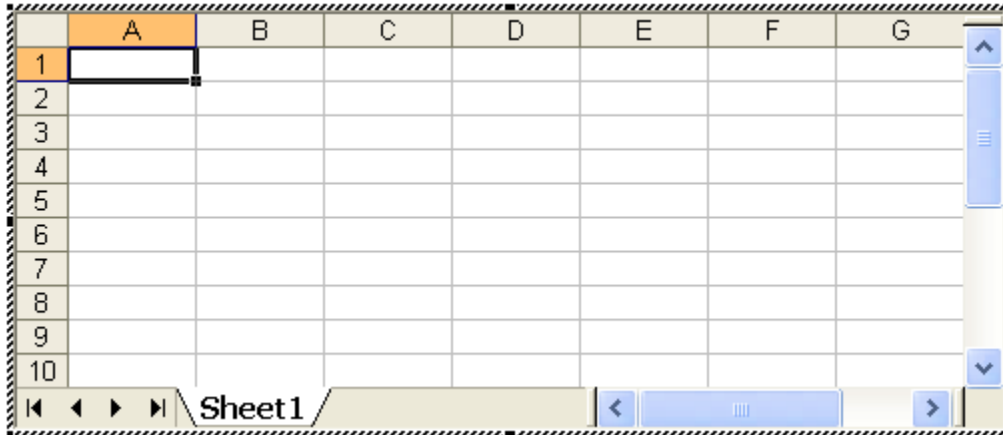


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INTRODUCTION TO EXCEL

Excel is Microsoft's spreadsheet program. A spread sheet presents arithmetic results in a useful way. On entry to the Excel program, we see a set of boxes, with rows labeled by numbers and columns labeled by letters.



A box is selected by using the mouse to point to the box and clicking the left mouse button.

A text entry is made by selecting a box and typing a single quote followed by the text.

A number entry is made by selecting a box and typing the number

Arithmetic can be done on numbers already entered using +, -, *, / and ^ for addition, subtraction, multiplication, division and exponentiation (raising a number to a power), respectively. Complicated expressions are made possible by using sets of parentheses. Boxes in arithmetic expressions are addressed by column letter and row number.

There are many other functions. In the following example, the SQRT function, which finds the square root of a number, will be used.

SIMPLE EXAMPLE

Enter the following

Box	Entry
A1	'A
A2	'B
B1	2
B2	3
A3	'A+B
B3	+B1+B2
A4	'sqrt(A+B)
B4	+SQRT(B3)

EXCEL, KEPLER'S THIRD LAW and ORBITAL RESONANCE

The spread sheet should now look like the one on the top of page 2.

	A	B	C	D	E	F	G
1	A		2				
2	B		3				
3	A+B		5				
4	sqrt(A+B)	2.236068					
5							
6							
7							
8							
9							
10							

If you need more space in a column, point the mouse to the vertical line between column labels and drag it over using the left mouse button.

Numbers can be formatted to your liking. Click on a cell, click on the Format menu entry and click on cells. You may then choose number or scientific, for scientific notation and also choose the number of decimal places to be displayed. All numbers are stored internally in double precision, which is about 15 significant figures.

Here, I have chosen the simplest possible way of doing things with Excel. It is not necessarily the best way when dealing with a large spreadsheet containing many numbers.

KEPLER'S THIRD LAW AND ORBITAL RESONANCE

Kepler's third law in its original form, applicable to planets revolving around the Sun, states that

$$P^2 = a^3 \quad (1)$$

where

a is the semi-major axis in AU (astronomical unit; average Earth Sun distance)

P is the period of revolution in Earth years.

Dividing by P^2 gives

$$1 = \frac{a^3}{P^2} \quad (2)$$

Newton's answer to "one what?" is one solar mass. For two body systems such as a planet and its relatively tiny moon, the mass of the planet is obtained as

$$m_{\text{planet}} = \frac{a^3}{P^2} \quad (3)$$

where

m_{planet} is the mass of the planet in solar masses

a is the semi-major axis of the moon's orbit in AU

P is the period of revolution of the moon about the planet in Earth years

Orbital resonance is detected by finding that periods of motions are in a ratio of small whole numbers.

EXCEL, KEPLER'S THIRD LAW and ORBITAL RESONANCE

EXPERIMENT

Here we are going to use Kepler's third law to determine the periods of revolution of the four moons of Jupiter discovered by Galileo in 1610, and the ratios of the periods. Rearranging equation (3) gives

$$P^2 = \frac{a^3}{m_J} \quad (4)$$

where

m_J is the mass of Jupiter in solar masses.

PROCEDURE

1) Make the following entries in an Excel spreadsheet. Your name is included because you will be printing it and handing it in.

Box	Entry
A1	'Name
B1	'your name
A2	'Date
B2	'the date
A3	'mJ
B3	+1/1047.3486
A4	'km/AU
B4	1.49597870691E8
A5	'Moon
B5	'Io
C5	'Europa
D5	'Ganymede
E5	'Callisto
A6	'a(km)
B6	421800
C6	671100
D6	1070400
E6	1882700
A7	'a(AU)
B7	+B6/B4
C7	+C6/B4
D7	+D6/B4
E7	+E6/B4
A8	'a^3
B8	+B7^3
C8	+C7^3
D8	+D7^3
E8	+E7^3
A9	'P^2
B9	+B8/B3
C9	+C8/B3
D9	+D8/B3
E9	+E8/B3

EXCEL, KEPLER'S THIRD LAW and ORBITAL RESONANCE

Your spreadsheet should now look something like this.

	A	B	C	D	E	F	G
1	Name	Mortimer Snerd					
2	Date	9/1/11					
3	mJ	0.000954792					
4	km/AU	1.50E+08					
5	Moon	Io	Europa	Ganymede	Callisto		
6	a(km)	421800	671100	1070400	1882700		
7	a(AU)	2.82E-03	4.49E-03	7.16E-03	1.26E-02		
8	a^3	2.24152E-08	9.02787E-08	3.66321E-07	1.99327E-06		
9	P^2	2.34766E-05	9.45533E-05	0.000383666	0.002087653		
10							

Sheet1

2) In the process of entering numbers and doing arithmetic, numbers were formatted automatically using Microsoft's default procedures, so it is necessary to clean up the mess. Re-format using scientific notation, using the appropriate number of significant figures.

The ratio of the mass of the Sun to the mass of Jupiter was correct to eight significant figures, so use 7 decimal places for the mass of Jupiter.

The km/AU conversion factor is given to 12 significant figures (its uncertainty is a mere 3 m) so use 11 decimal places.

The semi-major axes in km have 4 significant figures for Io and Europa, and five significant figures for Ganymede and Callisto, so use 3 decimal places for Io and Europa, and 4 decimal places for Ganymede and Callisto.

The number of significant figures for calculations based on the a values can't be better than the a values, so adjust the number of significant figures in rows 8 and 9 (and subsequent work, below) accordingly.

Adjust the column widths so that the numbers are shown properly.

3) Continue the spreadsheet with the periods and the ratios of periods

Box	Entry	Comment
A10	'P	
B10	+SQRT(B9)	Format to scientific notation, 3 decimal places
C10	+SQRT(C9)	Format to scientific notation, 3 decimal places
D10	+SQRT(D9)	Format to scientific notation, 4 decimal places
E10	+SQRT(E9)	Format to scientific notation, 4 decimal places
A11	'P/P(Io)	
B11	1	Format to number, 0 decimal places
C11	+C10/B10	Format to scientific notation, 3 decimal places
D11	+D10/B10	Format to scientific notation, 3 decimal places
E11	+E10/B10	Format to scientific notation, 3 decimal places

4) Answer the following question on the spreadsheet:

Which of the Galilean moons of Jupiter have orbital periods that are in ratios close to whole numbers?

5) Print the spreadsheet on one page (use the print preview to check this) and hand it in.