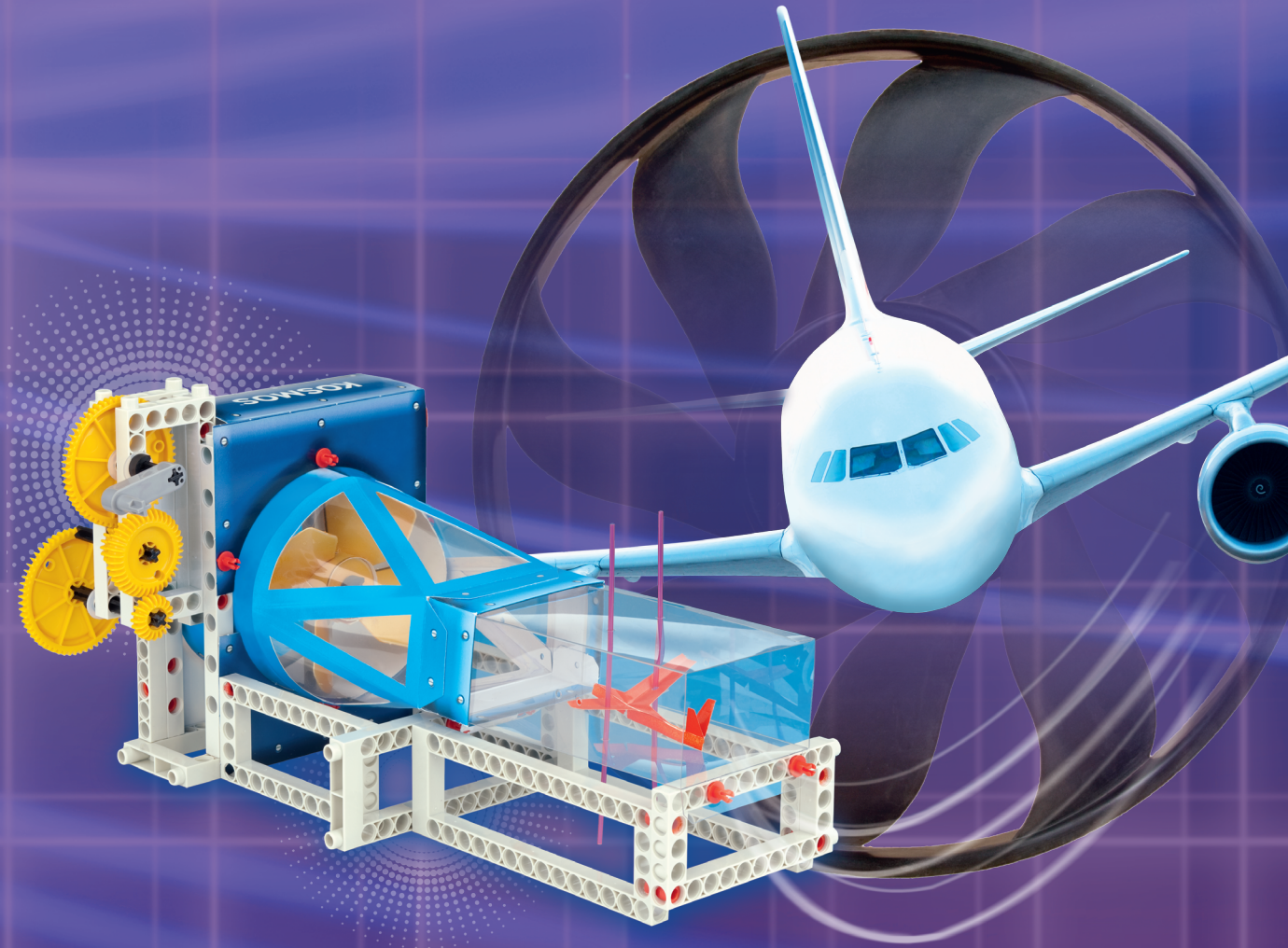
EXPERIMENT MANUAL

PHYSICS pro



THAMES & KOSMOS

WARNING — Science Education Set. This set contains chemicals and/or parts that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

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KIT CONTENTS

GOOD TO KNOW! If you are missing any parts, please contact Thames & Kosmos customer service. Any materials not included in the kit are indicated in *italic script* under the "You will need" heading.

✔	No.	Description	Count	Item 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	Baseplate	2	703237
❍	20	Crankshaft	2	702599
❍	21	XL (extra long) axle	1	703518
❍	22	Connector bridge	2	703231
❍	23	Turbine blade	16	702815

✔	No.	Description	Count	Item No.
❍	24	Rubber band (long)	1	703241
❍	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 (Part separator tool)	1	702590
❍	31	Crank	2	703377
❍	32	Straw (red)	2	703513
❍	33	Digging shovel	1	703514
❍	34	Experiment book (not shown)	1	703510
❍	35	Measuring cup	1	703532
❍	36	Plastic strip for spring motor	1	703240
❍	37	Film for cutouts	1	703380
❍	38	Boat hull	1	703519
❍	39	Die-cut cardboard sheets	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


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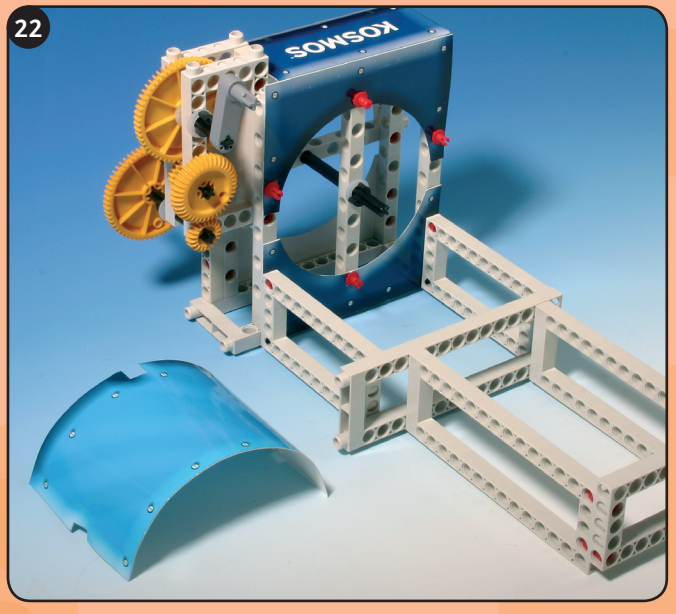
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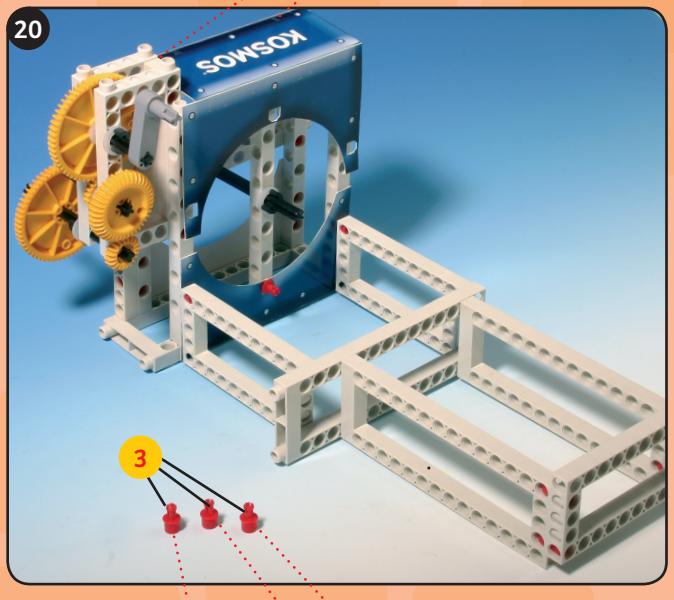
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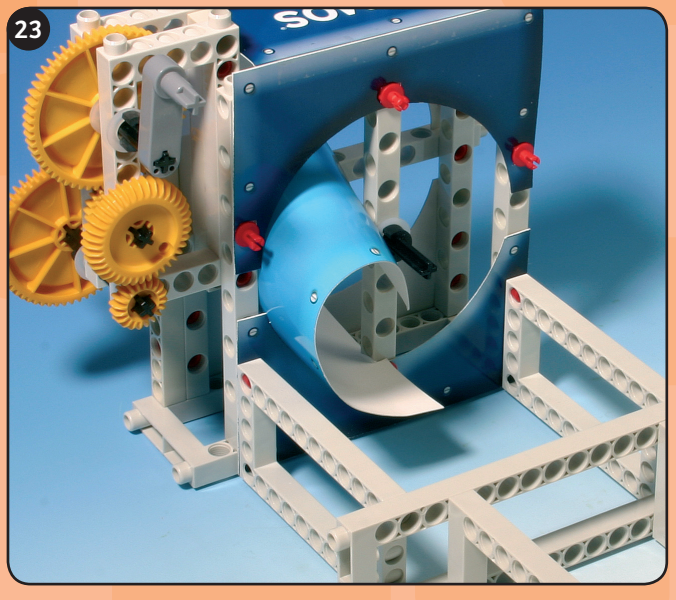
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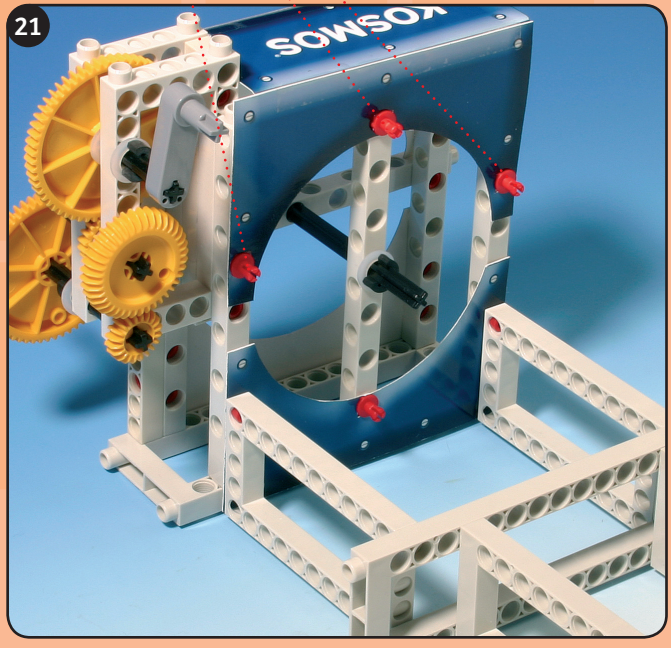
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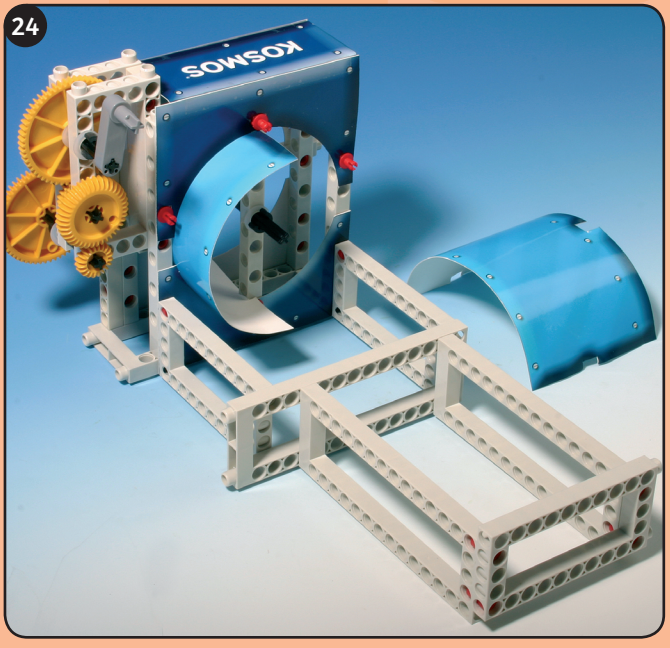
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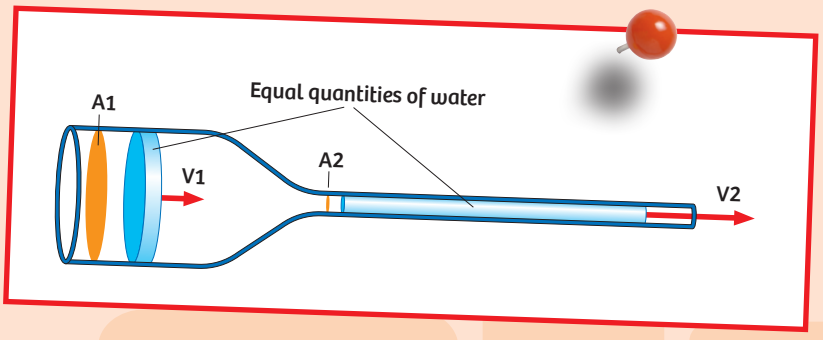
GOOD TO KNOW



Pressure in currents

Because the speed of the water increases in the narrow part of a tube, the pressure also increases in the direction of flow. But an increase in pressure also means an increase in force per unit of area and, thus, an increase in the distance the narrower stream of water can shoot.

The pressure in the direction of flow is also called dynamic pressure, because it arises with dynamics, or the force of movement. In tubes, there is always also something called static (resting) pressure, which is a product of the difference in pressure between the entrance to and exit from the tube.

Dynamic pressure is measured against the stream, static pressure in the stream. When the liquid is resting, there is only static pressure, and the dynamic pressure is equal to zero. When movement starts, dynamic pressure rises and static pressure simultaneously drops.

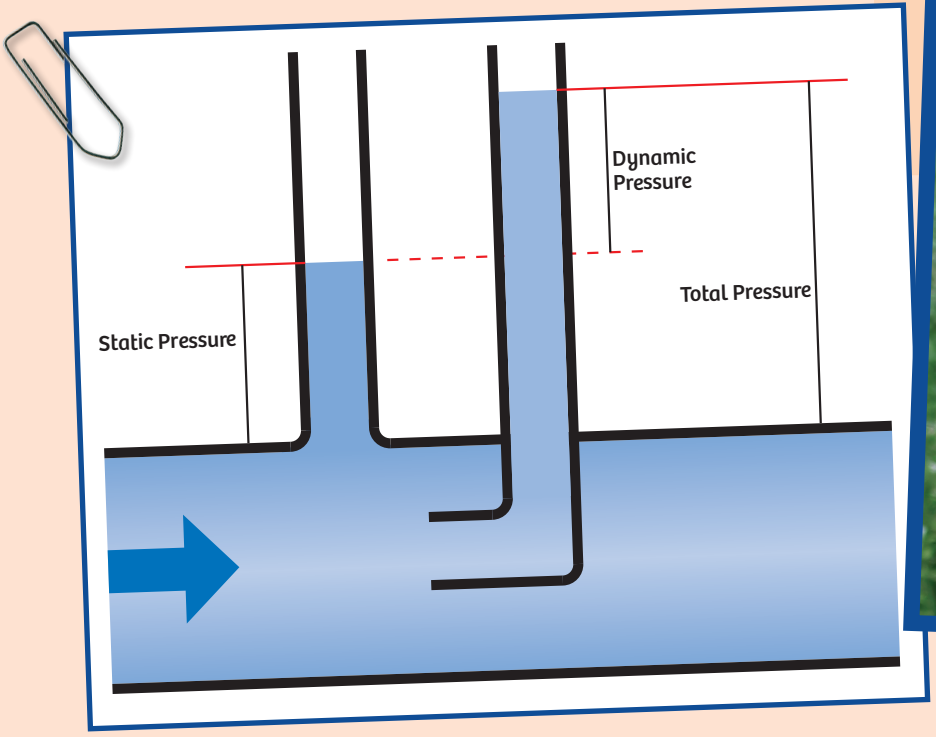
That also applies in reverse. In a uniform current, in any case, the sum of the two pressures is always the same.

THE FLOW EQUATION

If you multiply the large cross-sectional area (A_1) by the corresponding velocity (v_1), the product is the same as when you multiply the small cross-sectional area (A_2) by the velocity there (v_2).

This equation is called the flow rate equation or continuity equation:

$$A_1 \cdot v_1 = A_2 \cdot v_2$$



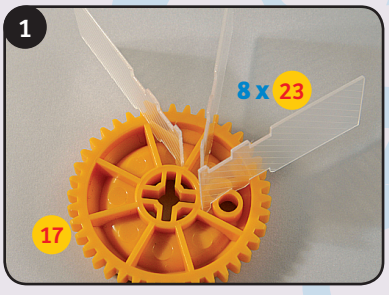
EXPERIMENT 18

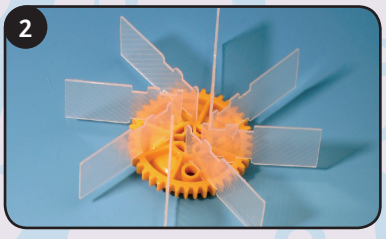
Compressed air

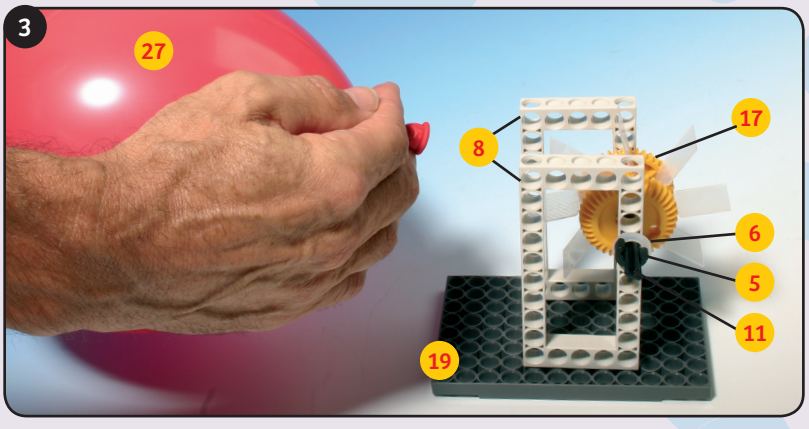
The air-filled balloon has potential energy too. You can drive a paddle wheel turbine with it.

YOU WILL NEED

- 1 Axle lock 5
- 1 Washer 6
- 2 Short frames 8
- 1 Long axle 11
- 2 Medium gear wheels 17
- 1 Baseplate 19
- 8 Turbine blades 23
- Balloon 27







Power is work divided by time

Work is measured independent of the time it takes to do the work. If you do the same amount of work in less time, then you exert more power doing it — whether its raising your hand in school or biking.

When you calculate power, time becomes a factor. Power is the relationship of the work performed to the time needed to do it:

$$P\ (\text{power}) = \frac{W\ (\text{work})}{t\ (\text{time})}$$

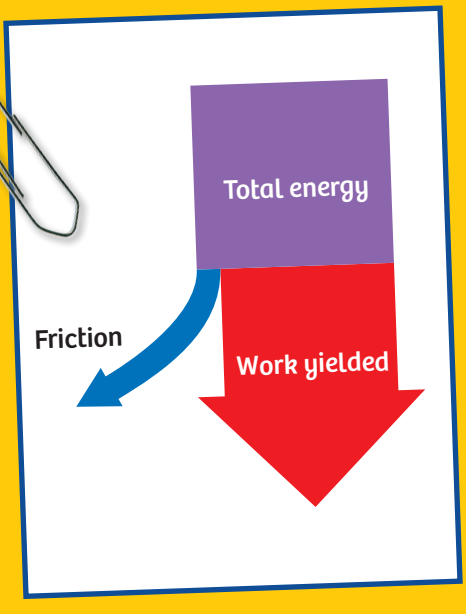
The unit of measure for power P is the watt (W):

$$1\ W = \frac{1\ J}{1\ s}$$

In addition to watts, kilowatts (1 kW = 1,000 W) and megawatts (1 mW = 1,000,000 W) are also used as units of power. The engine of a mid-sized car handles about 60 kW. A human can perform about 200 watts of physical work over a long period of time, while a cyclist with a bicycle can get to 1,500 watts fairly quickly.

CONSERVATION OF ENERGY

Not all of the potential energy of the water is converted into hammer beats in our gravity hammer experiment. Part of it is used up by friction in the axle seats, the pulley wheels, and the hammer shaft. In this process, it is only lost as far as the hammering is concerned. If you add up the work from the friction and the hammering, it equals the energy you started with.



In other words, **the conservation of energy law** applies:

In a closed mechanical system, no energy is lost. Energy can be neither created nor destroyed. It can only be converted. The sum of the mechanical energy remains the same (constant).

CAR WITH HYDRAULIC BRAKES

Every vehicle should be able to brake. As their main braking device, passenger cars have a hydraulically activated foot brake. Its hydraulic mechanism consists of a cylinder that transfers force from the brake pedal to the main cylinder. From there, the braking force is transferred equally by separate pathways to the braking cylinders on the wheels. Big and heavy vehicles, e.g. a tour bus or dredger, have so-called servo brakes, which amplify the braking force through a pump.

This model is like the racing car model (page 89) — but without the drive spring. Test the hydraulic brake by pushing against the car's brake pedal (the front pair of rods). Push the pedal down to activate the brake. That pulls the rear pair of rods down onto the tires. Water will serve as the hydraulic fluid. You will see in Experiments 1 and 2 (on pages 10 and 11) how to fill it without air bubbles.

> See Pages 10-11 and 20-22

YOU WILL NEED

- 8 Anchor pins 1
- 4 Joint pins 2
- 2 Shaft plugs 3
- 10 Axle locks 5
- 8 Washers 6
- 1 Short frame 8
- 4 Long rods 9
- 6 Short rods 10
- 4 Long axles 11
- 3 Medium axles 12
- 2 Medium pulleys 14
- 2 Large gear wheels 16
- 2 Small gear wheels 18
- 1 XL (extra long) axle 21
- 1 Rubber band (medium) 25
- 2 Wheels 28
- 2 Tire rings for pulleys 29
- 2 Hydraulic cylinders 42
- 1 Piece of narrow tubing 43