Quadrivium 1 – Jim Donovan

You know what regular polygons are: two-dimensional figures that have all sides of equal lengths. There's the equilateral triangle (3), the square(4), etc. There are also regular solids which are three-dimensional figures made up of regular polygons. You're certainly familiar with one of the regular solids; the cube is a six-sided solid figure where every side is a square. People have known about the regular solids for a long time; they're often called 'the Platonic solids' since Plato refers to them.

So here is the question:

- How many different regular solids are there?
- What is the polygon (triangle, square, etc.) used in each?
- How many faces does each of them have?
- What are their names?

Quadrivium 2 – Bev Thurber

Imagine that you're running a race. You start at the same time as another runner. You fall behind at first, but come back to win. Is there a time during the race when you're both running at exactly the same speed? If not, why not? If so, how can you tell that you're there? (At the starting point, when you're both standing still, doesn't count.)

Quadrivium 3 – David Lukens

Insert the operations +(addition), -(subtraction), *(multiplication), and / (division) as many times as needed into the string of digits 987654321 to produce 99.

Quadrivium 4 – Jim Ulrich

Three musicians all start playing at exactly the same time and in time with one metronome, but they're playing in different time signatures. One is playing in 7/8 time, another is playing a waltz in 3/4 time, and another is playing in standard 4/4 time.

The obvious question is, is this jazz? Alternatively, if they're three mimes playing imaginary instruments in the woods and a tree falls on them, how many albums will they sell?

But now for the real question, assuming they are real musicians playing real instruments: What is the number of the downbeat when all three musicians will be playing the downbeat at the start of a measure simultaneously, not including beat number one?

Some definitions and examples that might be of help: The time signature indicates the number of beats in a measure and the note that gets one beat. In 3/4 time, there are three beats in a measure and the quarter note gets one beat. In 6/8 time, there are six beats in a measure, and the eighth note gets the beat. The downbeat is the first beat of a measure and is usually accented.

For those unfamiliar with 7/8 time, you can hear it in Pink Floyd's song Money, which starts off in 7/8, the goes back and forth between 4/4 and 7/8. Here's a link where you can hear it if needed http://video.libero.it/app/play?id=2d710293564528e496e6aaded9a2ca4a

For extra credit, what measure will each musician be in when they first simultaneously play a downbeat (again, not including the first measure).

Clarification

Just for clarification, the math question about beat number is asking for the first sequential beat at which all three musicians are simultaneously playing a downbeat. Sequentially as in positive, non-repeating integers 2,3,4,5,6,7,8,9,10...etc.

The downbeat occurs on beat 1 of each measure, as in **1**,2,3,4,**1**,2,3,4, etc., but because the musicians are playing in different time signatures, they won't hitting their downbeats simultaneously most of the time.

Quadrivium 5 – Stuart Patterson

So far we've covered three of the four arts of the quadrivium -geometry, arithmetic, and music (we've also done some strange modern hoodoo with changing rates of speed, but enough of that). This brings us to astronomy.

Now, I was hoping that we could do some problem solving based on observations, but with the weather looking like it'll be cloudy for another week at least, let me pose the following set of 4 questions based on what you might expect to see - and feel - in these waning days of the year.

1. Why is it getting colder? (i.e. according to the [arch-modern] Copernican system - so the answer should have mainly to do with what our planet is doing.)
2. Tomorrow, when the sun's at its highest point in the sky (or "zenith"), would the shadow cast (given some *%&#! sunshine!) by the Willis (nee Sears) Tower be longer, shorter or the same length as that it cast back in June?
3. At the next full moon (which will be the "Beaver Moon," on November 2, btw), would the moon-shadow cast by the Tower be longer, shorter or the same length as its moon-shadow under the full moon back in June (i.e. the "Strawberry Moon")?
4. Assuming that we could see the North Star back in June from the top of the Tower, where is it relative to the horizon now (i.e. closer to, further from, or the same distance)?

Short answers are fine, but you are also welcome to give your reasoning!
(A final caution: please don't risk your health answering these questions!)

Quadrivium 6

Not available

Quadrivium 7 – Jim Donovan

This week's challenge is not to solve a math problem, but to bridge the gap between words and equations, often a challenge even for professional physicists. But since Shimerians drink from both wells, it should be a snap.

Below is a limerick. The challenge is to put it into the form of a mathematical equation. There's a catch, of sorts: the equation uses one or more symbols that you won't find on your keyboard. While it's possible to type the answer on a computer and email it (by using math and symbol fonts), you are welcome to write it on paper and slip it with your name into my mailbox. Or, scan what you've written and email that. However you get it to me—carrier pigeon, even—I'll accept it.
So here it is:

> The integral z-squared dz
> From one to the cube root of three,
> Times the cosine
> Of three pi over nine
> Equals log of the cube root of e.

Quadrivium 8 – Jim Ulrich

Why do we have a 12 tone scale in Western music (and I don't mean just Country Western)? It would be convenient if we had 12 fingers, but most of us don't. So perhaps if you started with an ancient Greek scale that had 6 notes in an "octave" and wanted to make more complex music, it might make sense to just double the number of notes. But those of you who have had Hum 1 and know more about music theory than me can clarify this if needed.

Let's define our octave as being between A440 and A880. A string tuned to A440 would vibrate 440 times per second when plucked (not including overtones). A string of half the length would vibrate at 880 cycles/second. The Greek harps often had 6 strings tuned to ratios corresponding to the initial length, e.g., 4/5, 3/4, 2/3, 3/5, and 1/2. However, using ratios to tune to a 12 tone scale results in a problem. One of the 12 notes is going to be "off" by a little bit, i.e., sharper or flatter than it should be if the octave could be divided into equal divisions.

Enter the well tempered scale around 1700. In this tuning method, the frequency of each note is based on, ugh, exponents. The frequency (cycles per second) of each note in a 12 tone scale is 2 to the one twelvth (2 to the 1/12) times higher than the note below it. In other words, if you multiplied 440 by 2 to the 1/12, you would arrive at the frequency for A#. Feel free to use a calculator to solve this problem, you might need one.

If the C above A440 is played on two instruments, one tuned in the Greek style based on ratios and one tuned using the modern method based on exponents, calculate the frequencies played on each instrument to determine how far off in cycles per second will they be? A string 4/5 the length of one that vibrates at 440 cycles/second will play a C note. Hint: If halving the string length doubles the frequency, what does shortening it by 4/5 do?

Quadrivium 9 – Bev Thurber

How high can you count on your fingers? Figure out a way to count higher than 10 using only your fingers.

Quadrivium 1 (Second semester) – Jim Donovan

Here is a sequence of numerals. What comes next in the sequence, after 10? What is the pattern?

1111
120
33
30
23
21
17
16
15
14
13
12
11
10

Hint, computer geeks may have an easier time with this.

Quadrivium 2 – Stuart Patterson

Given a square, how can you find the line on which to draw a new square exactly double the size of the first one? (That is, you're looking for the length of the new square's sides.)

Hint: it's an oldie, but a goody, which you may recollect from having read a certain dialogue . . .

Quadrivium 3 – Bev Thurber

Get out your Norton Anthology of Poetry and solve at least 2 of the problems on pages 1829--30.