

نظام المقاييس أو الواحدات الدولي – THE SI UNIT SYSTEM

The International System of Units (in French, Le Système International d'Unités, where the "SI" comes from) which is the metric standard of units and is based on mks (meter, kilogram, second) units.

The fundamental units in the SI system are:

- The meter (m), the fundamental unit of length.
- The second (s), the fundamental unit of time.
- The kilogram (kg), the fundamental unit of mass.
- The degree kelvin (K), the fundamental unit of temperature.
- The mole (mol), the fundamental unit of quantity of particles.
- The ampere (A), the fundamental unit of electric current.
- The candela (cd) The unit of luminous intensity.

الواحدات الأساسية في النظام الدولي للوحدات هي

- المتر ورمزه m، وهو الوحدة الأساسية لقياس الأطوال.
- الثانية ورمزها s، وهي الوحدة الأساسية لقياس الزمن.
- الكيلوغرام ورمزه kg، وهو الوحدة الأساسية لقياس الكتلة.
- الكلفن ورمزه K، وهو وحدة قياس درجة الحرارة.
- المول ورمزه mol، وحدة قياس كمية الجزيئات.
- الأمبير ورمزه A، وهو وحدة قياس شدة التيار الكهربائي.
- القنديلة (الكاندلا) ورمزها cd، وهي وحدة قياس شدة الإضاءة.

UNIT NAMES AND ABBREVIATIONS

The next table lists several SI units that were named after the scientists who made discoveries in the fields in which these units are used. Note that these unit names do not begin with a capital letter, but their abbreviation is capitalized (e.g., newton, N).

SI units that were named after the scientists		
ampere (A)	joule (J)	siemens (S)
celsius (°C)	kelvin (K)	tesla (T)
coulomb (C)	newton (N)	volt (V)
farad (F)	ohm (Ω)	watt (W)
hertz (Hz)	pascal (Pa)	weber (Wb)

قواعد كتابة الوحدات ---- Rules in writing units

يبدأ اسم الوحدة المشتقة من اسم علم أم لا، بحرف صغير إلا في بداية الجملة. (Name of the unit is newton, its symbol is N)
عندما يكتب رمز الوحدة مختصراً، يبدأ بحرف كبير فقط إذا كان مشتقاً من اسم علم.
أثناء إجراء بعض العمليات الحسابية إذا احتاج الأمر لذكر وحدة مقدار ما، نضع الوحدة بين معترضتين [...].

Some Derived SI Units.

بعض الواحدات المشتقة (المركبة من الواحدات الأساسية)

Quantity	Name	Symbol	Formula	Fundamental Units
Frequency	hertz	Hz	1/s	s ⁻¹
Force	newton	N	kgm/s ²	m kg s ⁻²
Energy	joule	J	Nm	m ² kg s ⁻²
Power	watt	W	J/s	m ² kg s ⁻³
Electric charge	Coulomb	C	As	As
Electric potential	volt	V	W/A	m ² kg s ⁻³ A ⁻¹
Electric resistance	ohm	Ω	V/A	m ² kg s ⁻³ A ⁻²
Electric capacitance	farad	F	C/V	m ⁻² kg ⁻¹ s ⁴ A ²

SI Unit Prefixes.

سابقات الواحدات، المضاعفات والأجزاء

Multiples	Prefixes	Symbols	Submultiples	Prefixes	Symbols
10^{18}	exa	E	10^{-1}	deci	D
10^{15}	peta	P	10^{-2}	centi	c
10^{12}	tera	T	10^{-3}	milli	m
10^9	giga	G	10^{-6}	micro	μ
10^6	mega	M	10^{-9}	nano	n
10^3	kilo	k	10^{-12}	pico	p
10^2	hecto	h	10^{-15}	femto	f
10^1	deka	da	10^{-18}	atto	a

SIGNIFICANT FIGURES --- الأرقام ذات الدلالة

تعطي الآلات الحاسبة نتائج العمليات الحسابية بعدد كبير من الأرقام (يمكن التحكم بذلك). يجب الاحتفاظ بعدد منها فقط، تكون له دلالة (أي معنى واقعي أو فائدة) ويتناسب مع الهدف المراد من التصميم ومع الدقة التي يحتاجها تنفيذ هذا التصميم.

DEFINITION OF A SIGNIFICANT FIGURE

A significant figure is any one of the digits 1, 2, 3, 4, 5, 6, 7, 8, and 9. (0) is a significant except when it is used simply to fix the decimal.

Example: In 0.500 or 0.632000 the zeroes are significant, but in 0.006 or 0.000968 the zeroes are NOT significant.

The number 234 has three significant figures, and the number 7305 has four significant figures, since the zero within the number is a legitimate significant digit.

Leading zeroes before a decimal point are not significant. Thus, the number 0.000,452 has three significant figures (4, 5, and 2), the leading zeroes (including the first one before the decimal point) being place markers rather than significant figures.

EXAMPLES

- | | |
|---|-----------|
| a. The number of significant figures in 2.2900×10^7 ? | is 5. |
| b. The number of significant figures in 4.00×10^{-3} ? | is 3. |
| c. The number of significant figures in 0.048? | is 2. |
| d. The value of $345.678 - 345.912 = ?$ | = - 0.234 |
| e. The value of $345.678 - 345.9 = ?$ | =- 0.2. |

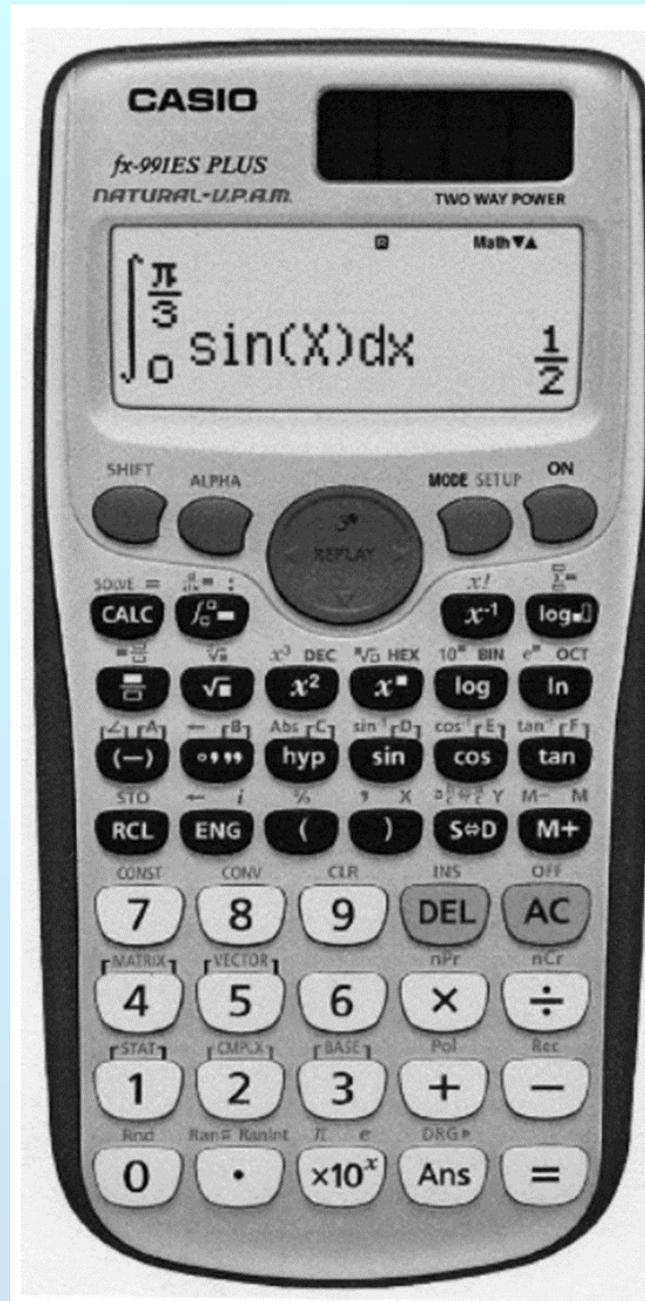
RULE 4: ONLY APPLY THE SIGNIFICANT FIGURES RULE TO YOUR FINAL ANSWER

For example, suppose you need to calculate the area of a circle and the answer is to be in square meter, but you are given the circle's radius as 22.5 cm.

You can convert the radius into meter as $R = 22.5[\text{cm}]/100 [\text{cm/m}] = 0.225 \text{ m}$.

Then you would calculate the circle's area as

$$A = \pi R^2 = (3.1416) \times (0.225 [\text{m}])^2 = 0.20428254 \text{ m}^2 = 0.204 \text{ m}^2 \text{ (rounded to 3 significant figures)}$$



All calculators have **+**, **-**, **x** and **÷** functions and these functions will, no doubt, already have been used in calculations.

Problem 1. Evaluate $364.7 \div 57.5$ correct to 3 decimal places

- (i) Type in 364.7
- (ii) Press \div .
- (iii) Type in 57.5
- (iv) Press = and the fraction $\frac{3647}{575}$ appears.
- (v) Press the $S \Leftrightarrow D$ function and the decimal answer 6.34260869... appears.

Alternatively, after step (iii) press Shift and = and the decimal will appear.

Hence, $364.7 \div 57.5 = 6.343$, correct to 3 decimal places.

Problem 2. Evaluate $\frac{12.47 \times 31.59}{70.45 \times 0.052}$ correct to 4 significant figures

- (i) Type in 12.47
- (ii) Press \times .
- (iii) Type in 31.59
- (iv) Press \div .
- (v) The denominator must have brackets; i.e. press (.
- (vi) Type in 70.45×0.052 and complete the bracket; i.e. press)
- (vii) Press = and the answer 107.530518... appears.

Hence, $\frac{12.47 \times 31.59}{70.45 \times 0.052} = 107.5$, correct to 4 significant figures.

Now try the following Practice Exercise

Practice Exercise 12 Addition, subtraction, multiplication and division using a calculator (answers on page 1149)

1. Evaluate $378.37 - 298.651 + 45.64 - 94.562$
2. Evaluate 25.63×465.34 correct to 5 significant figures.
3. Evaluate $562.6 \div 41.3$ correct to 2 decimal places.
4. Evaluate $\frac{17.35 \times 34.27}{41.53 \div 3.76}$ correct to 3 decimal places.
5. Evaluate $27.48 + 13.72 \times 4.15$ correct to 4 significant figures.
6. Evaluate $\frac{(4.527 + 3.63)}{(452.51 \div 34.75)} + 0.468$ correct to 5 significant figures.

7. Evaluate $52.34 - \frac{(912.5 \div 41.46)}{(24.6 - 13.652)}$ correct to 3 decimal places.
8. Evaluate $\frac{52.14 \times 0.347 \times 11.23}{19.73 \div 3.54}$ correct to 4 significant figures.
9. Evaluate $\frac{451.2}{24.57} - \frac{363.8}{46.79}$ correct to 4 significant figures.
10. Evaluate $\frac{45.6 - 7.35 \times 3.61}{4.672 - 3.125}$ correct to 3 decimal places.

4.3 Further calculator functions

Square and cube functions

Locate the x^2 and x^3 functions on your calculator and then check the following worked examples.

Problem 3. Evaluate 2.4^2

- (i) Type in 2.4
- (ii) Press x^2 and 2.4^2 appears on the screen.
- (iii) Press = and the answer $\frac{144}{25}$ appears.
- (iv) Press the $S \leftrightarrow D$ function and the fraction changes to a decimal: 5.76

Alternatively, after step (ii) press Shift and = .
Thus, $2.4^2 = 5.76$

Problem 4. Evaluate 0.17^2 in engineering form

- (i) Type in 0.17
- (ii) Press x^2 and 0.17^2 appears on the screen.
- (iii) Press Shift and = and the answer 0.0289 appears.
- (iv) Press the ENG function and the answer changes to 28.9×10^{-3} , which is **engineering form**.

Hence, $0.17^2 = 28.9 \times 10^{-3}$ in engineering form. The ENG function is extremely important in engineering calculations.

Problem 5. Change 348620 into engineering form

- (i) Type in 348620
- (ii) Press = then ENG.

Hence, $348620 = 348.62 \times 10^3$ in engineering form.

Problem 6. Change 0.0000538 into engineering form

- (i) Type in 0.0000538
- (ii) Press = then ENG.

Hence, $0.0000538 = 53.8 \times 10^{-6}$ in engineering form.

Problem 7. Evaluate 1.4^3

- (i) Type in 1.4
- (ii) Press x^3 and 1.4^3 appears on the screen.
- (iii) Press = and the answer $\frac{343}{125}$ appears.
- (iv) Press the $S \Leftrightarrow D$ function and the fraction changes to a decimal: 2.744

Thus, $1.4^3 = 2.744$

Now try the following Practice Exercise

Practice Exercise 13 Square and cube functions (answers on page 1149)

1. Evaluate 3.5^2
2. Evaluate 0.19^2
3. Evaluate 6.85^2 correct to 3 decimal places.
4. Evaluate $(0.036)^2$ in engineering form.
5. Evaluate 1.563^2 correct to 5 significant figures.
6. Evaluate 1.3^3
7. Evaluate 3.14^3 correct to 4 significant figures.
8. Evaluate $(0.38)^3$ correct to 4 decimal places.
9. Evaluate $(6.03)^3$ correct to 2 decimal places.
10. Evaluate $(0.018)^3$ in engineering form.

Square and cube functions

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Reciprocal and power functions

The reciprocal of 2 is $\frac{1}{2}$, the reciprocal of 9 is $\frac{1}{9}$ and the reciprocal of x is $\frac{1}{x}$, which from indices may be written as x^{-1} . Locate the reciprocal, i.e. x^{-1} , on the calculator. Also, locate the power function, i.e. x^{\square} , on your calculator and then check the following worked examples.

Problem 8. Evaluate $\frac{1}{3.2}$

- (i) Type in 3.2
- (ii) Press x^{-1} and 3.2^{-1} appears on the screen.
- (iii) Press = and the answer $\frac{5}{16}$ appears.
- (iv) Press the $S \Leftrightarrow D$ function and the fraction changes to a decimal: 0.3125

Thus, $\frac{1}{3.2} = 0.3125$

Problem 9. Evaluate 1.5^5 correct to 4 significant figures

- (i) Type in 1.5
- (ii) Press x^{\square} and 1.5^{\square} appears on the screen.
- (iii) Press 5 and 1.5^5 appears on the screen.
- (iv) Press Shift and = and the answer 7.59375 appears.

Thus, $1.5^5 = 7.594$, correct to 4 significant figures.

Problem 10. Evaluate $2.4^6 - 1.9^4$ correct to 3 decimal places

- (i) Type in 2.4
- (ii) Press x^{\square} and 2.4^{\square} appears on the screen.
- (iii) Press 6 and 2.4^6 appears on the screen.
- (iv) The cursor now needs to be moved; this is achieved by using the cursor key (the large blue circular function in the top centre of the calculator). Press \rightarrow
- (v) Press -
- (vi) Type in 1.9, press x^{\square} , then press 4
- (vii) Press = and the answer 178.07087... appears.

Thus, $2.4^6 - 1.9^4 = 178.071$, correct to 3 decimal places.

Now try the following Practice Exercise

Practice Exercise 14 Reciprocal and power functions (answers on page 1149)

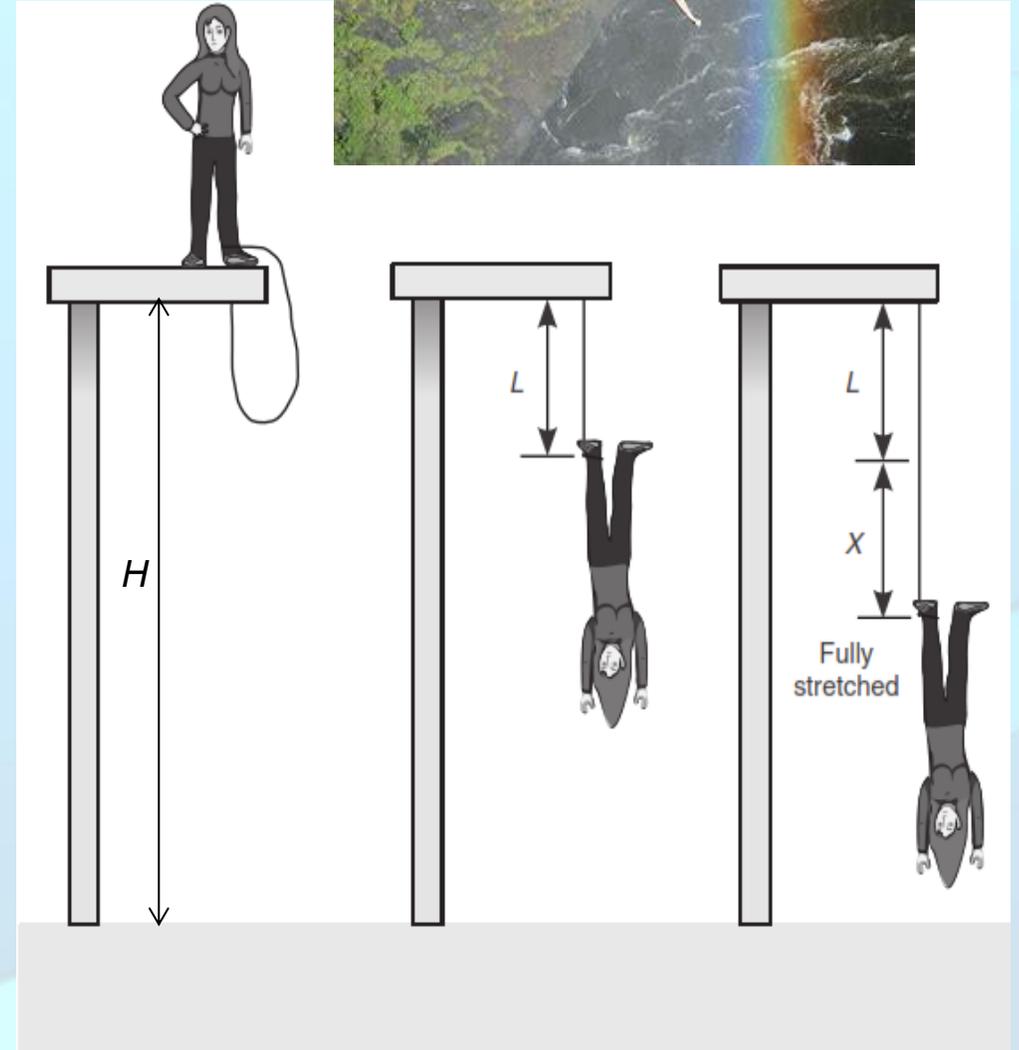
1. Evaluate $\frac{1}{1.75}$ correct to 3 decimal places.
2. Evaluate $\frac{1}{0.0250}$
3. Evaluate $\frac{1}{7.43}$ correct to 5 significant figures.
4. Evaluate $\frac{1}{0.00725}$ correct to 1 decimal place.
5. Evaluate $\frac{1}{0.065} - \frac{1}{2.341}$ correct to 4 significant figures.
6. Evaluate 2.1^4
7. Evaluate $(0.22)^5$ correct to 5 significant figures in engineering form.
8. Evaluate $(1.012)^7$ correct to 4 decimal places.
9. Evaluate $(0.05)^6$ in engineering form.
10. Evaluate $1.1^3 + 2.9^4 - 4.4^2$ correct to 4 significant figures.

Bungee Jumping Design.(Kosky)

As displayed in the figure. At full stretch, the elastic rope of original length L stretches to $L + X$. For a person whose weight is W [N] and a cord with a stiffness K [N/m], the extension X [m] is given by the following formula:

$$X = \frac{W}{K} + \sqrt{\frac{W^2}{K^2} + \frac{2WL}{K}}$$

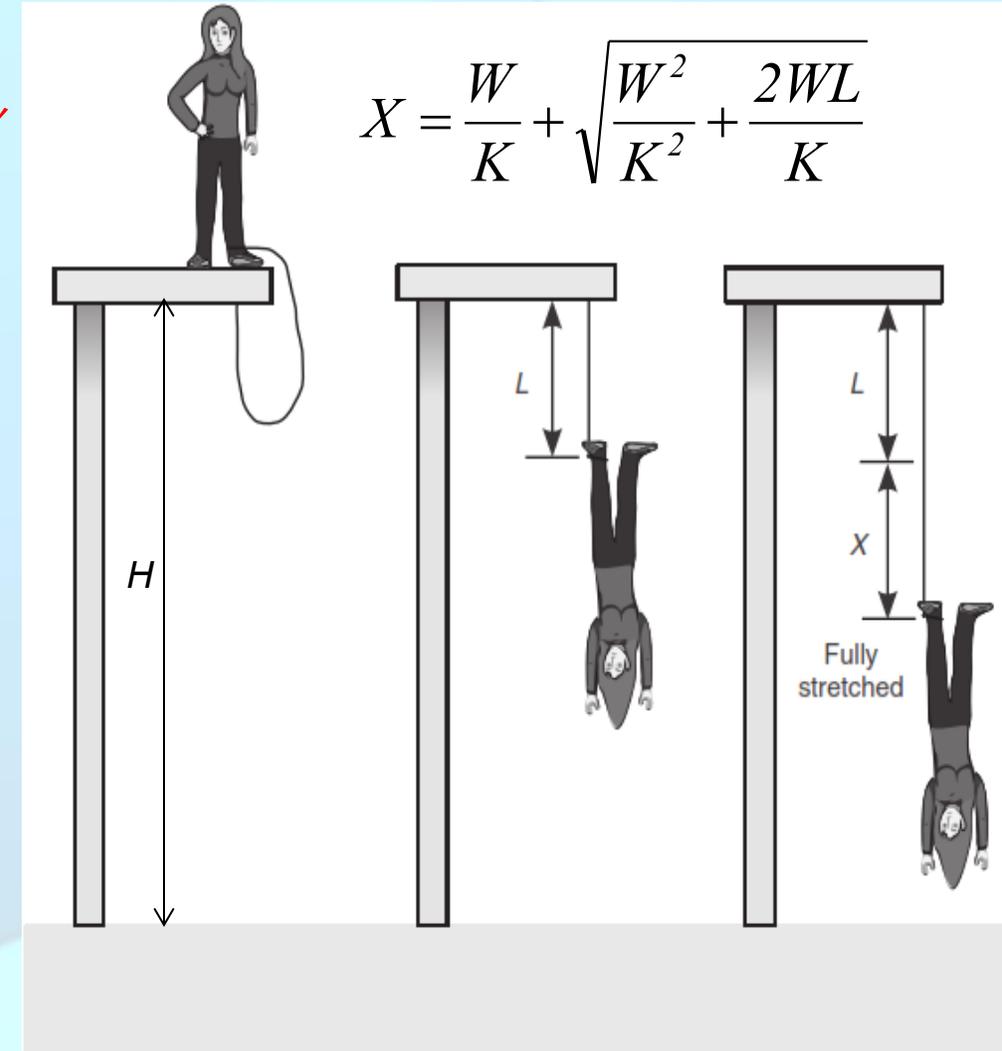
1. If the height of the tower H is 50 m, $K = 100$ N/m, $L = 15$ m, and the person's weight W is 700 N, will the person be able to bungee jump safely? Support your answer by giving the final value for $L + X$.
2. What's the jumper's weight limit?



3. If the height of the tower is 60 m, and the weight of the person is 800 N, and the unstretched length $L = 20$ m, find a value of K that enables this person to stop exactly 2 m above the ground.

4. Determine the height of the tower H , if $K = 80$ N/m, $L = 22$ m, and the person's weight W is 1000 N, and if the person must stop exactly 3m above the ground

5. Determine L the length of the rope, if $K = 80$ N/m, $H = 64$ m, and the person's weight W is 1000 N, and if the person must stop exactly 3m above the ground.



Solving simultaneous equations

- solve simultaneous equations in two unknowns by substitution
- solve simultaneous equations in two unknowns by elimination

Problem 1. Solve the following equations for x and y ,

(a) by substitution and

(b) (b) by elimination

$$x + 2y = -1 \quad (1)$$

$$4x - 3y = 18 \quad (2)$$

Problem 2. Solve, by a substitution method, the simultaneous equations

$$3x - 2y = 12 \quad (1)$$

$$x + 3y = -7 \quad (2)$$

Problem 3. Use an elimination method to solve the following simultaneous equations

$$3x + 4y = 5 \quad (1)$$

$$2x - 5y = -12 \quad (2)$$

Calculator Practice revision

Use your calculator to

1. Evaluate $\cos 63.74^\circ$ correct to 4 decimal places
2. Evaluate $\tan 39.55^\circ - \sin 52.53^\circ$ correct to 3 decimal places
3. Evaluate $\sin(0.437 \text{ rad})$ correct to 4 decimal places
4. Evaluate $\frac{\sin 67^\circ - \sin 43^\circ}{\sin 10^\circ}$ correct to 3 decimal places

Use your calculator to

1. Evaluate $2.7(\pi - 1)$ correct to 3 significant figures
2. Evaluate $\pi^2(\sqrt{13} - 1)$ correct to 4 significant figures
3. Evaluate $3e^{(2\pi-1)}$ correct to 3 significant figures
4. Evaluate $\sqrt{\left[\frac{5.52\pi}{2e^{-2} \times \sqrt{26.73}}\right]}$ correct to 4 significant figures

A man wants to purchase the largest fenced-in square ranch he can afford. He has 320,000,000 SP available for the purchase. Fencing costs 10×10^6 SP a kilometer, and land costs 100×10^6 SP a square kilometer.

How large a ranch, as measured by the length of one side of the square, can he buy?

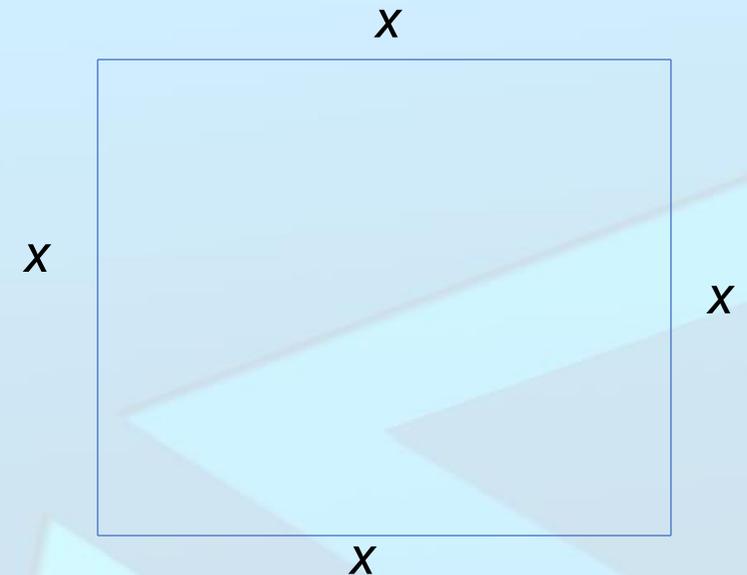
Need: The length of a side of the largest square of land the man can buy.

Knowns: Fencing costs 10×10^6 SP a kilometer, and land costs 100×10^6 SP square kilometer.

The man has 320,000,000 SP to invest.

How?: Let the unknown length = X kilometers. It may not be immediately obvious how to write an equation to find X . Now sketch the ranch.

Solve:



مسألة تقديرات: كم محل للحلاقة الرجالية تحتاج مدينة عدد سكانها 60,000 نسمة؟ سجل فرضياتك المبررة لنتائجك.

Write the two following equations in a suitable form to be solved using your calculator

- | | |
|---|--------------------------------------|
| 1. $7p + 11 + 2q = 0$ | 2. $\frac{x}{2} + \frac{y}{3} = 4$ |
| $-1 = 3q - 5p$ | $\frac{x}{6} - \frac{y}{9} = 0$ |
| 3. $\frac{a}{2} - 7 = -2b$ | 4. $\frac{3}{2}s - 2t = 8$ |
| $12 = 5a + \frac{2}{3}b$ | $\frac{s}{4} + 3t = -2$ |
| 5. $\frac{x}{5} + \frac{2y}{3} = \frac{49}{15}$ | 6. $v - 1 = \frac{u}{12}$ |
| $\frac{3x}{7} - \frac{y}{2} + \frac{5}{7} = 0$ | $u + \frac{v}{4} - \frac{25}{2} = 0$ |
| 7. $1.5x - 2.2y = -18$ | 8. $3b - 2.5a = 0.45$ |
| $2.4x + 0.6y = 33$ | $1.6a + 0.8b = 0.8$ |

Write the following equations in a form suitable to be solved using your calculator

1. $\frac{3}{x} + \frac{2}{y} = 14$

2. $\frac{4}{a} - \frac{3}{b} = 18$

$\frac{5}{x} - \frac{3}{y} = -2$

$\frac{2}{a} + \frac{5}{b} = -4$

3. $\frac{1}{2p} + \frac{3}{5q} = 5$

4. $\frac{5}{x} + \frac{3}{y} = 1.1$

$\frac{5}{p} - \frac{1}{2q} = \frac{35}{2}$

$\frac{3}{x} - \frac{7}{y} = -1.1$

5. $\frac{c+1}{4} - \frac{d+2}{3} + 1 = 0$

$\frac{1-c}{5} + \frac{3-d}{4} + \frac{13}{20} = 0$

6. $\frac{3r+2}{5} - \frac{2s-1}{4} = \frac{11}{5}$

7. $\frac{5}{x+y} = \frac{20}{27}$

$\frac{3+2r}{4} + \frac{5-s}{3} = \frac{15}{4}$

$\frac{4}{2x-y} = \frac{16}{33}$

8. If $5x - \frac{3}{y} = 1$ and $x + \frac{4}{y} = \frac{5}{2}$, find the value of $\frac{xy+1}{y}$