

*Problems Set By the Herald Lemma Two Dot Four,  
Reverent Servant of Ylenrith*



*Set unto the bright minds of the empire at the  
Spring Equinox of three hundred and eighty YE.*

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### *The First Problem*

*There is a room with a hundred tiles in. Each tile is numbered, and the numbers range from one up to a hundred, all different. Each tile also has the rune Ophis on one side, and the rune Diras on the other.*

*Initially, all the tiles have the Diras side face-up.*

*A Herald comes in, and flips every tile, and leaves.*

*Another Herald comes in, and flips the second tile, the fourth tile, the sixth tile, and so on, flipping alternate tiles, up to the hundredth tile, and leaves.*

*A third Herald comes in, and flips every third tile, starting with the third.*

*A fourth comes in, and flips every fourth: and so on.*

*Obviously, the last Herald - the hundredth - will come in and flip only the hundredth tile.*

*At that time, how many tiles show Ophis: and which ones?*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Second Problem*

*It is the year three hundred and eighty YE.*

*The highest common factor of two whole numbers is the greatest number which divides both of them.*

*Find the sum of the highest common factor of three hundred and eighty and each number between one to three hundred and eighty inclusive: so add the highest common factor of three hundred and eighty and one, to the highest common factor of three hundred and eighty and two, and so on, up to the highest common factor of three hundred and eighty and three hundred and eighty.*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Third Problem*

*Three positive whole numbers satisfy the property that the sum of their reciprocals is not less than one.*

*Determine all triples that satisfy this property.*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Fourth Problem*

*A whole number is such that when it is multiplied by twenty-four and added to a square of itself, it is sixteen less than a perfect square.*

*What is the largest value the number could take?*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Fifth Problem*

*Three positive whole numbers satisfy the property that the sum of their reciprocals is the reciprocal of forty-two.*

*What is the largest value any of these numbers can take?*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Sixth Problem*

*It is the year three hundred and eighty YE.*

*Consider, for each number dividing three hundred and eighty, the number of factors that the square of each of these divisors has. Imagine adding up each of these numbers of factors in form, to form the sum of the number of factors of the square of each number which divides three hundred and eighty.*

*Show that this sum is the same as the square of the number of factors of three hundred and eighty.*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

### *The Seventh Problem*

*Recall the room with the tiles, which have Ophis and Diras on either side, from the First Problem.*

*One day, the same procedure as before is started: heralds come in, turn some tiles – for instance, the fifth herald flips every fifth tile before leaving.*

*However, on this day some Heralds decide to neglect their duties, and when they enter the room they don't flip any tiles at all, and leave after an appropriate amount of time. The next Herald is unaware of their fellow's failure, and so flips the tiles they would have flipped anyway. For instance, if the seventh Herald doesn't do their job, then nobody flips every seventh tile, and then the eighth Herald just flips every eighth tile.*

*After all the Heralds have left, only the first tile shows Ophis, and the rest show Diras.*

*Characterize and count the absent Heralds.*

*Present your answer with a full explanation of your reasoning and any further comment you wish to make.*

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*Lemma Two Dot Four, Servant of Ylenrith, shall return on the Sunday of the Spring Equinox, in the year three hundred and eighty YE, at the hour of three past midday, in order to discuss these problems and receive any solutions. Lemma Two Dot Four is excited to meet those who share its passion for the purity of numbers.*