

# THE CALCULUS

Adapted from *Rozšiřující materiály pro výuku anglického jazyka*, Křepinská, Houšková, Bubeníková, Matfyzpress 2006.

Read the text and answer these QS.

- Who „invented“ calculus? .....
- From which techniques was it developed? .....
- What did Newton use infinitesimals for? .....
- Which algorithm did he devise? .....
- Which transcendental curves were subjects of his analysis? .....

The historian Carl Boyer has called the calculus “the most effective instrument for scientific investigation that mathematics has ever produced”. As the mathematics of variability and change, the calculus was the characteristic product of the scientific revolution. The subject was properly the invention of two mathematicians, the German Gottfried Wilhelm Leibniz and the Englishman Isaac Newton. Both men published their researches in the 1680s, Leibniz in 1684 in the recently founded journal *Acta Eruditorum* and Newton in 1687 in his great treatise *Principia Mathematica*. Although a bitter dispute over priority developed later among followers of the two men, it is now clear that they each arrived at the calculus independently.

The calculus developed from techniques to solve two types of problems, the determination of areas and volumes and the calculation of tangent curves. The essential insight of Newton and Leibniz was to use Cartesian algebra to synthesize the earlier results and develop algorithms that could be applied uniformly to a wide class of problems.

Using the Cartesian equation of the curve, Newton reformulated Wallis’ results, introducing for this purpose infinite sums in the power of an unknown  $x$ , now known as infinite series. He used infinitesimals to establish for various curves the inverse relationships of tangents and areas. The operations of differentiation and integration emerged in his work as analytical processes that could be applied generally to investigate curves.

Leibniz investigated relationships among the summing and differencing of finite and infinite sequences of numbers. Having read Barrow’s geometric lectures, he devised a transformation rule to calculate quadratures, obtaining the famous infinite series for  $\pi/4$ :

$$\frac{\pi}{4} = \frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots$$

Leibniz was interested in questions of logic and notation, of how to construct a *characteristica universalis* for rational investigation. After considerable experimentation he arrived by the late 1670s at an algorithm based on the symbols “d” and “∫”. His research on differential calculus was published in 1684 in an article *A new Method for Maxima and Minima as Well as Tangent, Which Is Impeded Neither by Fractional nor by Rational Quantities, and a Remarkable Type of Calculus for This*. In this article he introduced the differential  $dx$  satisfying the rules  $d(x+y)=dx+dy$  and  $d(xy)=xdy+ydx$  and illustrated his calculus with a few examples. Two years later he published his second article, *On a Deeply Hidden Geometry*, in which he introduced and explained the symbol  $\int$  for integration. He stressed the power of his calculus to investigate transcendental curves, the very class of “mechanical” objects Descartes had believed lay beyond the power of analyses, and derived a simple analytical formula for the cycloid.

## Exercises

1. *In the passage above find all the nouns which form their plurals irregularly and those that have only a singular or plural form. (Write their singular and plural forms if possible).*
2. *Put into the singular form:*
  - a) The experiments may confirm the hypotheses.
  - b) The analyses are not exact.
  - c) What criteria do the authors use?
  - d) The articles describe certain features of those phenomena.
  - e) DNA is stored in the nuclei of cells.
  - f) The radii of these wheels are 30 cm.
  - g) Students are writing their theses on black holes.
  - h) Cacti are desert plants with thick stems for storing water and with spines.
  - i) The media focus on politicians' private lives.
  - j) Is the German language on the curricula at British schools?
3. *Choose the correct word for each of the following and give the plural form: (analysis, criterion, memorandum, phenomenon, formula, datum, crisis, medium)*
  - a) ..... are facts given.
  - b) ..... are observed events.
  - c) ..... are decisive moments.
  - d) ..... are channels of communication.
  - e) ..... are notes to assist the memory.
  - f) ..... are standards or means of judging.
  - g) ..... are general expressions for solving problems.
  - h) ..... are separations of things into their parts or components.
4. *Fill in a suitable expression in the correct form: (radius, formula, datum, criterion, focus, spectrum, crisis, vertex, nucleus, curriculum vitae. They may be used more than once)*
  - a) The ..... of a circle is the length of a straight line drawn between the centre and the outside edge.
  - b) We had to learn many chemical ..... at school but I can only remember H<sub>2</sub>O for water.
  - c) The ..... was/were collected by various researchers.
  - d) The Health Service should not be judged by financial ..... alone.
  - e) All the line segments extending from the centre of a circle are called .....
  - f) In physics the point where waves of light or sound which are moving towards each other meet is called a.....
  - g) A ..... is a short group of letters, numbers or other symbols which represent a scientific or mathematical rule.
  - h) The set of colours into which a beam of light can be separated is called a .....
  - i) Now the ..... is being transferred from magnetic tape to hard disc.
  - j) The ..... I apply to (= by which I decide about) any problem is "What will make me happiest?"
  - k) I've passed several ..... during my illness, but the fever's started to go down since yesterday.
  - l) How many ..... are there in a triangle?
  - m) Nuclear fission means the dividing of a ..... and nuclear fusion means the joining of the two .....
  - n) My uncle's ..... written before and after the Velvet revolution differ a lot.

# FOCUS C

## IRREGULAR PLURAL OF NOUNS: SPECIAL CASES

### I. Nouns of Greek or Latin origin

Words which retain their original Greek or Latin forms make their plurals according to the rules of Greek or Latin. Some of them can have two plural forms, sometimes with different meanings.

#### 1. -is → -es [i:z]

<i>singular</i>		<i>plural</i>	
analysis	[ə'neɪlɪsɪs]	analyses	[ə'neɪlɪsɪ:z]
axis	['æksɪs]	axes	['æksɪsɪ:z]
basis	['beɪsɪs]	bases	[beɪsɪ:z]
crisis	['kraɪsɪs]	crises	['kraɪsɪ:z]
diagnosis	[daɪəg'naʊsɪs]	diagnoses	[daɪəg'naʊsɪ:z]
ellipsis	[ɪ'lɪpsɪs]	ellipses	[ɪ'lɪpsɪ:z]
hypothesis	[haɪ'pɒθɪsɪs]	hypotheses	[haɪ'pɒθɪsɪ:z]
neurosis	[njuə'reʊsɪs]	neuroses	[njuə'reʊsɪ:z]
oasis	[ou'eɪsɪs]	oases	[ou'eɪsɪ:z]
parenthesis	[pə'renθɪsɪs]	parentheses	[pə'renθɪsɪ:z]
synthesis	['sɪnθəsɪs]	syntheses	['sɪnθəsɪ:z]
thesis	[θɪ:sɪs]	theses	[θɪ:sɪ:z]

#### 2. -on → -a [ə]

<i>singular</i>		<i>plural</i>	
criticon	['kraɪtɪkən]	criteria	['kraɪ'tɪəriəl/ənz]
octahedron	[ɒktə'hedrən]	octahedra	['ɒktə'hedrə/ənz]
phenomenon	[fɪ'nɒmɪnən]	phenomena	[fɪ'nɒmɪnə]
polyhedron	[pɒli'hedrən]	polyhedra	[pɒli'hedrə/ənz]

#### 3. -a → -ae [i:]

<i>singular</i>		<i>plural</i>	
abscissa	[æb'sɪsə]	abscissae	[æb'sɪsɪ:/əs]
alga	[ælgə]	algae	[ældʒi:]
formula	[fo:'mjulə]	formulae	[fo:'mjulɪ:/əs]
lacuna	[lə'kjʊ:nə]	lacunae	[lə'kjʊ:nɪ:]
larva	[lɑ:və]	larvae	[lɑ:vɪ:/əs]
nebula	[nebjulə]	nebulae	[nebjulɪ:]
persona	[pə'seɪnə]	personae	[pə'seɪnɪ:]
vertebra	['vɛɪbrə]	vertebrae	['vɛɪbrɪ:]

#### 4. -um → -a [ə]

<i>singular</i>		<i>plural</i>	
addendum	[ə'dendəm]	addenda	[ə'dendəm]
bacterium	[bækt'ɪəriəm]	bacteria	[bækt'ɪəriə]
curriculum	[kə'rɪkjuləm]	curricula	[kə'rɪkjulə]
datum	['dætəm]	data	[deɪtə]

erratum	[ə'reɪtəm]	errata	[ə'reɪtə]	tisková chyba
frustrum	['frʌstrəm]	frustra	['frʌstrə/əms]	kužel, komolý jehlan

maximum	[mæksɪmə]	maxima	~ums [mæksɪmə/əms]	maximum
medium	[mi'diəm]	media	~ums [mi'diə/əms]	medium
memorandum	[memə'rendəm]	memoranda	~ums [memə'rendə/əms]	memorandum
millennium	[mi'lenɪəm]	millennia	~ums [mi'lenɪə]	mléniúm
pendulum	[pendjulum]	pendula	~ums [pendjulə/əms]	kyvadlo
spectrum	[spektrəm]	spectra	[spektrə]	spektrum
stratum	[strætəm]	strata	[stratə]	vrstvá
trapezium	[trə'pi:zjəm]	trapezia	~ums [trə'pi:ziə/əms]	lichoběžník

#### 5. -ex / -ix → -ices [ɪsɪz]

<i>singular</i>		<i>plural</i>	
apex	[eɪpeks]	apices	[eɪpɪsɪz/ eɪpeksɪz]
appendix	[ə'pendɪks]	appendices	[ə'pendɪsɪz/ kɪsɪz]
directrix	[di'retrɪks/ daɪ'retrɪks]	directrices	[di'retrɪsɪz/ daɪ'retrɪsɪz]
index	[ɪndeks]	indices	[ɪndɪsɪz]
matrix	[mætrɪks]	matrices	[mætrɪsɪz/ mætrɪksɪz]
radix	[reɪdɪks]	radices	[reɪdɪsɪz]
vertex	['vɛrteks]	vertices	['vɛrtɪsɪz]

#### 6. -us → -i [aɪ]

<i>singular</i>		<i>plural</i>	
annulus	[ænju:ləs]	annuli	[ænju:lɪ]
bacillus	[bɒsɪləs]	bacilli	[bɒ'sɪlɪ]
cactus	['kæktəs]	cacti	['kæktɪ]
calculus	[kælkjʊləs]	calculi	[kælkjʊ:lɪ]
focus	['faukəs]	foci	['fauzəl/ fɒukəsɪs]
fungus	['fʌŋɡəs]	fungi	['fʌŋɡəl/ fændʒɪ]
genius	[dʒɪ'njəs]	genii	[dʒɪ'maɪ/ jəsɪz]
locus	['lɒkəs]	loci	['lɒnsɪ]
nucleus	[nju:'kliəs]	nuclei	[nju:'klɪəl]
radius	['reɪdɪəs]	radii	['reɪdɪəl/ əsɪz]
rhombus	['rɒmbəs]	rhombi	['rɒmbɪ]
stimulus	['stɪmjuləs]	stimuli	['stɪmjulɪ]
terminus	['tɜ:mɪnəs]	termini	['tɜ:mɪnəl/ əsɪz]

Notice: genus [dʒɪ:nəs] – genera [dʒenərə] (zool. rod, třída, druh)

There is a tendency, particularly with fairly common Latin or Greek words, to make the plural according to the rules of English.