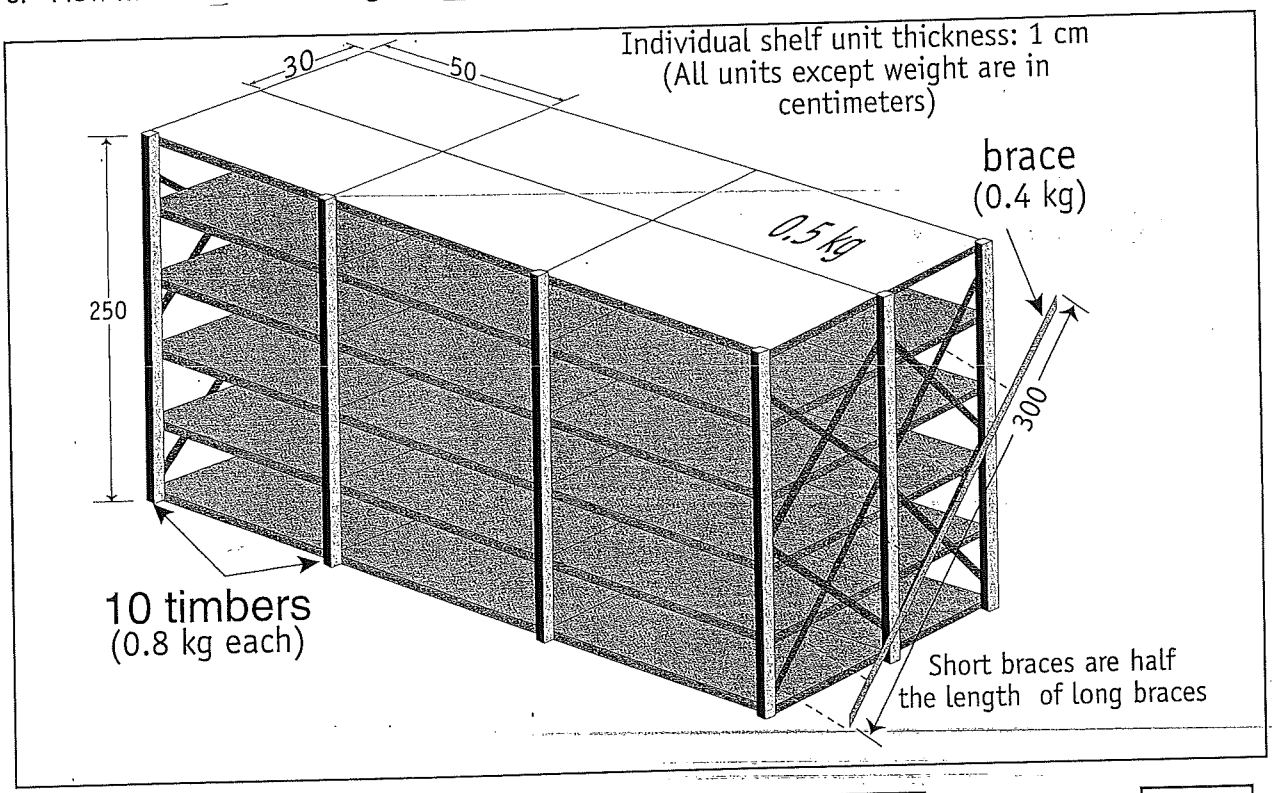
UNIT 1 DIMENSIONS, DISTANCES AND MEASUREMENTS

1.1. Basic dimensions: length, height and width ★

How big is this case of storage shelves? ★

1. How long is each shelf? _____
2. How wide is each shelf? _____
3. How thick is each shelf? _____
4. How long is each stud? _____
5. How high is the case? _____
6. How much does a unit weigh? _____
7. How many long braces are there? _____
8. What is the length of the long braces? _____
9. How many short braces are there? _____
10. What is the length of the small braces? _____
11. What is the weight of each brace? _____
12. How many studs are there in all? _____



Total length: ☐ Total height: ☐ Total width: ☐ Total weight: ☐

language and usage notes

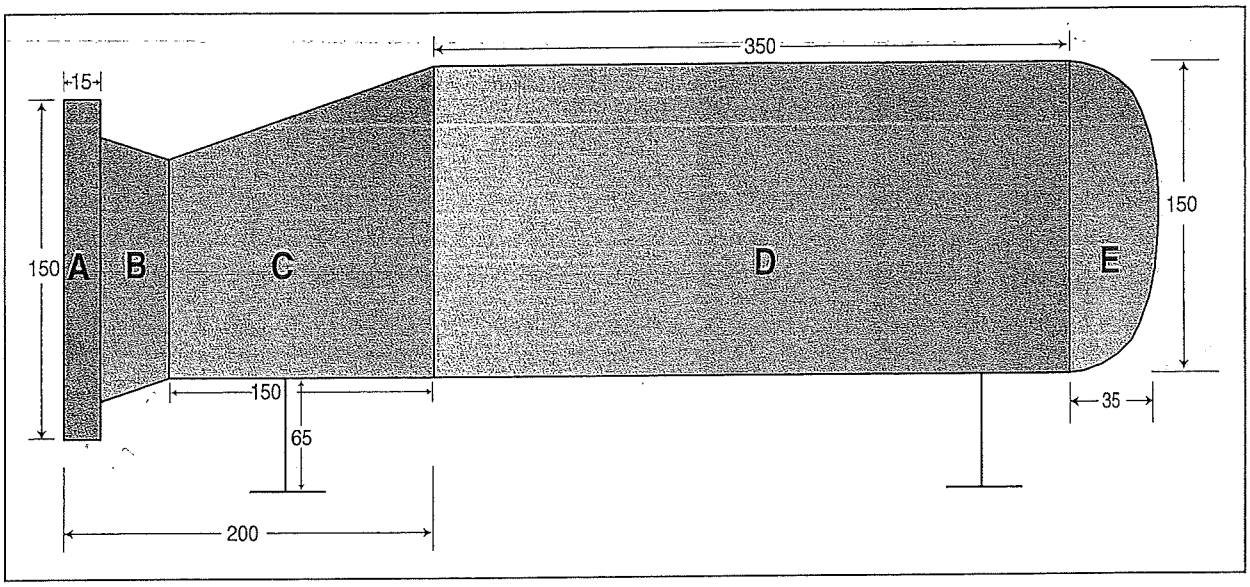
1. How + adjective...?

QUESTIONS	POSSIBE WAYS TO ANSWER THESE QUESTIONS	
How high is it? (What is its height)?	The case is 250 cm in height.	It's 250 cm high.
How wide is it? (What is its width)?	It is 60 cm in width.	It's 60 cm wide.
How long is it? (What is its length)?	It's 150 cm in length.	It's 150 cm long.
How much does each shelf unit weigh? (What is the weight of each unit?)	One shelf unit weighs 0.5 kg.	Its weight is 0.5 kg.
How heavy is each unit?		

NOTE THE USE OF THE PREPOSITION **IN**:
It measures / It is 25 cm **in** height, **in** length, 20 cm **in** width.

1.2. Dimensions: the nouns and the corresponding adjectives ★

Refer to the diagram of this storage cistern. ★



Practice 1 Fill in the blanks with the correct adjective or noun form. ★

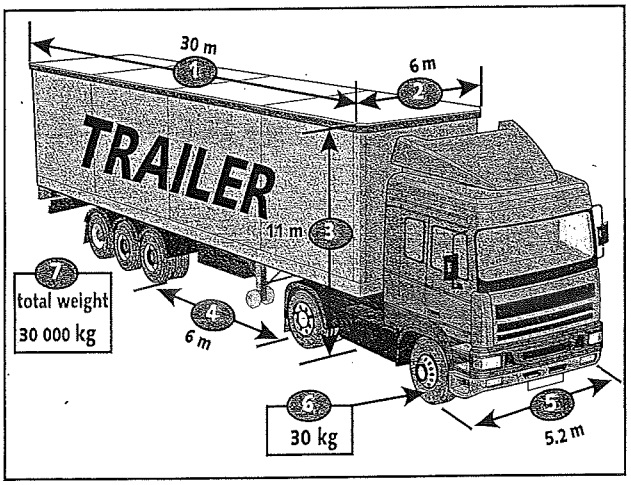
1. How _____ is *A*? Its _____ is 15 cm.
2. How _____ is *A*? Its _____ is 150 cm.
3. *E* is 35 cm _____. It is 35 cm in _____.
4. The _____ of the cistern is 250 kg.
5. In the figure we see two dimensions only: The _____ and the _____. The _____ is not shown.

IMPORTANT

1. Note that **WEIGH** is a verb; **WEIGHT** is a noun. The questions are **How much does it weigh? What is its weight?**
2. Note that something is **HEAVY**. So we can also ask: **How heavy is it?**
3. For distance we ask: **What is the distance from *A* to *B*?**

Practice 2 Write the QUESTIONS on the left, then write the ANSWERS on the right. ★

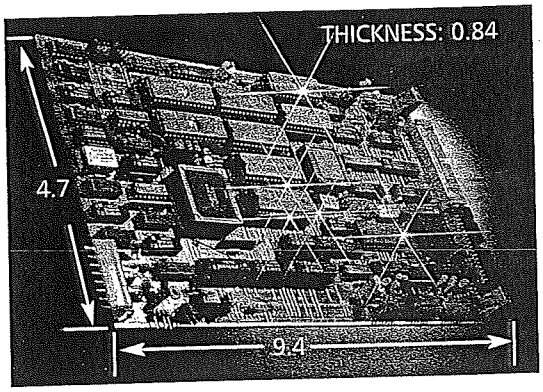
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____



1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____

Practice 3 Read the description then answer the questions which follow.★

A conventional circuit board



Circuit boards are indispensable in conventional connections in telephone-switching systems. The circuit board here is roughly 8 or 9 cm in length, about 5 cm in height, and approximately 1 cm in width (thickness). It carries many interconnected chips. Hybrid circuit boards are connected with other components on the same board.

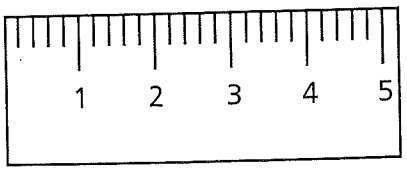
1. How important is this circuit board? .....
2. How accurate are the measurements given in the description? .....
3. State the exact measurements as shown in the photo. .....
4. State its thickness (its width). .....
5. How accurate is your answer in 4? .....
6. How heavy is it, do you think? .....
7. How many interconnected chips does it carry? .....

language and usage notes

2. Precision or accuracy?

precise

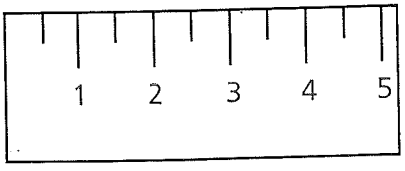
How close are measurements of the same quantity to each other? How uncertain is a measurement? Here are 2 rulers drawn to scale. Measurements made with ruler A have a smaller amount of uncertainty (0.01 cm) and will be more precise than those made with ruler B.



ruler A

accurate

How close is the observation or measurement to the true value? A stop watch can give us a precise measurement of a length of time as 3 seconds; an atomic clock would show that this is not accurate; the length is 3.119989990.



ruler B

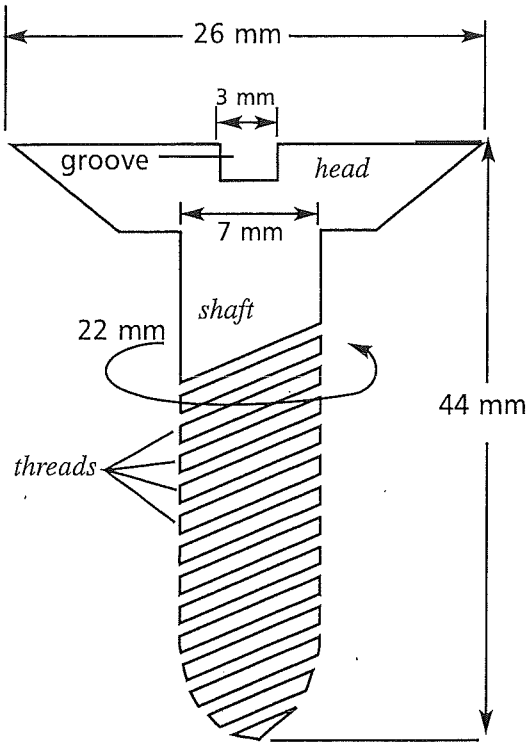
language and usage notes

3. Expressing approximation

approximately	It's approximately 10 mm long (10 mm in length).
roughly	It weighs roughly 10 grams.
almost/nearly	It's almost / nearly 10 mm high (10 mm in height).
about/around	It's about / around 5 mm thick (5 mm in thickness).

Practice 4 State the indicated dimensions ★

Give the dimensions of the screw. In some cases you will need to make approximations.



1. head length .....
2. head width .....
3. shaft width .....
4. total length .....
5. groove width .....
6. groove depth .....
7. shaft circumference .....
8. shaft length .....

language and usage notes

4. Build your word power

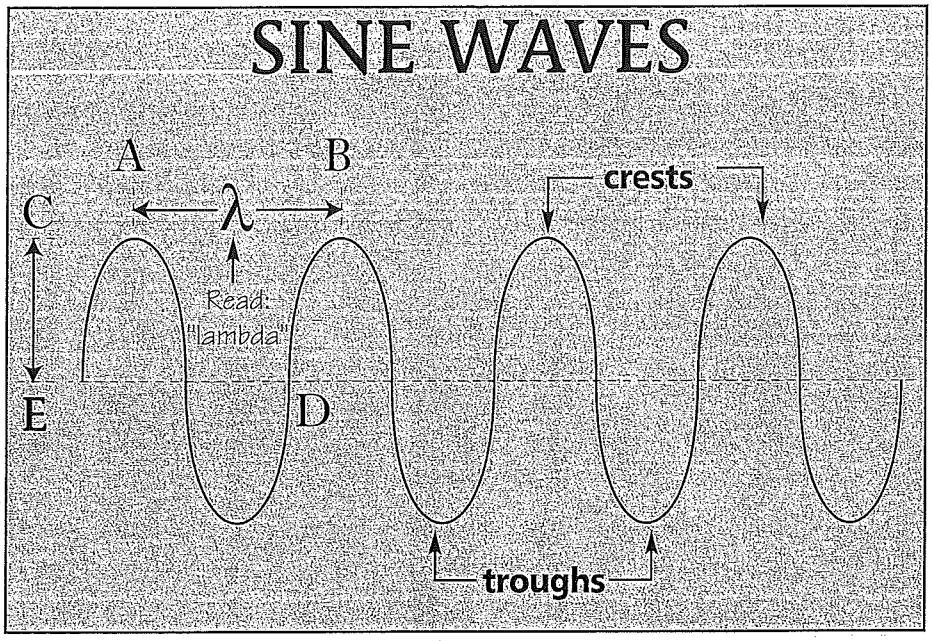
Some common nouns and a corresponding adjective. Do you know the opposite?

We speak of the	*It is*	*or the opposite*
1. HEIGHT	high	.....
2. SIZE	small	.....
3. SPEED	fast	.....
4. LENGTH	long	.....
5. THICKNESS	thick	.....
6. BREADTH/WIDTH	wide	.....
7. SIZE	heavy	.....
8. LUMINOSITY	bright	.....
9. DEPTH	deep	.....
10. DEPENDABILITY	reliable	.....
11. EFFICIENCY	efficient	.....
12. BULK	bulky	.....
13. INTENSITY	strong	.....
14. SUFFICIENCY	sufficient	.....
15. REQUIREMENTS	mandatory	.....
16. WHAT IS RIGHT	proper	.....
17. PRECISION	precise	.....
18. ACCURACY	accurate	.....
19. SUITABILITY	suitable	.....
20. CONVENIENCE	convenient	.....

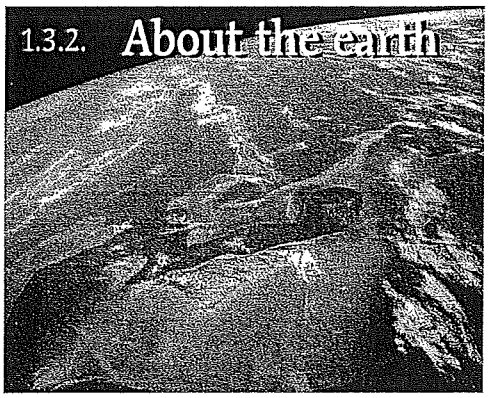
1.3. Other measurements ★★

1.3.1. Waves

The wavelength (λ) is the distance from one crest (the highest value reached) to the next crest (in the figure, from A to B). The amplitude of the wave is the distance from C to E. The frequency of the wave is the number of waves per second at a given point (here: D).
Frequencies of light vary from 77 x 10^{13} to 37 x 10^{13} cycles per second.



Read: "seventy-seven times ten to the thirteenth power"
or "seventy-seven times ten power thirteen"

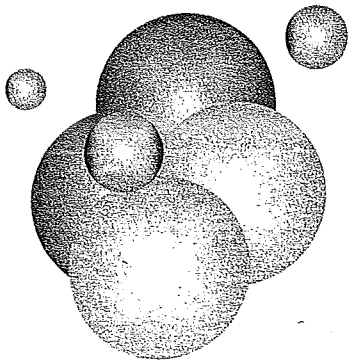


The radius of the earth is 1.5 x 10^{11} m. The distance from the earth to the sun is 150 million km. The atmosphere of the earth is composed of nitrogen, oxygen and argon. The average density of the earth is 5.52. The density of rocks on the surface of the earth varies from 2.5 to 3.2. In the interior of our planet, at the center, the density is extremely high, reaching 12 to 12.5. The mass of the earth is approximately 5.98 x 10^{24} kg.

Read: "five point nine eight"

1.3.3. Atoms and Atomic Nuclei

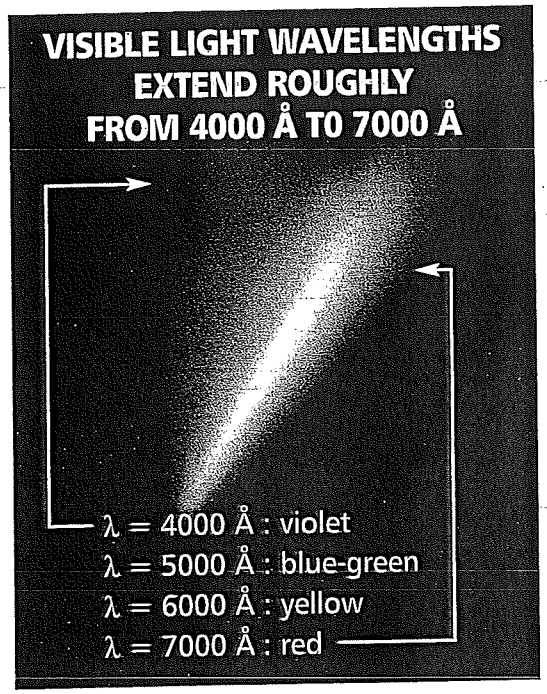
The nucleus holds most of the mass of an atom. Because atoms are so small, a special unit is needed when speaking of their mass. The mass of the nucleus is expressed in terms of a basic unit, the atomic mass unit: amu (often given as simply **u**, from *unified atomic mass unit*). This is equal to 1.66 x 10^{-24} gram.



Read: "one point six six times ten to the negative twenty-fourth power"

1.3.4. The range of visible light wavelengths ★★

Visible light makes up only a small part of the electromagnetic spectrum. It is the wavelength (λ) which determines the color we see. On the long end of the spectrum, beyond visible red, lie infrared and radio waves, the latter having the longest wavelengths extending up to miles in length.



On the short end of the spectrum are types of radiation with increasingly shorter wavelengths: ultraviolet, x-ray, and including radiation with the shortest wavelength: γ-rays (gamma rays).

Wavelengths are measured here in angstroms. Below, some equivalents.

1 Å = 1 hundred-millionth of a cm
1 Å = 10^{-18} cm
1 Å = 0.1 nm (nanometers: 1 nanometer = 10^{-9} m)
1 Å = 100 pm (picometer: 1 picometer = 10^{-12} m)

READ
"is equal to"
"equals"
"is equivalent to"

READ
"ten (raised) to the negative twelfth power"

Practice 5 Practice with fractions. Write out these fractions (and say them aloud). ★

1. 2/15 .....
2. 5/32 .....
3. 2/13 .....
4. 21/23 .....
5. 1/10,000 .....
6. 1/100,000 .....
7. π (pi) = 22/7 .....

Practice 6 And with scientific notation. Write out the following (and say them aloud). ★

1. 3.54×10^{4} .....
2. 6.66991×10^{9} .....
3. 4.61×10^{-5} .....
4. 2.5×10^{-12} .....
5. 6.8×10^{10} .....
6. 4.11×10^{8} .....
7. 0.6×10^{-3} .....

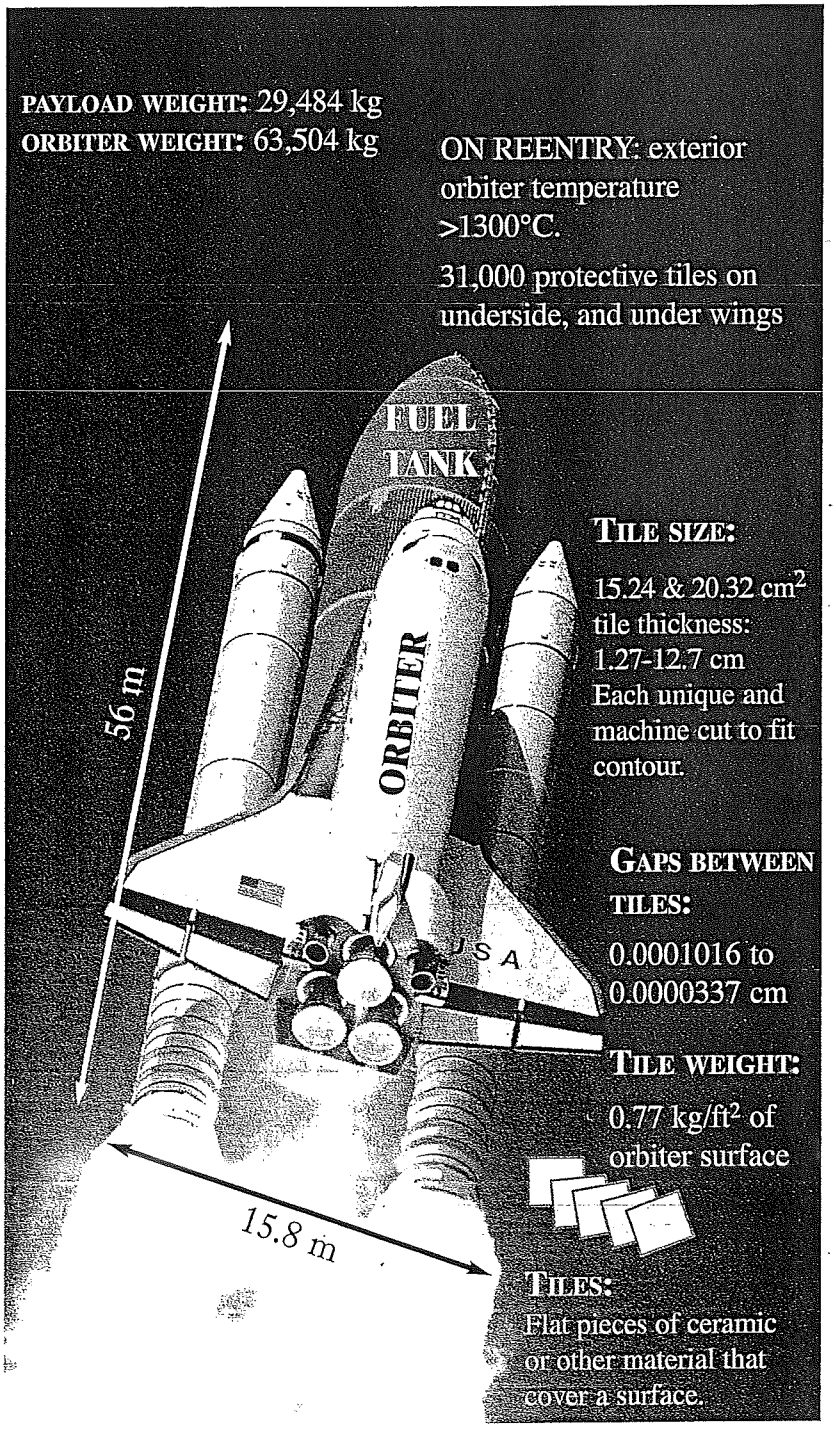
language and usage notes

5. Useful expressions: common math symbols

> "is larger (greater) than"
< "is smaller (less) than"
~ "is approximately (roughly)"
Δ "delta"
± "plus or minus"
• "times" or "multiplied by"
≠ "is not equal to"
≈ "is approximately equal to"

Practice 7 Describing the space shuttle launch rocket and orbiter ★★

Look at the information supplied in the illustration below and prepare a complete description.



1.4. Quantities: basic notions ★

1.4.1. Countable and uncountable ★

How much does it hold?

How much does it contain?

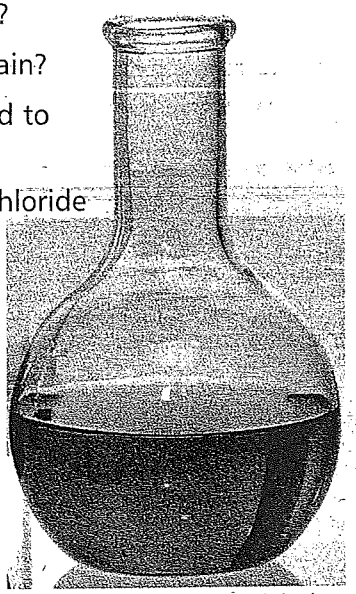
How much water is used to make the solution?

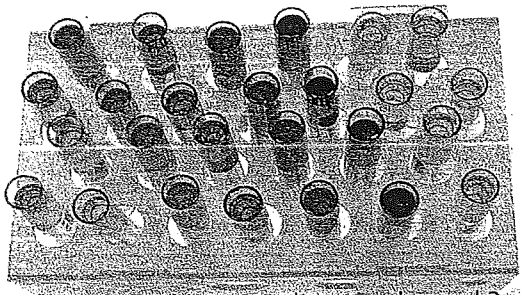
How much potassium chloride is there in the solution?

The solution here does not contain **much** KCl (potassium chloride).

It contains **a little** coloring.

It contains 0.01 mg of NaCl. That is **very little** salt.





How many tubes are there in the rack?

How many tubes can be filled from one 250 ml solution?

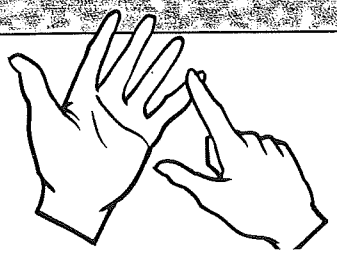
How many milligrams of KCl does each tube contain?

The rack does not hold **many** tubes.

Note that **a few** of the tubes contain a dark solution (About 10).

many ● not many ● a few ● few
plural nouns (what we can count)

much ● not much ● a little ● little
singular nouns (what we cannot count)



Be sure to distinguish between A LITTLE and LITTLE; A FEW and FEW!

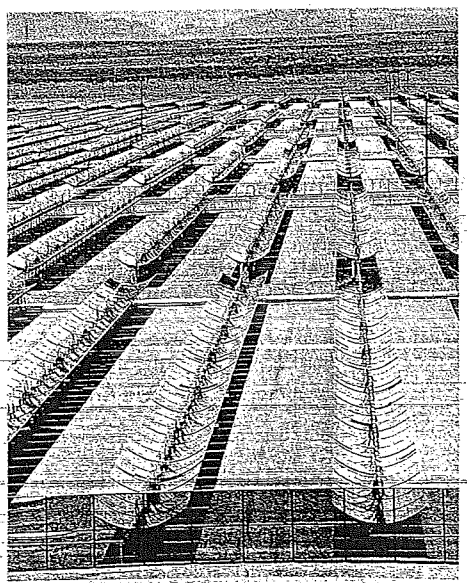
Practice 8 Supply a suitable word. ★

1. There are _____ solar power plants in the world.

2. How _____ solar captors are there at this plant in the photograph?

3. _____ of the units here are defective and need to be replaced.

4. Not _____ people work here, and very _____ people visit this plant. It is located in the desert where there are _____ days of sunshine and _____ days are cloudy.



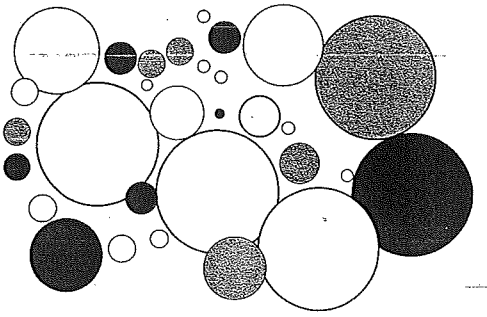
5. How _____ energy do solar power plants generate?

6. Solar power plants are generally efficient, but _____ of the energy generated is lost.

7. Not _____ time is necessary to replace a defective unit. There is very _____ space between each unit.

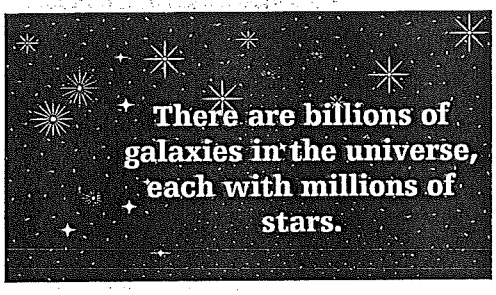
8. There is _____ room here for more panels.

1.4.2. Indefinite quantities and numbers ★



There are many circles here.
Some are large; some are small.
Some are very small.
Some are white; **some** are gray; **some** are black.
There aren't **any** red circles.
No circles here are red.
None of the circles (here) is (or: *are*) red.
None of the objects here are (or: *is*) four-sided.

1.4.3. Indefinite quantities and numbers ★



Some are very far; **others** are closer to us.

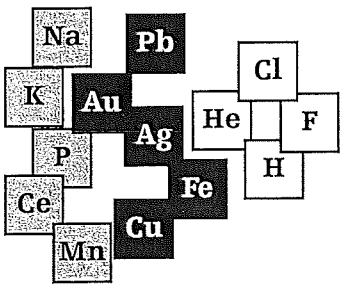
Some are relatively near us. **None** is closer than 3 light-years. (*The plural is also found after* none.)

Some stars are very bright. **Some** are white, **some** are red, **some** are blue, and many, or **most**, are yellow, like our sun.

All stars are composed of gases.

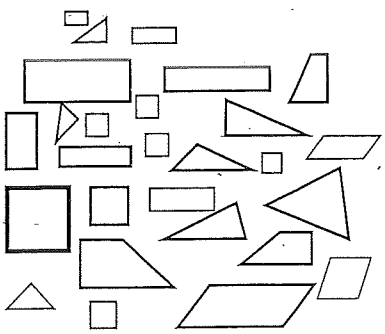
Practice 9 Complete the description. ★

Elements we use



1. There are ..... elements.
2. ..... are rare. ..... are common.
3. Here are ..... common .....
4. ..... elements, like uranium, are radioactive.
5. ..... here are radioactive.
6. ..... are metals. ..... are heavy ; ..... are light.
7. ..... are gases.
8. ..... the metals here are found in nature.

Practice 10 Make appropriate statements about the geometric figures. ★



1. (□: *squares*) .....
2. (△: *triangles*) .....
3. (▭: *rectangles*) .....
4. (○: *circles*) .....

1.5. Volumes and density: liquids and gas ★

1.5.1. A lake

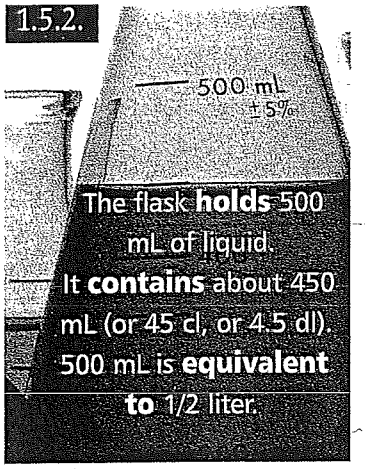
How deep is this lake?
How acidic is the water?
What is the **salt content**?
(How much salt does it contain?)
How great is the pressure **at a depth of 200 m?**
How dense is the water at the bottom, **at maximum depth?**

At the maximum depth of 200 m the pressure is 21 atm.

1 atm = 1.01325 bar
= 1.01325 x 10^3 Pa
= 760 torr

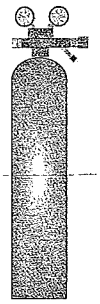
READ: "1 atmosphere equals ... bar, or ... pascals, which is equivalent to ... torr."

1.5.2.



The flask **holds** 500 mL of liquid.
It **contains** about 450 mL (or 45 cl, or 4.5 dl).
500 mL is **equivalent to** 1/2 liter.

1.5.3.

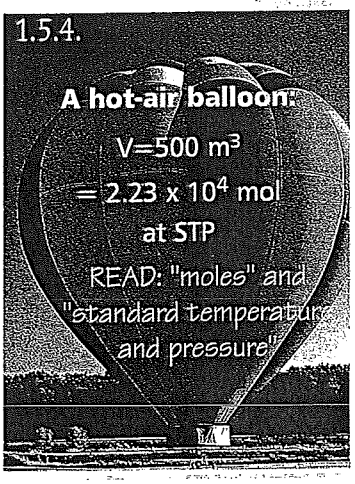


An acetylene cylinder holds 300 ft^3 (8.5 m^3) of acetylene at 250 psi (1724 kPa) at 21°C.

An oxygen cylinder holds up to 220 ft^3 (6.23 m^3) at 2200 psi (15,751 kPa) at 21°C.

READ: ""cubic feet" "eight point five cubic meters... at 250 pounds per square inch." kPa = "kilopascals"

1.5.4.



1.5.5.

Interstellar space is permeated with atomic hydrogen at a concentration of 1 atom cm^{-3}. Given that the temperature of interstellar space = 4°K, the atomic hydrogen exerts a pressure of 5.52 x 10^{-17} Pa.

1.6. Speeds and velocities ★

1.6.1. Interfaces with different speeds ★

A few years back, the ISDN (integrated-services digital network) offered 2 types of access to a digital transmission medium:

(1) **BRI (Basic Rate Interface)**
features 2 bearer channels operating at 64,000 bits sec^{-1} each and one data signalling channel operating at 16,000 bits sec^{-1}.

(2) **PRI (Primary Rate Interface)**
operating at 1.5 - 2.0 x 10^6 bits sec^{-1} on 23 to 30 channels.

PLEASE NOTE

bits sec^{-1} is found in scientific papers in place of bits/sec.

READ: "Bits per second"

Reminder:
The speed of electromagnetic energy (this includes light) is 2.997929 x 10^{10} cm sec^{-1}

1.7. Conversions ★

English system	metric system
distance	
1 inch (in)	2.54 cm
1 foot (ft)	0.305 m
1 yard (yd)	0.914 m
1 mile	1.609 km
area & volume	
1 in^2	6.45 cm^2
1 ft^2	0.093 m^2
1 yd^2	0.836 m^2
1 in^3	16.4 cm^3
1 ft^3	0.0283 m^3

English system	metric system
liquids	
1 pint	0.473 l
1 quart	0.946 l
1 US gallon	3.785 l
1 ounce	28.4 g
1 pound	0.454 kg
1 ton	0.907 (metric) ton

NOTE
1 Imperial gallon = 4.546 l.

Practice 11 Can you figure out the equivalences? ★

1. 1 inch = (a) 1/8 (b) 1/12 (c) 1/16 (d) 1/32 foot
2. 6 inches = (a) 1 foot (b) 2 feet (c) 1/2 foot (d) 1/4 foot
3. 1 foot = (a) 1 yard (b) 1/2 yard (c)1/3 yard (d) 1/4 yard
4. 1 mile = (a) 1000 feet (b) 2000 feet (c) 8530 feet (d) 5280 feet
5. 1 mile = (a) 1.6 km (b) 1.8 km (c) 2.2 km (d) 3 km
6. 1 pint = (a) 0.5 (b) 0.8 (c) 0.133 (d) 0.125 (US) gallons
7. 2 pints = (a) 1 (b) 2 (c) 3 (d) 4 quart(s).
8. 1 quart = (a) 3/4 (b) 1/2 (c) 1/4 (d) 1/8 (US) gallon
9. 1 gallon = (a) 3 (b) 4 (c) 6 (d) 8 pints.
10. 1 US gallon (a) 5/4 (b) 3/4 (c) 2/3 (d) 1/4 Imperial Gallon

Practice 12 Do you understand these? Can you say them correctly? ★

1. ft^2
2. in^2
3. mph
4. lbs/in^2
5. kg/m^2
6. in Hg
7. mi^2
8. km^2
9. kg/cm^2
10. mbar
11. N
12. mm Hg
13. m^3
14. Pa
15. kg/cm^3
16. STP
17. psi
18. km/sec (km sec^{-1})
19. J
20. m s^{-2}

language and usage notes

6. Speed or Velocity?

speed

the distance travelled divided by time, regardless of the direction

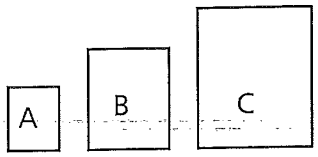
velocity

distance travelled per unit of time in a specified direction

1.8. Contrasts and comparisons

1.8.1. Short adjectives: comparative and superlative ★

B is **larger than** A.
C is **larger than** A or B.
C is **the largest** of the 3 figures.



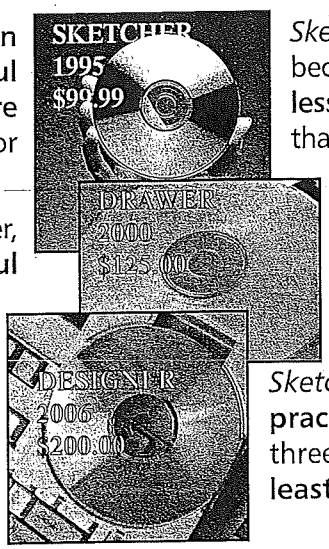
B is **smaller than** C.
A is **smaller than** B or C.
A is **the smallest** of the 3 figures.

1.8.2. Longer adjectives: comparative and superlative ★

Drawer is **more expensive than** *Sketcher* because it is **more powerful** and is **more useful**. It is also **more recent**. It is **better than** Sketcher for architects.

Designer is **more recent** than Drawer, and is **more powerful, more useful** and also **more expensive than** Drawer. It is **better than** Drawer.

Of the three applications, *Designer* is **the most recent, the most powerful** and **the most expensive**. For architects it is **the best** software available. It offers **the most** functionalities.



Sketcher is **less expensive than** *Drawer* because it is **less powerful** and the **less useful**. It is **older**, or **less recent**, than *Drawer*.

Sketcher is **the least expensive** because it is **the least powerful** and **the least useful**. It offers **the fewest** functionalities and **the fewest** possibilities.

Sketcher is **the least adapted, least practical**, and **hardest** to use of the three applications here. It is by far **the least interesting**.

language and usage notes

7. Comparative and superlative of adjectives

Short adjectives[1]

positive adjective	comparative adjective+er	superlative adjective+est
long	longer	the longest
short	shorter	the shortest
heavy[1]	heavier[1]	the heaviest[1]
easy[1]	easier[1]	the easiest[1]

Long adjectives

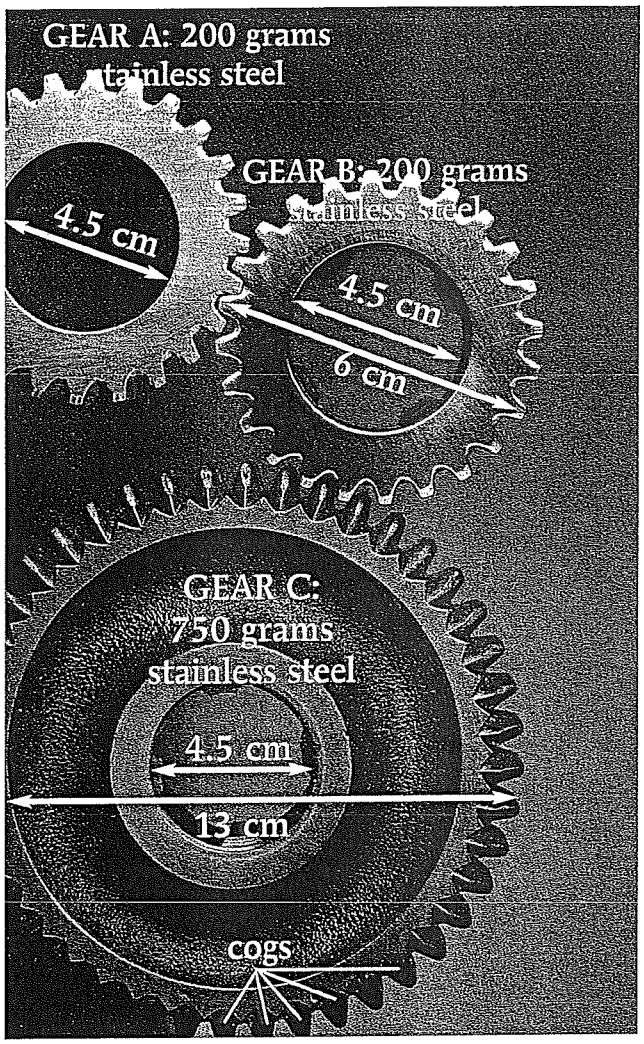
positive adjective	comparative more + ADJ	superlative most + ADJ
useful	more useful	the most useful
expensive	more expensive	the most expensive
adapted	more adapted	the most adapted
recent	more recent	the most recent

Irregular adjectives

good	better	the best
bad	worse	the worst
far	farther	the farthest

[1] One-syllable adjectives. Two-syllable adjectives follow the rule for long adjectives. But two-syllable adjectives ending in -y follow the rule for short adjectives.

1.8.3. Differences and similarities ★★



Gears A and B are **the same weight.**
Gear A is **as heavy as**, or **as light as**, gear B.
Gear A **weighs the same as** gear B.
Both gears A and B **have the same diameter and thickness**. A is **similar to** B; it is **identical to** B.
Gear A is **as big as** , or **as small as**, gear B.
They **are the same size**: 6 cm in diameter.
The central hole **is the same size** in **both** gears A and B: 4.5 cm.
In gears A and B there is **no difference in size or weight**. And **both** are made of **the same material**: stainless steel.

Gear C is **not the same size as** the other two.
A and B are **not as large as** C. However, the central hole in gear C is **just as large as** the central holes in gears A and B: 4.5 cm.
Gear C is **not as light as** the other two gears. It does not have the same weight. Gears A and B are **not as heavy as** gear C.
Like gears A and B, C is made of stainless steel.
C has 44 cogs (or teeth), **unlike** A and B.

Practice 13 Complete or answer: ★★

1. A and B do not have the same weight as C. They are ...
2. C does not have the same weight as A or B. It is ...
3. Of the three gears, gear C is ...
4. Why is gear C heavier than the two others?
5. Judging from the photograph, make statements about the thickness of the gears.What can you say about the cogs on the gears?

language and usage notes

8. Statements of equality/inequality

THE SAME AS / THE SAME

A is the same as B in weight.
A and B are the same weight.
A weighs the same as B.

AS ... AS

A is as heavy as B.
A and B are not as heavy as C..

SIMILAR TO / IDENTICAL TO

A is similar to B.
A is identical to B.

LIKE ... (or: UNLIKE ...)

Like A, B is made of steel.
Unlike C, A and B are small.

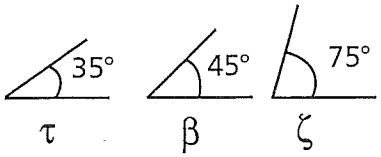
A DIFFERENCE IN

There is no difference in weight.

DIFFERENT FROM

C is different from A and B.

1.8.4. Differences between angles of 3 different sizes ★★



READ: "tau, beta, zeta", respectively

Angle β is **slightly greater than** angle τ. It **exceeds** angle τ by 10°. Angle ζ is slightly more than **twice as great as** angle τ, exceeding it by 40°.

1.8.5. Stating quantitative relationships ★★

Line *n* is **double the length** of line *m* (or: **twice the length** of *m*)

Line *n* is **twice as long as** *m*.

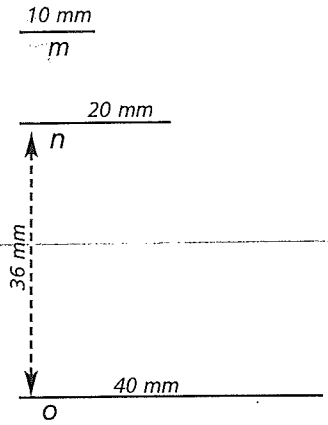
(It's **two times longer than** *m*.)

O is **twice as long as** *n*.

(It's **two times longer than** *n*.

It's double the length of *n*.

The distance between *n* and *o* is **greater than** the distance between *n* and *m*. *O* is **three times farther** from *n* than *n* is from *m*.



Line *m* is **half the length of** line *n*. (It is **half as long as** *m*.)

Line *n* is 10 mm **less long than** *m*.(It is 10 mm **shorter than** *m*.)

Line *n* is also half the length of line *o*. (It is half as long as *o*.)

Line *o* is **one fourth the length** of *m*. (It is **one fourth as long as** *m*.)

N is **closer to** *m* **than it is** to *o*. The distance between *n* and *m* is **one third the distance** between *o* and *n*.

Practice 14 TRUE or FALSE? Explain! ★★

1. The distance between *o* and *n* is not as great as the distance between *m* and *n*.
2. The lines do not differ in thickness.
3. Line *n* is not as short as line *m*.
4. Line *n* is closer to *o* than it is to *m*.

Practice 15 THE MATCH GAME.

Match each statement in column A with its equivalent in column B. Note: there are more sentences in B than required in A!

column A

1. A is lower than B. .....
2. A is not as good as B. .....
3. A is as long as B. .....
4. B is more expensive than A. .....
5. B weighs the same as A. .....
6. B is not as thick as A. .....

column B

a. A does not cost the same as B.
b. A is not as high as B.
c. B is not as high as A.
d. A is thicker than B.
e. B is thicker than A.
f. A is the same length as B.
g. B is better than A.
h. A is as light as B.

1.8.6. Stating quantitative differences and relationships ★★

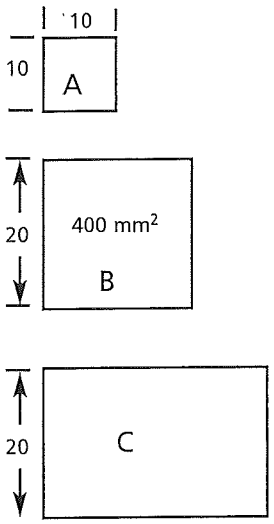
Read and practice saying the sentences on the left. Then cover the description and looking the figure, provide as complete a description as possible. Then do the practice on the right.

B is larger than A, but smaller than C. C is the largest of the three; A is the smallest.

Each side of B is **twice the length** of a side of A.

B has a **greater** area than A: it is **4 times greater in area than** A. B is as high as C.

C is 10 mm longer than B.



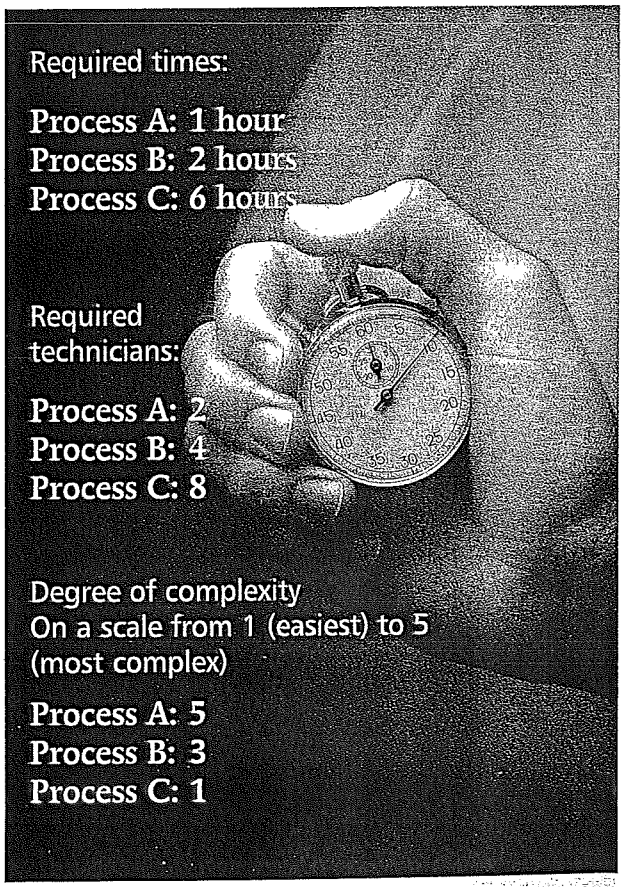
1. State the length of C.
2. State the surface area of A.
3. State the surface area of C.
4. How much greater in area is C than A?
5. Draw, and describe, figure *D* which is half as large as figure *C*.

DRAW YOUR FIGURE HERE.

1.8.7. Defining quantitative relationships: respective parts ★★

Process B **takes twice as long as** process A It requires **twice as much time as** process A.

Process C **takes 3 times longer than** process B, and **6 times longer than** process A. (Or: C takes **3 times as long as** B and **6 times as long as** A.)



Practice 16 Talk about the 3 processes. ★★

1 *State this same idea in another way!*

2 *Answer these questions:*

a. How much longer is C than A?
b. How many more hours does C require than B?
c. How much less time does A require than C?

3 *Now make statements about the number of technicians required and the degrees of complexity.*

Language and usage notes follow on the next page.

language and usage notes

9. References to items in comparisons or relationships:

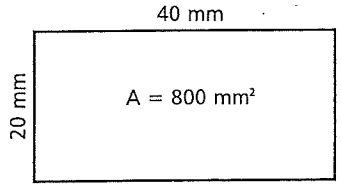
The time required for process A is double **that** for process B.
The area of *F* is 2.5 times greater than **that** of *G*.
The sedimentary rocks here are older than **those** found in other areas.
The angles in the three figures τ, β, and ζ above are 35°, 45° and 75°, **respectively**.

10. Precise and relative differences

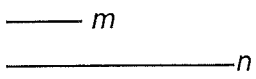
The diameters of particles A-E.

Particle A	10^{-10} cm	A is not **as small as** B. It is two orders of magnitude larger.
Particle B	10^{-12} cm	B and C are the same size. One is as large as the other. **Neither** is
Particle C	10^{-12} cm	larger than the other. **Both** measure 10^{-12} cm in diameter.
Particle D	$10^{-12.2}$ cm	D is only **somewhat / slightly** larger than B and C.
Particle E	10^{-3} cm	E is **considerably / much** larger than the others.

11. Two ways to say the same thing

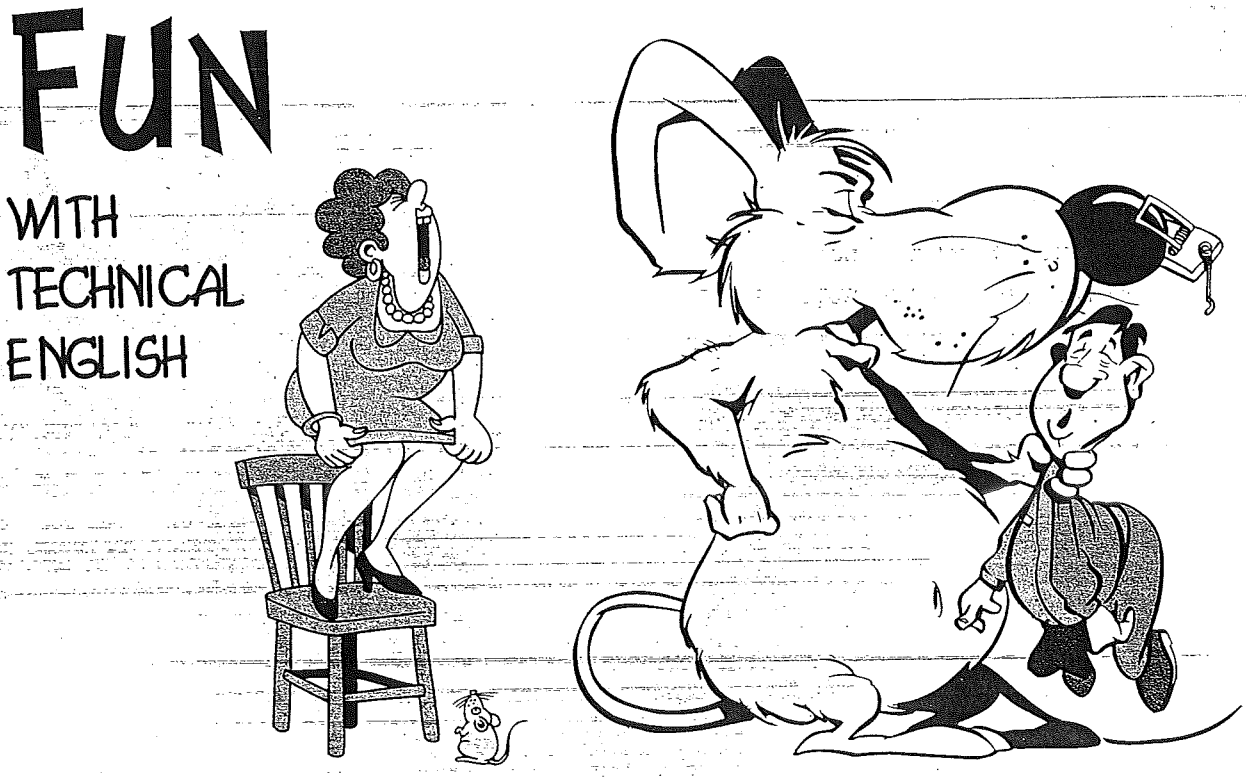


The figure covers 800 square millimeters. This rectangle is twice as long as it is wide. (**Its length is twice as great as its width**, or: its length **is double** its width).



N is **three times longer than** *m*.
N is **three times as long as** *m*.

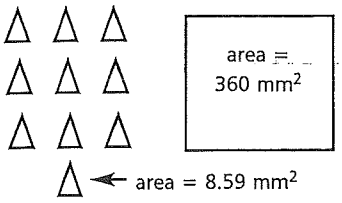
} These 2 sentences are the same in meaning.



1.9. Proportions, Ratios and Relationships ★

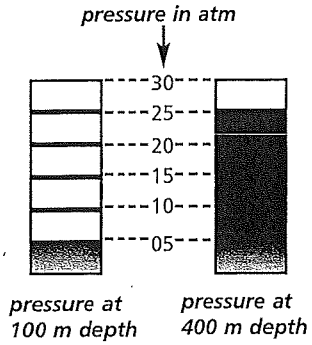
Practice suggestion: cover the descriptions on the right and describe the figures!

1.9.1. Simple proportions and ratios ★



△s outnumber □s by 10 to 1.
The ratio of △s to □s is 10:1. There are ten times more △s than □s. Or: there are ten times as many △s as (there are) □s. However, the ratio of the surface area of a △ to a □ is about 1:41.

1.9.2. Simple proportions and ratios: variations in pressure ★★



At a depth of 400 m, the pressure increases by a factor of 5. It is 5 times greater at 400 m than it is at 100 m: it is increased **by a factor of 5**. At a depth of 100 m, the pressure is 1/5 less than it was at 400 m: it is diminished by a factor of 1/5. As we descend from 100 m to 400 m, the pressure increases 5 atm **for every 100 m** of increased depth. At 400 m we note a **fivefold** increase in pressure.

1.9.3. How the human eye focuses ★★

The refractive ability of the human eye is measured in diopters, **the reciprocal of** the distance in meters between the eye and an object. An eye with a refractive power of 10 diopters can bend light rays to focus on an object 1/10 meter away (at a distance of 1/10 meter). Refractive power diminishes with increasing age:

AGE	REFRACTIVE ABILITY
Age 10:	14 diopters
Age 35:	4 diopters
Age 45:	1-2 diopters
Age 70:	0 diopters

Practice 17

State the distances of an object at which the eye correctly focuses at each age:

.....
.....
.....
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.....
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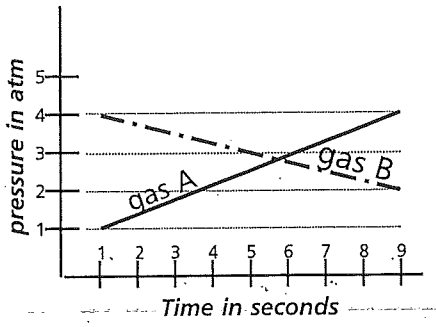
.....

1.9.4. Two different gases undergo different changes in time ★★



In 9 seconds, the pressure increases **by a factor of 4** for gas A, but is diminished by a factor or 2 for gas B. At the beginning the pressure of gas B was **4 times as great as** that of gas A. The pressures of gas B and A **stood in a ratio of 4:1 (four to one)**. At the end the ratio was 1:2. The pressure of gas A at 9 seconds was double that of gas B.

1.9.5. Momentum, mass, velocity and density ★★

p= mv — p = momentum; m = mass; v = velocity; D=density; V = volume

D= m/V — Momentum **is the product of** mass and velocity.

D **is the ratio of mass to volume**

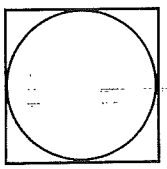
1.9.6. Mathematical formulae expressing proportions ★★

$P^2 = a^3$ — The **square of P** is in (stands in) **direct proportion to** the cube of *a*.
The square of *P* **is directly proportional to** the cube of *a*.
P squared equals *a* cubed.

$P^2 = \frac{1}{a^2}$ — The square of P **is inversely proportional to** the square of *a*.

$P^2 = \sqrt{a}$ — The square of *P* **is directly proportional to** the square root of *a*.

1.9.7. Squares and square roots ★★



For a circle and a square to be of equal size, one condition is absolute. The ratio between a side of the square and a radius of the circle must be the square root of π. ← READ: "pi" (like the word "pie" it rhymes with "by")
$s/r = \sqrt{\pi}$

Practice 18 Express the following relationships ★★

1. $I = 1/r^2$ (I= Intensity; r = distance)

.....

2. P=F/A (P = pressure; F = force; A = area)

.....

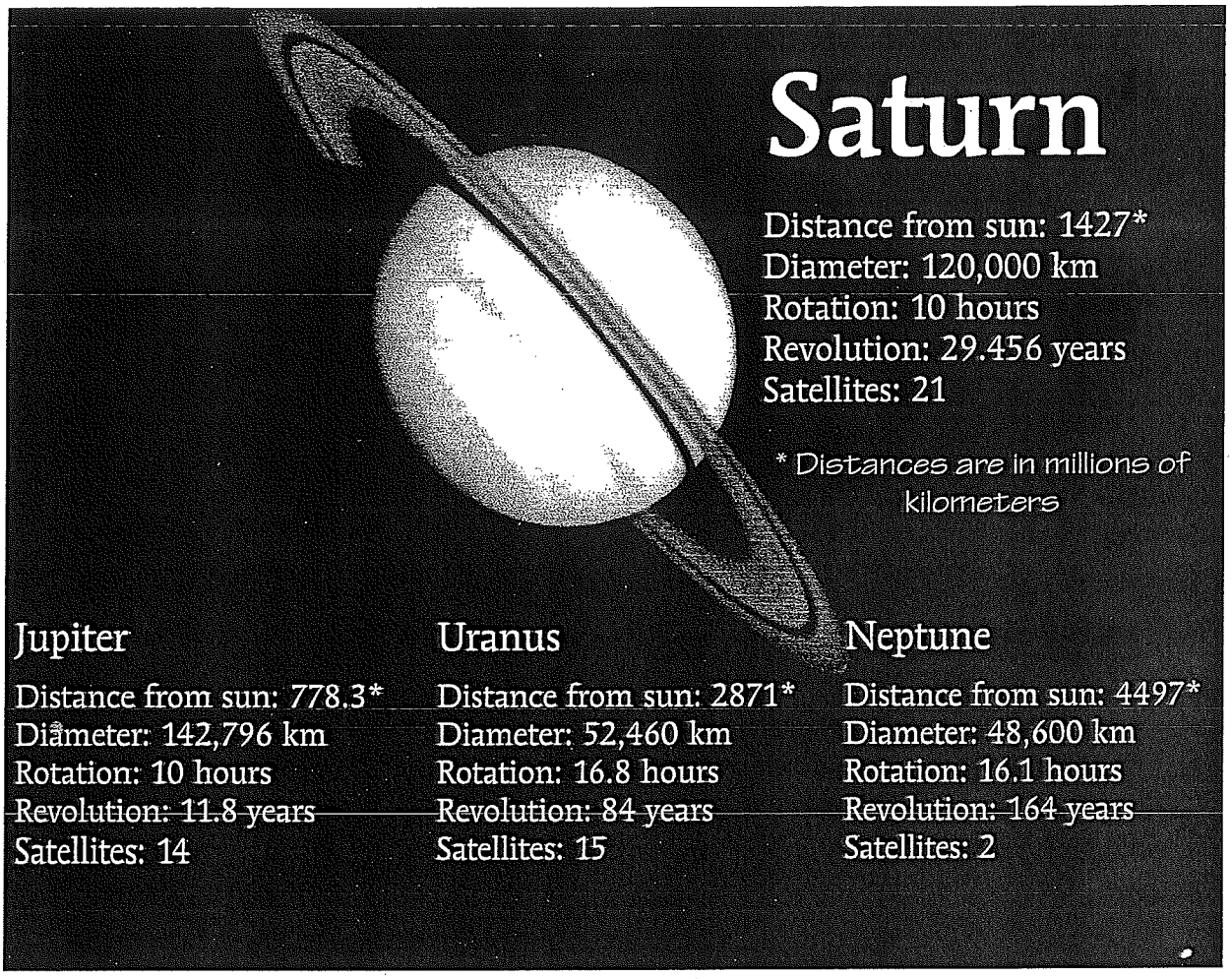
3. 1 atm = 760 mm Hg (atm= atmosphere; Hg = mercury)
= 101,325 Pa (Pa = pascal, another unit used to measure pressure)
= 101.325 kPa (kilopascal)
1 Pa = 1 N/m^2 (N = newton)

.....

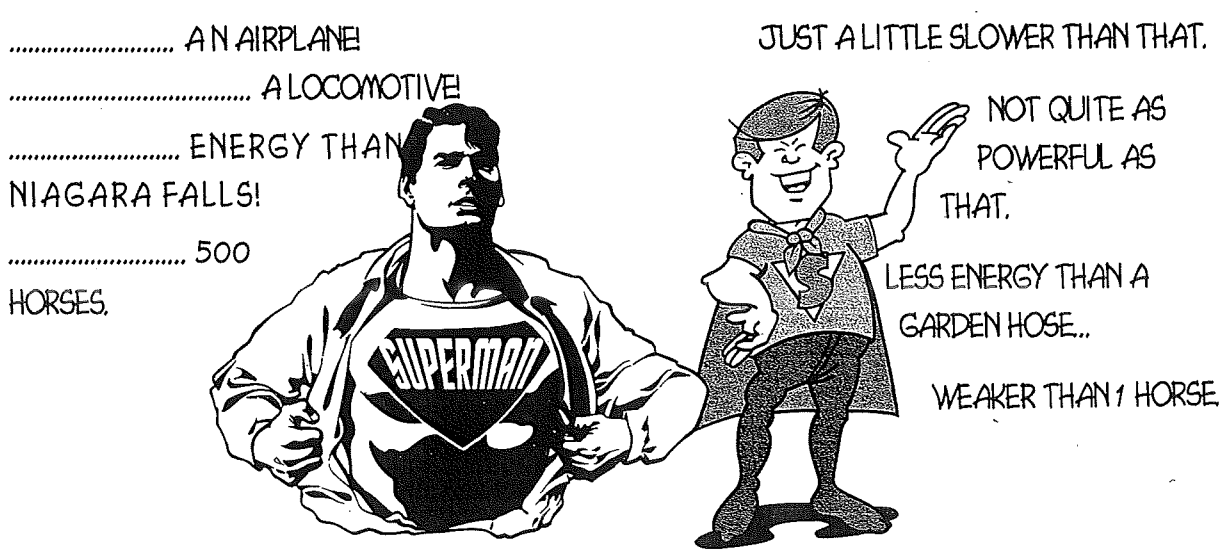
.....

Practice 19 The Great Outer Planets compared ★★

Write a complete description contrasting the 4 outer planets.



FUN WITH TECHNICAL ENGLISH



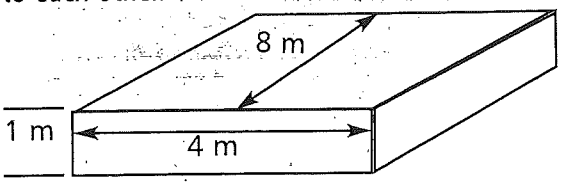
UNIT 1: FINAL PRACTICE

Practice 20 Restate as a ratio ★★

The weak nuclear force is 1,000 times weaker than the electromagnetic force, and 100,000 times less powerful than the strong nuclear force.

Practice 21 State the dimensions ★

State the dimensions and also how they relate to each other.



Practice 22 Capacity and contents ★

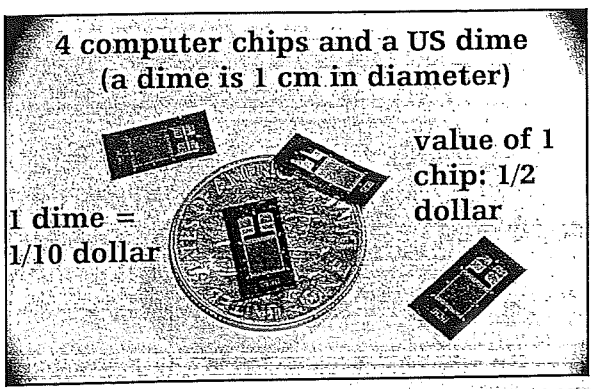
Use the vocabulary on the right to describe capacity and contents of this can.

alcohol: 28%
disinfectant: 12%
water: 60%

contains/holds/is made up of/ consists of

Practice 23 Relative sizes and values ★★

Make statements about the sizes and values.



Practice 24 Increase in gas concentrations shows global warming ★★★

Read the brief passage and note the quantitative information.

Sufficient evidence points to a global warming trend. The average temperature on earth has been steadily rising over the past ten years.

Many factors contribute to the trend, but none perhaps so much as increased levels of carbon dioxide ($C0_2$) and methane (CH_4). These gasses absorb infrared radiation.

10,000 years ago the levels of carbon dioxide and methane stood at 260 parts per million and 700 parts per billion, respectively. Today they reach 350 parts per million and 1,700 parts per billion.

Express the change in concentrations.

.....

.....

.....

.....

.....

.....

.....

Practice 25 A new LCD (liquid crystal display) monitor ★★★

How does this monitor compare to a conventional CRT monitor?

New LCD monitor

20.1 inch screen featuring 1280 x 1024 physical resolution
8.7" deep (vs 43")! (" is the common symbol for inch or inches.)
weight: 8.8 kg (vs. 17.5 kg for a conventional monitor)
consumes: 85 W.
smaller and more economical than conventional CRT monitors.

- expanded viewing angle up to 160°, up and down, from left to right
- supports 7 resolution modes, from 640 x 480 to 1280 x 1024.
- provides full-screen displays at lower resolution
- environment- and people-friendly: no magnetic field emitted.

See also: Unit 9: (noun clusters and complex adjectives) and Unit 3: (Features, Designs and Functions).

Practice 26 Photon energy is frequency-dependent ★★★

Read and express the possible ratios, proportions and relationships.

Photons of violet and blue light have the highest frequency and the most energy. Radio waves have the lowest frequency and the least energy. The shorter the wavelength, the higher the energy of the particle. The longer the wavelength, the less energy the particle has. What is the relationship between wavelength and frequency? One formula is:

$$E = \frac{hc}{\lambda}$$

where E is the energy, h is Planck's constant, c the speed of light (a constant), and λ the wavelength. Note also this formula:

$$f = \frac{\lambda}{c}$$

.....

.....

.....

.....

ANSWERS TO SOME PRACTICE EXERCISES – Unit 1

PRACTICE 1 (1) wide-width (2) long-length (3) wide-width (4) weight (5) length-height-width

PRACTICE 2 (1) How long is the trailer? It's 30 m long. (2) How wide is it? It's 6 m wide. (3) How high is it? It's 11 m high. What is the distance from the ground/from the wheel to the top of the trailer? It's 11 m. (4) What is the distance between the trailer wheels? It's 6 m. (5) What is the distance between the front wheels? It's 5.2 m. How far apart are the front wheels? They are 5.2 m apart. (6) How much does a wheel weigh? It weighs 30 kg. What is the weight of a wheel? It's 30 kg. (7) How heavy is this truck? It's 30 000 kg / What is the total weight of this truck? It's 30 000 kg.

PRACTICE 3. (1) It's extremely important ("indispensable") (2) Not very accurate; they are only approximations. (3) It measures 4.7 cm in height (*or* is 4.7 cm high) and 9.4 cm in length (*or* is 9.4 cm long). It's 0.84 cm thick. It measures 9.4 cm x 4.7 cm x 0.84 cm (4) It is 0.84 cm thick. (5) Very accurate; it's the precise or exact thickness. (6) It probably weighs about 5 g. (7) "Many."

PRACTICE 4. (1) 26 mm (2) about 9-11 mm (shaft diameter is 7 mm) (3) 7 mm (4) 44 mm (5) the groove is 3 mm wide and 1 mm in depth (6) The shaft measures 22 mm in circumference (7) It's about 41 mm long (44 - 3 mm)

PRACTICE 5. (1) two-fifteenths (2) five thirty-seconds (3) two-thirteenths (4) twenty-one twenty-thirds (5) one ten-thousandth (6) one hundred-thousandth (7) pi equals twenty-two sevenths

PRACTICE 6. (1) three point fifty-four times ten to the fourth power (2) six point six six nine nine one times ten to the ninth power (3) four point sixty-one times ten to the negative fifth power (4) two point five times ten to the negative twelfth power (5) six point eight times ten to the tenth power (6) four point eleven times ten to the eighth power (7) zero point six times ten to the negative third power Note 1: We can also say *four power ten.* Note 2: Some people say *four times ten to the tenth* or *four times ten to the minus tenth.*

PRACTICE 7. Total weight of the orbiter and its maximum payload (maximum payload + orbiter) is 92,988 kg, or nearly 93,000 kg. The total width, orbiter + solid rocket boosters comes to 15.8 meters, and total height measures 56 m. On reentry, temperatures may exceed (may be greater than) 1300° C, and for this reason special tiles are used to protect the orbiter. 31,000 protective tiles cover the underside of the orbiter and sensitive areas under the wings. There are two basic sizes: 15.24 cm^2 and 20.32 $cm.^2$ (They vary in thickness from 1.27 to 12.7 cm). Gaps between the tiles are extremely narrow: 0.0001016 to 0.0000337 cm, and their weight is 0.77 kg per square foot of surface area on the orbiter.

PRACTICE 8. (1) many (2) many (3) Some / a few (4) many - few - many - few (5) much (6) a little (7) much - little- little

PRACTICE 9. (1) many (2) some - others (3) some - ones (4) some (5) none (6) some-some-some (others) (7) some- (8) all

PRACTICE 10. (1) Some are squares. Some are large, others are small. (2) Some are triangles. Some of the triangles are large, others (some) are small. Some are right triangles, others are equilateral. Etc. (3) Some of the figures are rectangles. (4) None of the figures are circles.

PRACTICE 11. (1) b (2) c (3) c (4) d (5) a (6) d (7) a (8) c (9) d (10) b

PRACTICE 12. (1) square feet (2) square inches (3) miles per hour (4) pounds per square inch (5) kilograms per square meter (6) inches of mercury (7) square miles (8) square kilometers (9) kilograms per square centimeter (10) millibar (11) Newton (12) millimeters of mercury (13) cubic meters (14) pascal (15) kilograms per cubic centimeter (16) standard temperature and pressure (17) pounds per square inch (18) kilometers per second (19) joule (20) meters per second per second (acceleration)

PRACTICE 14. (1) FALSE. It is greater. (2) TRUE. (3) FALSE. *m* is not as short as *n*. *Line n* is longer. (4) FALSE. It is farther.

PRACTICE 15. (1) B (2) G (3) F (4) A (5) H (6) D

PRACTICE 17. at age 10: 0.07 m; at age 35: 0.25 m; at age 45: 1.0 to 0.5 m; at age 70: 0 m

PRACTICE 18. (1) Intensity is inversely proportional to the square of the distance (2). Pressure is the ratio of force per unit of area (3) 1 atm is equivalent to 760 millimeters of mercury, which is equal to 101,325 pascals or, equivalently, 101.332 kilo pascals. 1 pascal is equal to 1 newton per square meter.

PRACTICE 21. The item measures 4 m in length, is 1 meter high and 8 meters wide. Its width is twice as great as its length. The item is 4 times longer than it is high.

PRACTICE 22. The can holds 3 liters. It contains a disinfectant which consists of alcohol, disinfectant and water. Water makes up 70% of its contents. The mixture consists of 28% alcohol, 12% disinfectant, and 60% water. The ratio of alcohol to water is roughly 1/3.

PRACTICE 23: A dime is roughly 6-8 times larger than a chip. A dime is one tenth of a dollar, and is worth five times less than a chip (a chip is one sixth to one eighth the size of a dime and is worth half five times as much as a dime).

PRACTICE 24. Today there is one-third more CO_2 than there was 10,000 years ago. As for methane, the concentration has more than doubled; there is today 1.4 times as much methane as there was 10,000 years ago.

PRACTICE 25. Its width is one-fifth that of the CRT monitor; the CRT monitor weighs nearly twice as much as the LCD monitor (or: is nearly double the weight of the LCD monitor (8.8 kg vs. 17.5 kg)

PRACTICE 26. The frequency is proportional to the wavelength and inversely proportional to the speed of propagation (speed of light). The shorter the wavelength the higher the frequency; the longer the wavelength, the lower the frequency.

FUN

WITH TECHNICAL ENGLISH

JUST A FEW MINUTES AGO WILBUR WAS A FIFTH AS TALL AS HE IS NOW AND WEIGHED ABOUT A THIRD AS MUCH. WAIT UNTIL HE DRINKS ANOTHER GLASS!

UNIT 1 — Summary of important language

1. How + adjective...? and the possible answers

Question	Answer	Or this answer:
How wide is it?	It's 20 cm in width.	It's 20 cm wide.
How long is it?	It's 35 cm in length.	It's 35 cm long.
⚠ How much does it weigh?	It weighs 2 kg.	

2. Approximation

It's | **nearly / approximately / roughly / almost / about / around** | 14 cm wide.

3. Precision and Accuracy

Precise / precision

It's precise to ±0.1 cm.
The precision is ±0.1 cm.

Accurate / Accurately / Accuracy

not very reliable accuracy
The results were accurate.

4. Stating differences

> "is larger (greater) than"
< "is smaller (less) than"
~ "is approximately (roughly)"
Δ "delta"
± "plus or minus"
• "times" or "multiplied by"
≠ "is not equal to"
≈ "is approximately equal to"

5. Speed and velocity

It travels at 150 km per second.

The velocity (speed with direction) is 14,000 km per second.

Acceleration is 20 km per second per second

20 km/sec/sec = 20 km/sec^2 = 20 km sec^{-2}

6. Countable vs uncountable

COUNTABLE	UNCOUNTABLE
Many problems	much time
A few problems	a little time
Few problems	little time

7. Indefinite quantities

COUNTABLE	UNCOUNTABLE
some problems	some time
not any problems	not any time
no problems	no time

8. Some/other/all/both/none

Some are large; others are small.

Both A and B are small. (A and B are both small)

All are large; none is small.[1]

1 The plural can also be used after none.

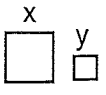
9. Similarities, differences

Similar to / identical to ...

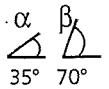
Different from ...

There's no difference in ...

10. Contrasts and comparisons



X **is twice as large as** Y. = X **is double the size of** Y.
X **is three, four times larger than** Y. = X **is three, four times as large as** Y.
A side of Y **is half the length of** a side of X. The area of Y **is one-fourth that of** X.
The area of X **is four times that of** Y (**is four times greater than that of** Y.)



Angle α **exceeds** angle β **by** 35°. (**It's 35° larger than** angle β.)
Angle α **measures 35°**. The line forms a 35° angle with the horizontal (line).