

Biorhythms



Solutions

7 8 9 10 11 12



TI-Nspire



Investigation



Student



30 min

Introduction

Ever had one of those days when you wake up feeling lethargic, mentally drained or seem to catch every cold going around. Alternatively some days you wake up feeling bullet proof, full of energy and shooting goals like a professional or smashing through your personal best times. What causes us to move between these extremes, is it diet, sleep or some sort of circadian rhythm?

In the 1890s a German doctor, Wilhelm Fliess, observed similar events when monitoring his patients. Some were depressed one week and fine the next; some seemed to be immune to the cold of the moment and yet caught everything two weeks earlier. Fliess started recording how his patients felt to see if there was a pattern.



The statistics he gathered led him to believe he had discovered certain cycles (rhythms) that were fundamental to a person's life. He theorised that everyone has internal clocks that start at birth and continue until they die. The two clocks he proposed were a 23 day cycle that influences physical condition, the other, a 28 day cycle influencing emotions.

In the 1920s, Alfred Teltscher, an Austrian engineering teacher, added the 'mind' (or 'intellectual') period of 33 days (which completes what is known as the three primary cycles (physical, emotional and intellectual), based upon his observation that his students' work followed a 33-day pattern.

More recently the 38-day intuitional cycle, the 43-day aesthetic cycle, and the 53-day spiritual cycle have been added. Some claim there are cycles that are combinations of the three primary cycles. The passion cycle is the physical joined with the emotional cycle. The wisdom cycle is the emotional joined with the intellectual cycle. And the mastery cycle is the intellectual joined with the physical cycle.

Having said all that, and for all the prophetic studies, Biorhythms is not exactly a science. Whilst our bodies do have naturally occurring cycles that help explain things like 'jet lag'; events such as feeling down are statistically in line with natural probability and more accurately aligned with diet and physical activity. For the sceptics, cynics and realists, you can put the study of Biorhythms on the bookshelf somewhere between "Astrology – a self-fulfilling prophetic vagueness" and "Where to find the Pixies, Gnomes and Fairies in your Garden".

Despite the scientific inaccuracies presented by Biorhythms, they're fun to calculate. In this activity you will be required to graph each of the following cycles:

- Intellectual
- Emotional
- Physical

Preparation cycle:

This is not a new cycle, rather the basic computations required to commence calculations and preparations for the determination of each 'cycle' equation.

Question: 1

Determine the number of days that you have been alive as of today. You can use a spreadsheet, Google or you can use your calculator!

Answers will be different for each student depending on their birthday; however the TI-Nspire "Biorhythms Answer" file provides most of these results by entering the student's date of birth and the current date. Some answers may be represented differently since expressions may be automatically 'simplified' such as: $\sin(x + \pi) = -\sin(x)$ and students should answer in the form $\sin(n(x-h))$ rather than $\sin(nx-h)$.

Page 1.1 contains a notes page with a series of 'maths' boxes. Edit the 'today' information; this should only need to be done once if all students are doing the task on the same day. Edit the student's birth date; make sure to press 'enter' as each entry is completed.

Navigate to page 1.2 and you will see most of the date relevant answers. In some cases fractional answers are included, these may be rounded accordingly.

TI-Nspire calculator screen showing Birth Details and Today information. The Birth Details section includes: Birth day (1 ≤ days ≤ 31) bday: =27, Birth month (1 ≤ month ≤ 12) bmonth: =8, Birth year (1950 ≤ year ≤ 2020) byear: =1998. The Today section includes: Day (1 ≤ days ≤ 31) day: =16, Month (1 ≤ month ≤ 12) month: =10, Year (1950 ≤ year ≤ 2020) year: =2015.

TI-Nspire calculator screen showing answers for Question 1 and Question 2. Answer Q1: 18046 days. Answer Q2 (a): 28 days into intellectual cycle, Answer Q2 (b): 14 days into emotional cycle, Answer Q2 (c): 14 days into physical cycle. Answer Q6: $i(x) = \sin\left(\frac{2 \cdot \pi \cdot x}{33} + \frac{10 \cdot \pi}{33}\right)$



Use the dbd() command in TI-Nspire. (dbd = Days Between Dates)
The syntax is as follows:

$$\text{dbd}(\text{MM.DDYY}, \text{MM.DDYY})$$

Example: How many days between August 27th 1998 and October 9th 2015:

$$\text{dbd}(08.2798, 10.0915) = 6252$$

Question: 2

Determine the number of days you have progressed into each cycle. (Use modular arithmetic)

- Intellectual 33 days
- Emotional 28 days
- Physical 23 days

Different for each student depending on their birthday, use the calculator answer file.



Modular arithmetic is a great way to find the remainder of a division problem. Suppose you were asked: “What will the time be 49 hours from now? Common sense would say ... “add one hour to the current time” since $49 = 2 \times 24 + 1$. We’re not interested in the number of days elapsed, just the time.

Using modular arithmetic this would appear as follows:

$$\text{mod}(49,24)$$

The ‘**mod**’ command can be found in the calculator menu: Number – Number Tools - Mod

Question: 3

The period of the function $p(x) = \sin(x)$ is 2π . (Radians) What would be the period of the function: $f(x) = \sin(2\pi x)$?

Period = 1. The purpose of this question is to create a ‘unit’ period for students to work with, similar to idea of a unit vector. Students can then think logically, focusing on dilation rather than using or relying on a formula. The question also serves as a quick check to ensure they are in radian mode.

Question: 4

What would be the period of the function: $f(x) = \sin\left(\frac{2\pi}{17}x\right)$?

Period = 17 Multiplying x by 2π resulted in dilation to a period of 1, so following this, dividing by 17 dilates the graph so that it has a period of 17 (days). This approach reinforces dilations rather than using the formula: $p = \frac{2\pi}{n}$.

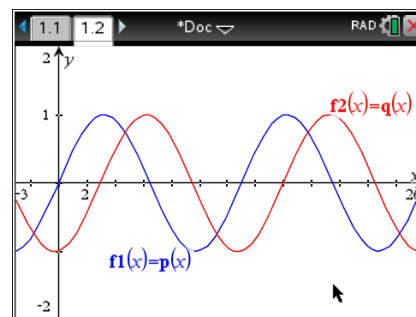
Question: 5

Given $p(x) = \sin\left(\frac{2\pi}{13}x\right)$ and $q(x) = p(x-3)$, sketch both graphs on the calculator and describe the graph of $q(x)$ in relation to $p(x)$.

In relation to $p(x)$, $q(x)$ is translated 3 units parallel to the x axis in a positive direction. This notation is used so that students recognise that their answers to questions later in this activity are easier to

generate when they are of the form: $q(x) = \sin\left(\frac{2\pi}{13}(x-3)\right)$ and

that $q(x) = \sin\left(\frac{2\pi}{13}x-3\right)$ would not be correct.





The **Window** settings for the Biorhythms questions should be:

Xmin: -1

Xmax: 62

Xscale: 7

Ymin: -3

Ymax: 3

Yscale: 1

The **Document** or **Graphs & Geometry** settings should have the angle set to **Radians**.

Intellectual cycle: (33 days)

Question: 6

Write down the equation for your intellectual cycle? (With today representing: $x = 0$)

Answer will be different for each student depending on their birthday. The general form uses the answer from Q2(a) $\sin\left(\frac{2\pi}{33}\left(x - \underline{Q2(a)}\right)\right)$ the calculator will expand the brackets or change the trigonometric function accordingly as per calculator answer file. This provides an opportunity to see how students are calculating their answers, calculator answers will have the 'expanded' form by default.

Question: 7

How many days until your next 'most intellectual' day?

Answer will be different for each student depending on their birthday, check the calculator answer file.

Emotional cycle: (28 days)

Question: 8

Write down the equation for your emotional cycle? (With today representing: $x = 0$)

Answer will be different for each student depending on their birthday. The general form uses the answer from Q2(b) $\sin\left(\frac{2\pi}{28}\left(x - \underline{Q2(b)}\right)\right)$

Question: 9

A critical day (good or bad) is when your cycle passes through zero. When are your next two emotionally critical days?

Answer will be different for each student depending on their birthday, check the calculator answer file.

Physical cycle: (23 days)

Question: 10

Write down the equation for your physical cycle? (With today representing: $x = 0$)

Answer will be different for each student depending on their birthday, check the calculator answer file.

Question: 11

If you're most likely to catch a cold during the lowest four days of your cycle, determine the dates during which this will occur.

Answer will be different for each student depending on their birthday, check the calculator answer file. The answer file contains the number of days ... add this result to today's date to answer the question specifically. (Note that question specifically asks for **dates**.)

Well Being

Question: 12

If awesome days occur when the sum of all three cycles produce a total greater than 2, determine approximately how many of these days you should experience in a year.

Answer will be different for each student depending on their birthday, check the calculator answer file where an approximate answer is provided for the next 12 months for the number of days.

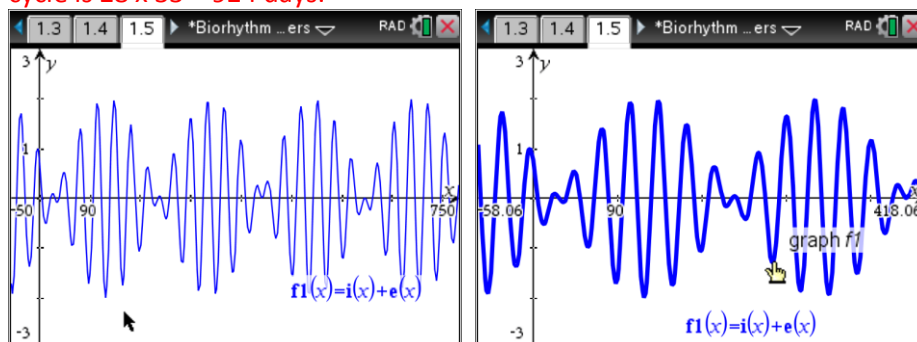
Students can define a new function as: $a(x) = i(x) + e(x) + p(x)$ being the sum of the three biorhythms and then solve $(a(x) = 2, x)$. Due to the nature of the function approximate results only will be found. Students should also check with the graph of $a(x)$

Question: 13

The 'wisdom' cycle is the sum of the intellectual and emotional cycles. Graph the sum of these two cycles over a two year period. You will notice it appears to be cyclic. Estimate from the graph how many days over which the graph cycles (period) and compare this to the calculated period.

Explain why these amounts are so different.

The first screen shot (left) shows a typical 'wisdom' cycle. The result is similar to 'beat' frequencies obtained in music where the two periods differ creating a combination of constructive and destructive interference. At first glance the period appears to be approximately 6 months. The second screen shot (right) zooms in on approximately 1 year where the subtle differences can be seen. So at first glance the period of the wisdom cycle appears to be approximately 6 months, this is a good answer from a practical perspective, however the real period can be determined by the lowest common multiple of the original periods. As 28 and 33 are mutually prime the period of the wisdom cycle is $28 \times 33 = 924$ days.



Question: 14

A zero day is when all cycles are set to zero and are just commencing. How old is a person when they experience their second zero day? (The first one occurs when you are born)



The three periods: 23, 28 and 33 are mutually prime. The first zero day after birth is therefore the product of these: $23 \times 28 \times 33 = 21252$ days or 58 years and just over 2 months... depending on what year you are born.

Note: The disturbance offered by the introduction of the third cycle (compared with the previous question) means the constructive and destructive interference cause an apparent randomness in the combined result.