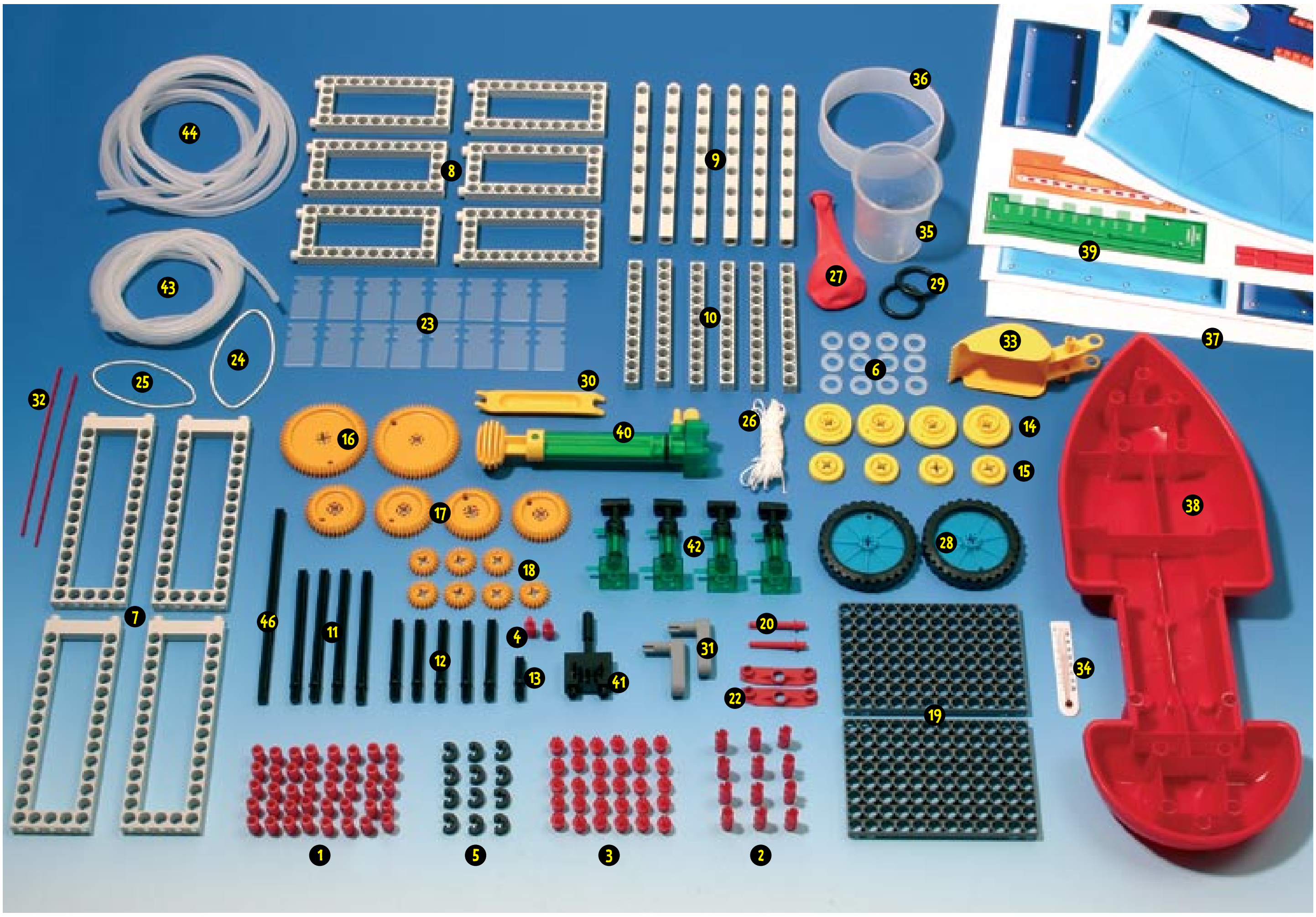
Thames & Kosmos

PHYSICS pro

Experiment Manual

Kit Contents



No.	Name	Qty.	Part. No.
1	Anchor pin	40	702527
2	Joint pin	12	702524
3	Shaft plug	30	702525
4	Shaft pin	2	702526
5	Axle lock	12	702813
6	Washer	12	703242
7	Long frame	4	703239
8	Short frame	6	703232
9	Long rod	6	703235
10	Short rod	6	703233
11	Long axle	4	703234
12	Medium axle	5	703238
13	Short axle	1	703236
14	Medium pulley wheel	4	702518
15	Small pulley wheel	4	702519
16	Large gear wheel (60 teeth)	2	702506
17	Medium gear wheel (40 teeth)	4	702505
18	Small gear wheel (20 teeth)	7	702504
19	Base plate	2	703237
20	Crankshaft	2	702599
22	Connector bridge	2	703231
23	Turbine blade	16	702815
24	Rubber band (long)	1	703241

No.	Name	Qty.	Part. No.
25	Rubber band (medium)	1	703374
26	Cotton cord (white)	1	703244
27	Balloon	1	703531
28	Wheel	2	703230
29	Tire ring (medium pulley wheel)	2	703251
30	Anchor pin lever	1	702590
31	Crank	2	703377
32	Straw (red)	2	703513
33	Digging shovel	1	703514
34	Thermometer	1	702280
35	Measuring cup	1	703532
36	Plastic strip for clockwork motor	1	703240
37	Film for cutouts	1	703380
38	Boat hull	1	703519
39	Die-cut cardboard sheet	1	703522
40	Hydraulic pump	1	703515
41	Hydraulic switch	1	703516
42	Hydraulic cylinder	4	703378
43	Narrow tubing	1	703500
44	Thick tubing	1	703511
45	Experiment book	1	703510
46	XL (extra long) axle	1	703518

You will need these components:

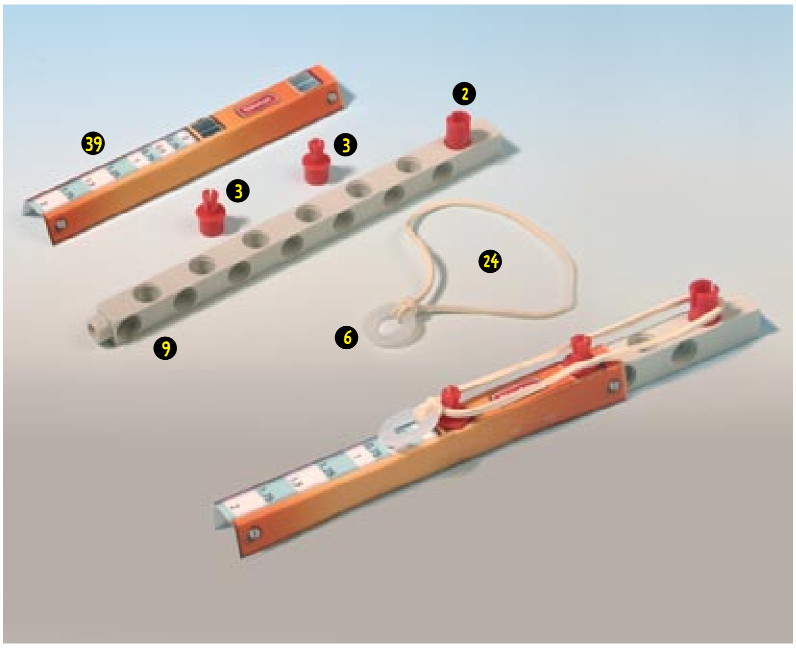
1 joint pin	2
2 shaft plugs	3
1 washer	6
1 long rod	9
1 rubber band	24
1 cutout sheet	39

Your force meter can measure the weight that pulls on the bottle. Thus, it functions as a scale.

WORKSHOP

Force Meter (0 to 2 N)

The force meter measures forces between 0 and 2 N. Pull on the washer and read the value on the scale. This will let you get a feel for the Newton unit of measure.



It is difficult to imagine that air weighs anything at all. But it can actually rip up trees when it is moved in a strong storm, so here is a demonstration that air does in fact have weight:

4 Invisible Yet Weighty

Weighing Air

You will need: 4 anchor pins 1 , 2 shaft plugs 3 , 1 axle lock 5 , 4 long rods 9, 1 short rod 1, 2 medium axles 12, 1 base plate 19, cord (20 cm) 26, 1 balloon 27

Assemble the scale. Wrap the end of the cord around the neck of the deflated balloon using a simple knot, but do not tie it tight yet. Tie the other end of the cord to the end of the scale arm (see picture). Establish a balance with a few counterweights (e.g. 1 axle, 1 shaft plug). Now fully inflate the balloon and pull the knot tight. The air is captured inside, and the scale arm with the balloon drops.

The densities of selected solid and liquid substances in kg/dm³

Fir tree wood	0.4 – 0.7
Gasoline	0.75
Water	1.0
Nylon	1.1
Sand (damp)	2.0
Aluminum	2.7
Iron	7.5
Gold	19.3

Densities of selected gaseous substances in kg/m³

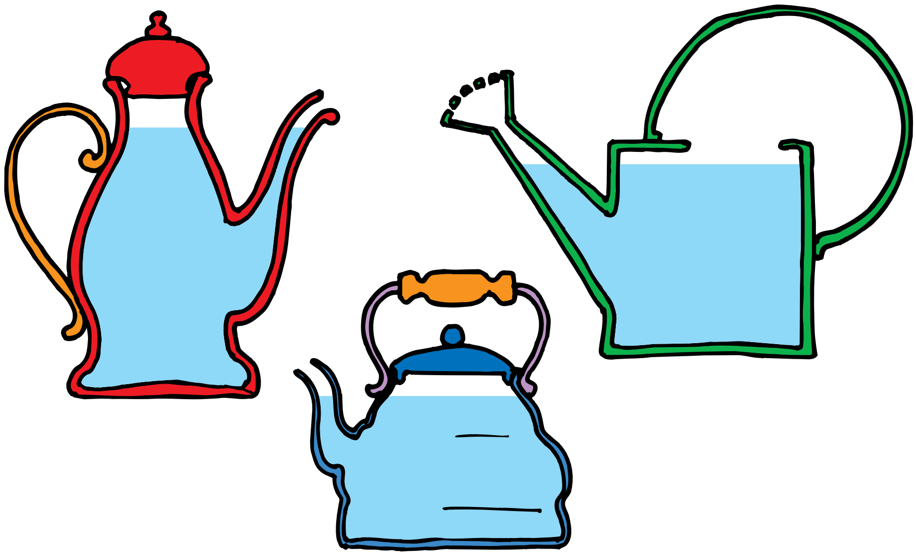
Hydrogen	0.09
Air	1.23
Oxygen	1.4
Nitrogen	1.25

The weight of air

4. Gravity Helps Water Tip the Scales

We will now be dealing with a property that air and water share with all bodies. They both obey the force of gravity and are attracted by the Earth. Of course, they do it in different ways. As explained above, a gas completely fills the container it is in, so it changes its volume correspondingly. It can be made "thicker" or "thinner." Liquid water also adjusts to its surrounding container. But it retains its volume, filling only as much space as its volume requires. Because gravity pulls water straight down, water fills the container in such a way that it comes closest to the center of the Earth. In the process, its surface, or water level, forms a horizontal plane. That is the case even if it doesn't have a continuous surface, as long as all parts of its volume are connected to one another.

Let's do an experiment:



In interconnected containers such as coffee pots, teapots, or watering cans, the surface of the liquid is always at one level.

Under the influence of gravity, the surface of a resting liquid always orients itself horizontally (at the same level). In **communicating vessels** (containers with different parts connected to each other), the surface of a liquid is always at one single level.

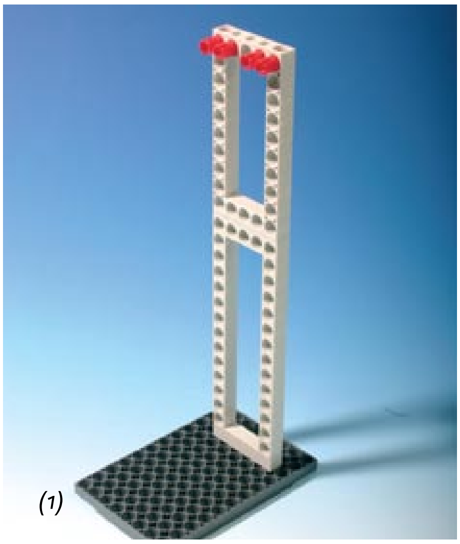
5 Everything on the Scale

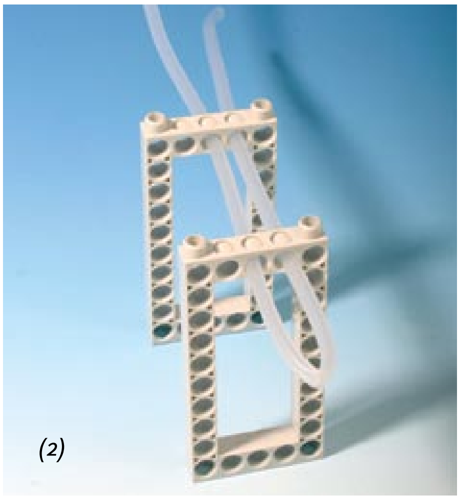
Water in Communicating Tubes

You will need: 4 joint pins 2, 1 large frame 7, 3 small frames 8, 1 base plate 19, 1 measuring cup 35, 1 section of the thicker tubing (about 60 cm) 35, water

Guide the tube through the holes of the framework. Loosen one end of the tube from its clamp and place it into a measuring cup filled with clean water. Using your mouth on the other end of the tube, suck water from the measuring cup until the water level in the tubing stands about halfway between the two horizontal frame sections. If you suck up too much water, blow some carefully back. Be sure that no air bubbles form in the tube — all the water must be connected without any interruptions. Clamp the loose end of the tube back into position, and watch the water level. Tilt the framework to the left or right and watch what happens.

You will see that on both sides of the tube, the water is at the same level, regardless of how the framework may be tilted. You will notice that the water has a cupped, concave surface, not a flat one, because it clings to the side walls of the tube. (You will learn more about this in the next chapter.) The principle of communicating vessels is also used with the water level in our next Workshop, which you can easily build yourself.





Assemble the framework, and secure the tube with the water to it

Backhoe

Most excavators work with a hydraulic mechanism. It comprises a motor pump (which produces the operating power) and hoses that transfer the power, along with operating cylinders that amplify the force.

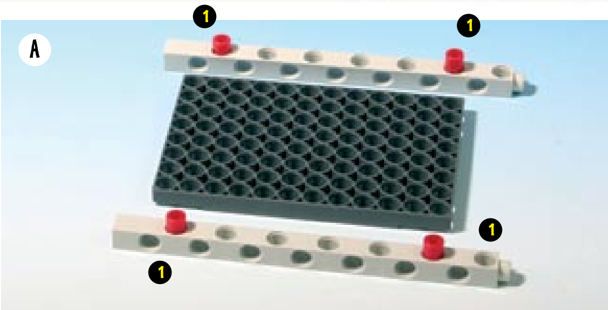
The backhoe driver controls the movement direction of the pistons and the movement of the shovel and shovel arm by way of control valves. The hydraulic fluid used is a special oil that coats the mechanism and only freezes at very low temperatures. In our model, the two rear cylinders work as a pump. The force for the pump is produced at the hand levers. They are also used to control the direction of movement of the pistons in the cylinders.

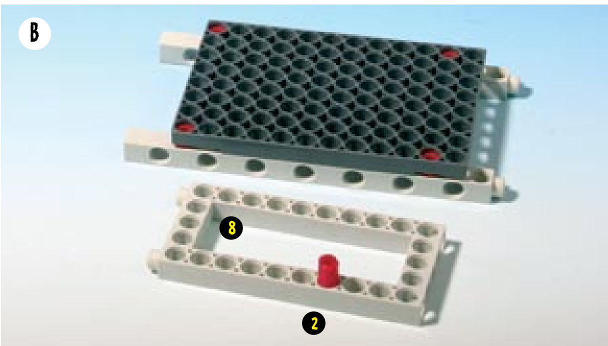
Read Chapter 10.

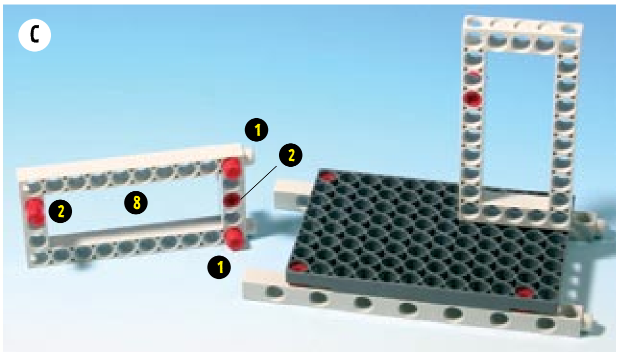
You will need these components:

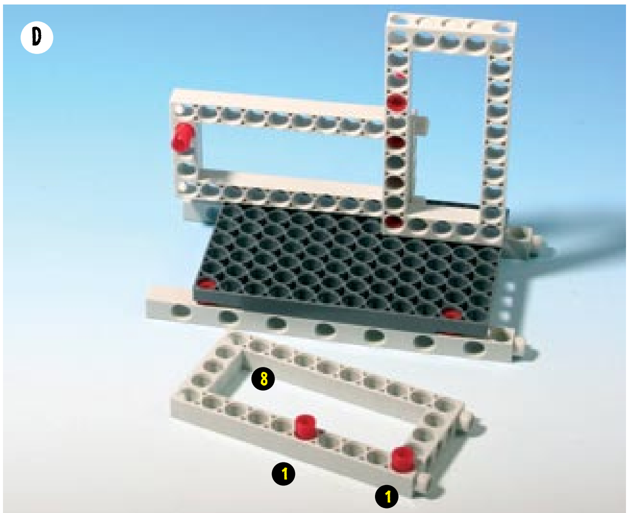
8 anchor pins	1
12 joint pins	2
3 axle locks	5
1 washer	6
4 small frames	8
2 long rods	9
4 short rods	10
2 long axles	11
3 medium axles	12
2 medium pulley wheels	14
1 base plate	19
2 wheels	28
2 tires for medium pulley wheels	29
1 XL (extra long) axle	46
1 backhoe shovel	33
4 hydraulic cylinders	42
4 sections of narrow tubing	43

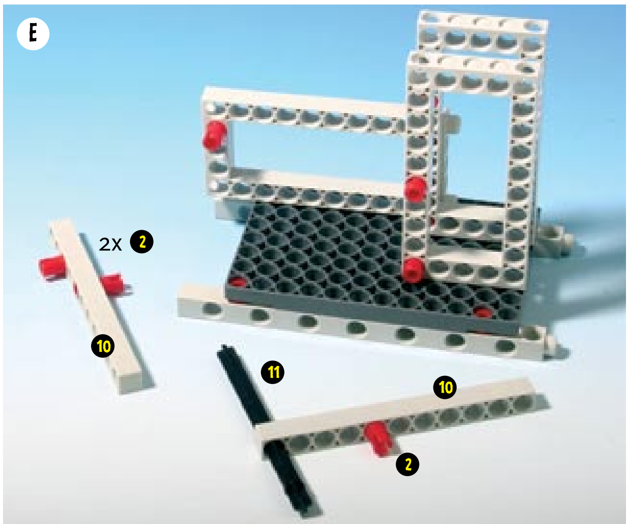
WORKSHOP

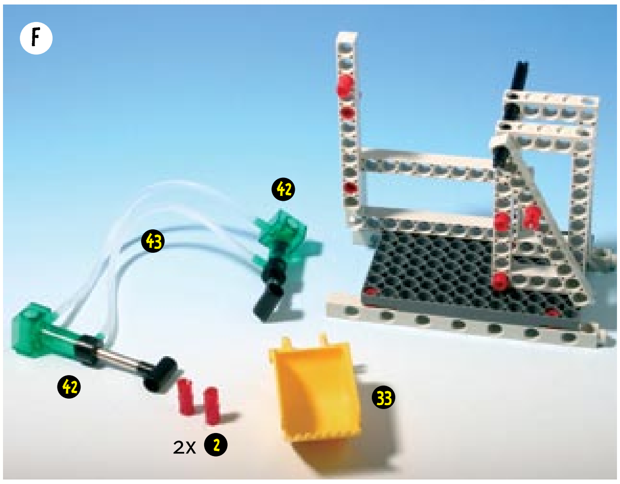


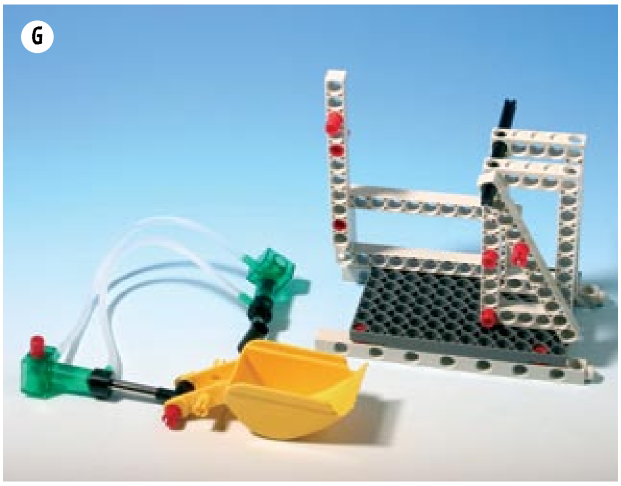












Be sure that there is only water and no air in the two hydraulic cylinders and in the tubes. See pages 9 and 10 for how to remove air from cylinders and tubing.