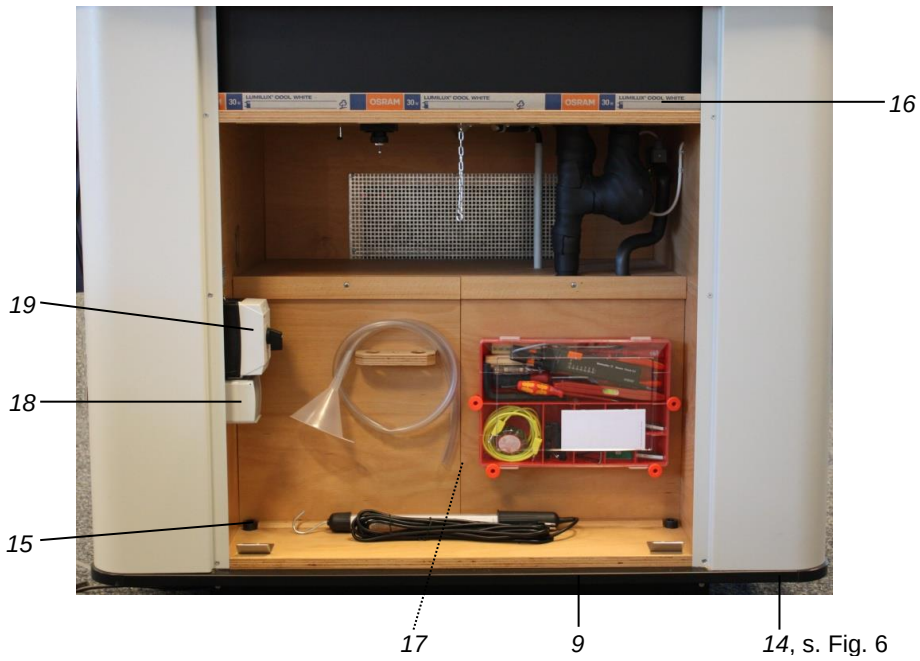
The average values of all settings are given on the plate adhered to the instrument panel.



FRONT VIEW WITHOUT BODY COVER

8 Cover frame
9 Skirting
10 Instrument panel
11 Automatic fuses
12 Alcohol reservoir
13 Alcohol pump
14 Star knob for cover frame
15 Allen screws for base
16 Fluorescent lamp (located behind cover plate)

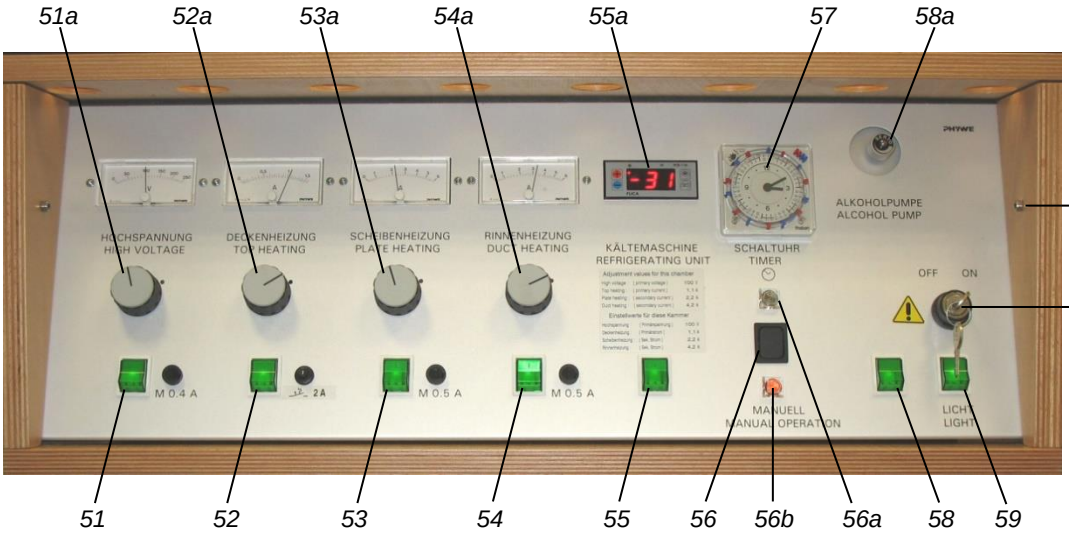
Fig. 3: Front view of the diffusion cloud chamber without body cover.



REAR VIEW WITHOUT BODY COVER

9 Skirting
14 Star knob for cover frame
15 Allen screws for base
16 Replacement refrigerating unit
17 Refrigerating unit (not visible behind wooden cover)
18 Electrical socket
19 Main switch

Fig. 4: Rear view of the diffusion cloud chamber without body cover.



INSTRUMENT PANEL

51 Switch for high voltage
51a Turning knob for high voltage
52 Switch for top heating
52a Turning knob for tip heating
53 Switch for plate heating
53a Turning knob for plate heating
54 Switch for duct heating
54a Turning knob or duct heating
55 Switch for refrigerating unit
55a Thermostat
56 Tumbler switch for timer and manual operation
56a Control lamp (timer)
56b Control lamp (manual operation)
57 Timer
58 Switch for alcohol pump
58a Regulation for alcohol
59 Switch for illumination
60 Key switch
61 Allen screw for clamping the instrument panel (needed for drawing out the instrument panel)

Fig. 5: Instrument panel of the diffusion cloud chamber 09043-93.

4 TRANSPORTATION OF THE INSTRUMENT

It is vital to ensure the cloud chamber is not tilted during transport (<10° from the vertical) as otherwise the refrigeration unit will be irreparably damaged.

5 SET-UP OF THE INSTRUMENT

If possible, install the chamber in a room darkened to a great extent or one that can be darkened. The floor on which it is to stand must have an appropriate load-bearing capacity and must be so stable that the chamber is not subject to vibrations (concrete and carpet). Take off the skirting (*9*) and push the instrument to the planned site on the free-standing swivel castors (*20*, Fig. 6). Turn the adjustable levelling Allen screws (*15*, Fig. 3) to lift the instrument and, using the spirit level supplied, bring it to the horizontal position.

To ensure a sufficient supply of fresh air, do not cover up the skirting.

An additional fan is installed in the housing of the cloud chamber to dissipate heat. The temperature inside the cloud chamber is set to the target value of 27.5°C via a thermostat. The fan speed is set to 70% ex works and can be adjusted as required.

As delivered, the **mains lead** of the cloud chamber is under its right hand side part.

To reach it, remove the body side cover, then lead the connection cord that is now accessible through the lower vent slot and out.

Subsequently replace the body side cover, hook the safety chain on and lock the cover.

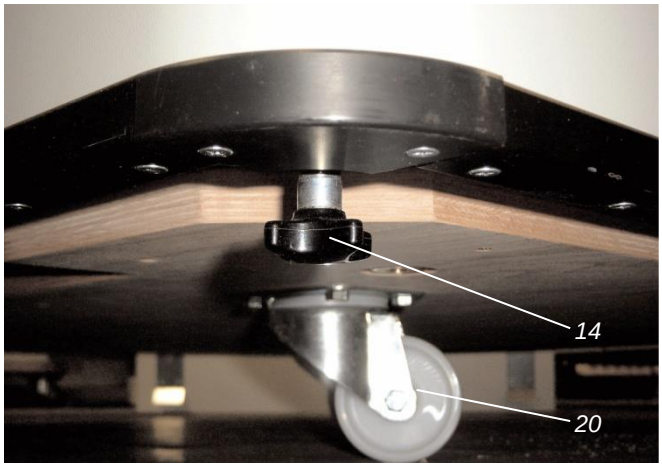


Fig. 6: View on the bottom side of the cloud chamber corner (without skirting).

6 PUTTING INTO OPERATION

1. Ensure that the alcohol reservoir (*12*) is filled with sufficient (min. 3 litres) isopropyl alcohol, PHYWE art. no. 30092-70. The alcohol must have a high level of purity (99% minimum). Observe section “8 Handling instructions for isopropyl” when doing so. Fill isopropyl alcohol into the alcohol reservoir using the funnel plus tube that is supplied. Close the isopropyl alcohol reservoir.
2. Now switch the cloud chamber on at the main switch (*19,* Fig. 4, left outer wall), operate the key-operated switch (*60*) and switch the two-way switch (*56*) to "down". Indicator lamp “manual operation” (*56b*) lights up.
3. Switch on all rocker-actuated switches (*51*, *52*, *53*, *54*, *55*, *58* and *59*), see Fig. 5.
4. Open the alcohol dosing valve (*58a*) by about 2 turns. There is now a strong flow of alcohol through the filling tube into the alcohol channel (*5*, Fig. 2). When this channel is filled to about half way up, close the regulating valve so far that the flow from the filling tube into the channel is about 3–4 drops per second. Excess alcohol automatically flows off, so that the channel cannot overflow.
5. Compare the values displayed by the instrument with the factory setting values on the adhered plate and correct them with the corresponding adjusting knobs if appropriate.
6. The chamber should be fully functional after about 45 minutes.
7. When the chamber is to be turned off, it is sufficient to switch it off at the key-operated switch, so that the top heating (*3*, Fig. 2) and the plate heating (*6*) remain switched on (max. 200 Watt). (*Caution*: When the chamber is turned off with the key-operated switch, the cover heating and the glass pane heating must remain switched on to avoid unwanted condensation of alcohol on the inner glass cover. Because of this, do not separate the chamber from the mains supply). Simply use the key-operated switch to put the system back into operation.
8. Operation using the timer:
   Set the timer (*57*, Fig. 5) to the wanted switching symbol (see the enclosed operating instructions from the manufacturer of the timer) and switch the rocker-actuated switch (*56*) to “up”. The indicator lamp (timer) lights up. The key-operated switch must always remain switched on when the timer is in use (the key can be removed).
   Should a power failure occur, the timer has reserve power for about 1 week (see the enclosed operating instructions).

7 MAINTENANCE AND CARE

Seen from the outside, the construction of the machine-cooled Diffusion Cloud Chamber is simple, clear and sturdy. Despite this, it is a highly sensitive thermodynamic system that has been finely tuned in long-time tests over many weeks prior to transfer to the customer and whose individual functional parts and their interaction are the result of many years of technological development and experience.

Because of this, interventions, changes and repairs to the instrument are only to be carried out by qualified skilled personnel.

In the case of any refrigeration unit fault that occurs in Germany, please contact the RAPO company at 37081 Goettingen, Koenigsstieg 104 (Tel.: +49 (0) 551–64 44 2) to be informed on the particular service station responsible for your area (otherwise, see “9 Technical Data”).

A reduced cooling performance of the refrigerating unit could result when an insufficient amount of fresh air is supplied. In the case of such an insufficiency, check if this is because the skirting (*9*) of the chamber has been blocked. Also ensure that the cooling fins of the heat exchanger and the air filter are cleaned monthly using a vacuum cleaner or a brush. Replace the air filter if it is very dirty (Fig. 7, PHYWE art. no. 09043-53).

Fig. 7: Air filter for diffusion cloud chamber 09043-53.

The cooling fins can be cleaned after removal of the left body cover.

The temperature inside the chamber should not exceed 40 °C when there is a sufficient supply of fresh air.

The replacement of fluorescent lamps (*16*) can be easily carried out after removal of the cover frame (*8*, Fig. 3). To do this, undo the 4 star knobs (*14*, Fig. 6). After taking the cover frame off and undoing the knurled thumb screws, take out the black-lacquered covering sheet. The fluorescent lamps are now freely accessible. Only carry out this work when the chamber is without current (**unplug the mains plug**).

If there is a fault in the electrics, the instrument panel (*10*) can be drawn out by about 30 cm, but before doing this, interrupt the supply of power to the chamber (**unplug the mains plug**) and screw out the Allen screws (*61*, Fig. 5) to take the side covers off.

From time to time, it is recommended to also clean the outer glass cover. This can be done with any type of commercially available glass cleaner.

Attention!

Prior to removing the glass cover for cleaning, disconnect the chamber from the mains power supply **(unplug the mains power plug)**.

Cleaning the outer cover (*1*, Fig. 2):
After removing the cover frame (*8*), the outer glass cover can be lifted off for cleaning.

Only employees of PHYWE Systeme GmbH & Co. KG are authorised to perform the following task:

Cleaning the inner cover (2, Fig. 2):
After removing the cover frame, unscrew the 2 connecting leads to the lower hood before lifting off the inner cover by hand. If the colour of the black-anodized observation plate should have unfavourably changed after many years, it can be simply removed and replaced by a new one after opening the glass chamber and screwing out the 9 small countersunk screws.

8 HANDLING INSTRUCTIONS FOR ISOPROPYL ALCOHOL

The handling of isopropyl alcohol (2-Propanol, Isopropanol, Propan-2-ol) is subject to the same hazard control rules that also apply to the handling of other chemicals, reagents, and dye solutions. It is clear that these types of substances must be handled with great caution and care so that neither the students and teachers nor other persons are exposed to unnecessary health hazards.
This is why the instructions on the relevant safety data sheets (in accordance with the REACH Regulation (EC) No 1907/2006) in their latest edition, the applicable accident prevention regulations, and workplace-related operating instructions must be complied with when handling isopropyl alcohol.
Some of the most important handling rules and general rules of conduct are stated below without any claim to completeness:

Isopropyl alcohol is a clear, highly flammable, and slightly oily liquid with an odour that is reminiscent of a mixture of ethanol and acetone. It is readily mixable with water and most organic solvents. Isopropyl alcohol vapours can form explosive mixtures with air.

Signal word
DANGER

Hazard information
H225: Highly flammable liquid and vapour.
H319: Causes serious eye irritation.
H336: May cause drowsiness or dizziness.

Safety information
P210: Keep away from heat/sparks/open flames/hot surfaces. No smoking.
P233: Keep container tightly closed.
P305 + P351 + P338:
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P501: Dispose of contents/container to a recognised waste management facility.

First aid
If inhaled:
Fresh air. If you feel unwell, seek medical advice.
After skin contact:
Rinse with plenty of water. Take off all contaminated clothing.
After contact with the eyes:
Rinse the eyes with the lid gap wide open (10 minutes minimum). Consult an ophthalmologist.
If swallowed:
Make the victim drink plenty of water; avoid vomiting (risk of perforation!). Seek medical advice immediately. In the case of spontaneous vomiting, risk of aspiration. Respiratory failure possible.

Disposal
Recommendation:
Must not be disposed of with normal household waste. Do not empty into drains.
Liquid residues must be recycled or taken to a suitable waste incineration plant.
Chemicals must be disposed of in compliance with the respective national regulations. You can find country- and substance-specific information and contact data at www.retrologistik.de.
Uncleaned packaging:
Recommendation: To be disposed of in accordance with the official local regulations.

9 TECHNICAL DATA

The unit is a class I unit and it may only be connected to power sockets with a protective earth conductor (PE).

Connecting voltage (+6 %/−10 %)	see type plate

The series transformer that is supplied enables the cloud chamber to be operated by a line voltage from 100 V AC to 200 V AC.

Mains connection	230 V plug with earthing contact Special voltages with series transformer are supplied without connecting plug (matching to the local supply network under observation of the valid local regulations).
Mains frequency	50/60 Hz
Power consumption	approx. 2.0 kV A Caution: The power consumption may be exceeded by about 20 % during the starting up phase (approx. 15 min after switching on).
Protection	Quick-brake cut-outs and blow-out fuses in the primary circuit
Mains fusing at the installation site	230 V, 16 A 100–115 V, 20 A
Quick-brake cut-outs K-characteristic	

Dimensions	Height 126 cm Outer dimensions 128 cm × 128 cm Skirting height approx. 10 cm The skirting (*9*) is removable. When it is removed, the instrument can be moved on its swivel castors (*20*). Chamber base (Observation plate) 80 cm × 80 cm Fully transparent chamber: Upper hood Side area 17 cm × 100 cm Glass thickness 6 mm
Weight	approx. 450 kg

Attention!

The installation site surface must have sufficient load-bearing capacity (check prior to installation).

Refrigerant	R 404 A, CFC-free
Alcohol circulation	Membrane pump (*13*) 12 V Alcohol reservoir (*12*) 10 L
Alcohol filling	Isopropyl alcohol, 1000 ml, extra pure, Art. no. 30092-70
Heating	Duct heating (*4*) max. 6 A at 17 V Top heating (*3*) max. 20 A at 17 V Plate heating (*6*) max. 5 A at 17 V
High voltage supply (*51*)	0–230 V AC at the monitoring device = 0–7 kV at the grid (pos.)

The cover heater is simultaneously used as a high-voltage grid (ion extraction)!

Fluorescent lamps (*16*) TLD 30/84 „white“

The instrument is fully functional after 45 minutes.

The values for optimal setting of the chamber are given on this adhesive label. It takes about 25 minutes before changes to them come into effect.

Adhesive label

10 ACCESSORIES

- Isopropyl alcohol, extra pure, 1000 ml 30092-70

As replacement:

- Air filter for the diffusion cloud chamber PJ 80 09043-53

11 WASTE DISPOSAL

The packaging consists predominately of environmentally compatible materials that can be passed on for disposal by the local recycling service.

Should you no longer require this product, do not dispose of it with the household refuse.
Please return it to the address below for proper waste disposal.

PHYWE Systeme GmbH & Co. KG
Customer Service
Robert-Bosch-Breite 10
D–37079 Goettingen
Germany

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Fax +49 (0) 551 604-246

12 POSSIBLE FAULTS

Fault message	Possible cause	Remedy
Cloud chamber does not start	No current	Switch current on.
	Main switch off	Switch main switch on.
	Time switch off	Set the time switch or switch to "Manual".
	Key-operated switch off	Switch key-operated switch on.
	Defective fuse	Switch fuse on / replace it. On renewed switch-off, call skilled personnel or Service.
	After a longer downtime of the diffusion cloud chamber, the alcohol pump does not pump anymore	Check the filter of the extraction probe immersed to the alcohol reservoir (*12*, Fig. 3) for contamination and clean it if necessary. Remove the extraction probe from the alcohol reservoir. Take a disposable syringe, fill it with clean isopropyl alcohol, and connect it to the suction side of the extraction probe via a hose. Use the alcohol regulation (*58a*, Fig. 5) to set the pump to maximum. With the aid of the disposable syringe, squeeze the isopropyl alcohol under moderate pressure into the line. The liquid should ascend visibly to the pump. In case of any troubles during the filling, abort the process! Do not excessively increase the pressure with the disposable syringe; otherwise the hoses will get leaky. As soon as the pump starts to suck, and the isopropyl alcohol reaches the outlet in the chamber, turn the alcohol control (*58a*) to minimum. Remove the disposable syringe and reinsert the extraction probe in the tank. Afterwards, the alcohol control (*58a*) can be set to the regular dripping speed.
No tracks or no cloud can be seen	No isopropyl alcohol in the alcohol channel	Open alcohol valve, fill channel, throttle flow to regular drops.
	There is isopropyl alcohol in the alcohol chamber	Check duct heating. Check cooling (approx. −32 °C).
Blurred traces	No high-voltage	Check high-voltage; switch on set regulator to 100 V, check fuse. On renewed switch-off, call skilled personnel or Service.
Loud noises from the membrane pump (rapid clacking)	No isopropyl alcohol in the alcohol reservoir	Fill isopropyl alcohol in alcohol using funnel plus tube, min. 3 L to max. 10 L. See "8 Handling instructions for isopropyl alcohol".
Cooling stays on for a very long time or constantly	Room temperature too high	Let fresh air in.
	Air inlet blocked	Clean vents. See instructions. If these measures do not lead to normal running of the chamber, call refrigerating engineer / air conditioning engineer. See instructions.

Excessive consumption of isopropyl alcohol	Chamber leakage	Check gasket under the lower hood. The stopper must be in the lock passage. Check chamber for outflow of isopropyl alcohol. If isopropyl alcohol soaks the wooden parts, hoses leak or drops are to be seen, put the cloud chamber out of operation. Emerging isopropyl alcohol is a fire hazard. See "8 Handling instructions for isopropyl alcohol". If sealing problems cannot be eliminated, do not further operate the cloud chamber. The wooden body will be destroyed and there is an increased risk of fire. The cloud chamber must be repaired by skilled personnel or by Service.