Departmental *F*(u)nctions

The newsletter of the Department of Mathematics, University of Alabama

volume V, number 2 Fall 2016

Note from the Chair

August 2016

My first year as Chair has gone by in a whirl of meetings and classes, but it has been a good one. I am blessed with an extremely competent and energetic staff—without them things would have been a lot harder. I have enjoyed getting to know the faculty, and the graduate students and undergraduates are a constant source of energy and inspiration.

For 2016-17 the department has the largest entering class of graduate students in memory: 12 students. And, for the second year in a row, 50% of them are women. Recruiting was helped by a National Alumni Association Tag Fellowship, and by four new Enhanced GTA lines, which have a reduced teaching load and guaranteed summer support. These are funded using the scholarship created by the late Edith and Richard Ainsworth, and we intend to use these funds to continue to make competitive offers to top students. In addition, one continuing student, Brandon Reid, received a Graduate Council Fellowship.

This past year we hired several new faculty members: Bulent Tosun, a tenure-track assistant professor in topology, Hanh Nguyen, a postdoc in harmonic analysis, and Seonguk Kim, an FTTI who will be teaching calculus. Yangyang Xu, who does optimization, who was hired the previous year, has also joined the department after a postdoc. In the coming year we will be searching for three new faculty: one position in math education, and two in mathematical and computational modeling. These latter positions are intended to help build ties with the National Water Center, a research center at UA run by NOAA.

We have three big goals for the undergraduate program in the coming year. First, we want to revamp the honors calculus sequence. The number of entering students with AP calculus credit continues to increase, and we want to make honors calculus the preferred gateway for these strong students into the major. Second, we want to increase opportunities for undergraduate research. And finally, we want to attract more students into the University Scholars Program, the joint bachelors/masters program. Our goal is to attract more and better students into the math major, and to give them the best experience possible.

Finally, I want to note that the department has become a more attractive place in the past year. We now have several pieces of art on display that were loaned from the Paul R. Jones collection of African-American art. We have acquired an 18" tall glass Klein bottle, a beautiful example of a "one-sided" surface—the higher dimensional analog of the Möbius strip. And we have a Math Genealogy poster, showing the mathematical "ancestry" of every faculty member. (To look up individual faculty members, go to https://pfaff.genealogy.math.ndsu.nodak.edu/)

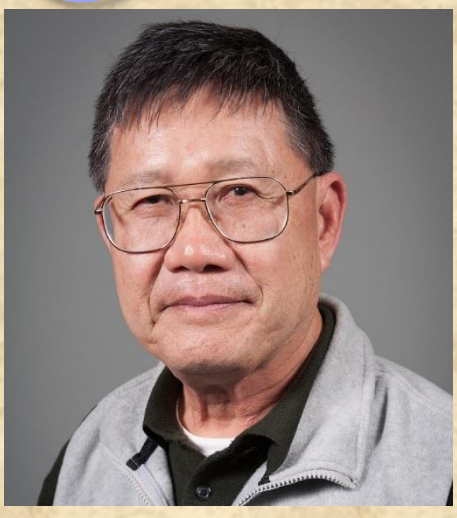
Additions

Our newest applied mathematician is **Yangyang Xu,** who received his B.S. in Computational Mathematics from Nanjing University in China in 2007 and his M.S. in Operations Research from the Chinese Academy of Sciences in Beijing with a thesis entitled *On Complexity of Multi-Task n-vehicle Exploration Problem*, with Professor JInchuan Cui. Dr. Xu was awarded the Ph.D. from Rice University in 2014, where he worked with Professor Wotao Yin and presented a dissertation entitled *Block Coordinate Update Method in Tensor Optimization.* His research interests include large-scale optimization, sparse optimization, stochastic computing, and tensor optimization. Dr. Xu has published in many prestigious venues, including the SIAM Journal on Optimization, and has given invited talks at many conferences, and has organized two sessions on Optimization, in San Diego and in Houston. Since 2015, Dr. Xu has been a postdoctoral fellow at the University of Minnesota. Dr. Xu enjoys poker and Chinese chess. We are doubly lucky this time: Dr. Xu's wife, **Jun Tan**, will also join us as a Graduate Teaching Assistant. We are very lucky to welcome Dr. Xu and Jun Tan to the University of Alabama.

Our search for a new topologist was arduous, but, luckily, the right candidate came along at just the right time. Say hello to **Bulent Tosun**, who was born and raised in Turkey and received his B.S. in Mathematics in 2001 from Yuzuncu Yil University. His Ph.D. came from Georgia Tech in 2012, where he worked with John B. Etnyre. Dr. Tosun was a CRM postdoctoral fellow at the Université du Québec à Montréal from 2012 to 2013, where he worked with Steven Boyer and Olivier Collin and also taught at McGill University. He was appointed Whyburn Instructor at the University of Virginia from 2013 to 2016. He has accepted visiting positions at the prestigious Max Planck Institute in Bonn, Germany, and at the MSRI in Berkeley, California. Dr. Tosun's interests include low-dimensional manifolds, symplectic geometry, and Heegaard-Floer homology. He has served as an invited speaker at many conferences and seminars, and has organized a number of sessions on topology, both at Georgia Tech and in Montreal. Bulent is also an aficionado of outdoor sports, including hiking and tennis. We are very happy to have Dr. Tosun join the faculty!

Also joining us as a postdoc this year is **Hanh Nguyen**, whose research is in harmonic analysis. And finally, please welcome **Seongkuk Kim**, our newest FTTI, who will be teaching calculus.

Subtractions



We are all sorry to hear of the retirement of **Wei Shen Hsia**. Wei Shen has been a valued member of the department for many years and a mentor to many of us (sometimes without his knowing it). His calm demeanor and steady hand on the tiller are not likely to be replaced any time soon. Wei Shen was awarded a Bachelor of Arts in Mathematics with honors by the National Tsing-Hua University (Taiwan) in 1968 and received his Ph.D. with a specialty in Operations Research from Rice University in 1973. The following year, he made his home at the University of Alabama. He was promoted to Associate Professor in 1979 and to Professor in 1985. Dr. Hsia served as Department Chair from 1990 through 1999. His time in that office was a period of stability and growth for the department. After the departure of Z. J. Wu, Wei Shen graciously accepted the role of interim chairman and guided the department through the search for a new permanent head. He is the author of thirty-one articles in research journals and conference proceedings and has directed seven doctoral dissertations and three master's degrees. He has received much grant support from NASA and from the University, and support for his work in education from PMET, the MAA, and from the Gabriella and Paul Rosenbaum Foundation. Dr. Hsia's concern for his students and for the promotion of mathematics beyond the university is evidenced by his participation in many workshops and national conferences to better prepare mathematics teachers in K-12 settings. He was always known as one of our most popular teachers. Wei Shen will become Professor Emeritus as of September 1, 2016. Don't be a stranger, Wei Shen!

The Math Department says goodbye to two other valued faculty members this year. First is **Dr. Song Song,** who arrived here in 2013 from Michigan State. Dr. Song will be leaving academia to pursue a consulting career here in Tuscaloosa. We will also miss the presence of **Dr. Drew Lewis**, who got his Ph.D. at Washington University in St. Louis. Dr. Lewis was the only faculty member who was an undergraduate at U of A! He will be joining his wife at the University of South Alabama.

Also leaving the university is longtime instructor and MTLC stalwart **Pat Moore**. For years, Pat taught Math 005 and other pre-calculus courses, but spent much of her time in the back offices, keeping the MTLC humming along. Pat is busily framing artwork in Northport, and hoping that her husband Bob will join her in retirement soon!

We were also very sad to hear of the passing away of **Dr. Frank Roehl** in March. Dr. Roehl was a long-time member of the Mathematics Department whom many of us remember fondly. Au revoir.

High School Students Compete in Math Tournament

In November, the Math Department once again hosted the annual Mathematics Tournament for high-school students, with **Dr. Kabe Moen** overseeing the festivities. This year, 12 schools and about 100 participants were on campus for the event. Bob Jones High School was the overall winner in Division I. In Division II, Jefferson County International Baccalaureate (on the campus of Shades Valley) took top honors and Division III was led by Holy Family High School. The top individual scores were posted by Aditi Limaye, Anthony Zhu, and Tyler Tolbert, all from Bob Jones High School.

CONGRATULATIONS TO THE WINNERS AND TO ALL THE PARTICIPANTS!

Putnam Exam Contestants Excel

The University of Alabama Putnam Exam Team for 2015 consisted of **Matt Ferrell, Qiangang Fu**, and **James Parkes**. Other students competing as individuals were **Phineas Agar, Alexander Mathers, John Deeble,** and **Connor Malin.** The Exam was held on December 5, 2015, and the participants were treated to a lavish breakfast provided by Dr. Cruz-Uribe. Big Al couldn't make it to cheer on our team, as he was busy at the SEC title game in football. (To us, it has always seemed foolish for the SEC to schedule its little football championship on the same day as the Putnam Exam, when so many people are busy! But the SEC didn't ask our opinion.) Overall, our team scored 4 points (national median score: 0), but some of our other contestants scored positively as well. Many of the participants are underclassmen, so they will be able to take part again next year. The future looks bright for the Putnam Team!

New Degree Recipients

The Mathematics Department conferred a number of advanced degrees during the past year:

Master's Degrees

Awarded in December of 2015:

Ziteng Wang, who worked with Dr. Wei Zhu on a project entitled *Two Approaches of Image Segmentation Based on Active Contour*.

Awarded in May of 2016:

Daniel Brown, who worked with Dr. Hyun Kwon on *Markov Chains in the Game of Monopoly*.

Summer Atkins, with a project entitled *Proximal Methods for Sparse Discriminant Analysis*, under the direction of Dr. Brendan Ames.

Alexander Barnes, who earned the degree by examination

Awarded in August of 2016:

Lingxue Song, by examination

Ph.D. Degrees

Awarded in August of 2015:

Soumyadip Acharyya, who completed his dissertation with Dr. Kabe Moen, entitled *A Difference of Composition Operators on Bergman Space*. Dr. Acharyya is now an Assistant Professor at Embry-Riddle Aeronautical University.

Duc Duy Nguyen, who worked with Dr. Zhao and produced a dissertation entitled *High Order FDTD Methods for Electromagnetic Systems in Dispersive Inhomogeneous Media*. Dr. Nguyen will be a postdoctoral fellow at Michigan State during the coming year.

Laxmi Chataut wrote his dissertation, *Groups with Conditions on Non-Permutable Subgroups*, with Dr. Martyn Dixon. Dr. Chataut will be an Instructor at the University of South Alabama.

Awarded in May of 2016:

Toyin Alli's work, *Statistical Networks with Applications in Economics and Finance*, was supervised by Dr. Song Song. Dr. Alli has found a position as Lecturer at the University of Georgia.

Kaitlyn Perry completed her dissertation, *Polydefree Properties of Polynomial Automorphisms* under the direction of Dr. Drew Lewis. Dr. Perry is now an Assistant Professor at Wingate University in North Carolina.

Anne Duffee worked with Dr. Moen and presented her work, entitled *Harmonic and Geometric Maximal Operators.* Dr. Duffee will be working at Sewanee: The University of the South at Tennessee.

Awarded in August of 2016:

Veny Liu worked with Dr. Jon Corson on work entitled *Free Inverse Semigroupoids and their Inverse Subsemigroupoids.* Dr. Liu will be an Assistant Professor the University of Hawaii, West Oahu.

Wei Cui worked with both Dr. Zhijian Wu and Dr. James Wang to produce the dissertation *Fractional Brownian Motion and Managing Risk with Short-Term Futures Contract.* Dr. Cui has found a position as Assistant Professor at Cottey College in Missouri.

Todd Neal worked with Dr. Hyun Kwon on a dissertation entitled *A Refinement of Wolff type Theorems for the Multiplier Algebras of Dirichlet Spaces.* Dr. Neal will be teaching classes at the University of South Alabama.

Mengpu Chen presented a dissertation entitled *Augmented Lagrangian Method for Euler's Elastica Based Variational Models,* written under the direction of Dr. Wei Zhu. Dr. Chen will remain at the University of Alabama this year.

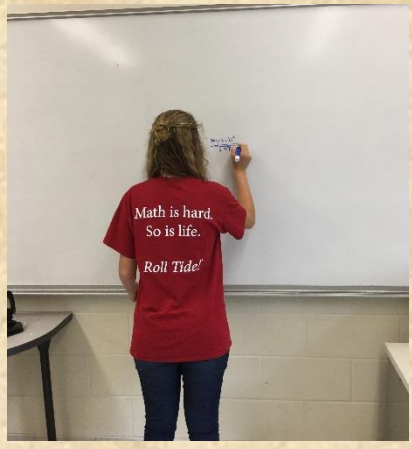
Hooray for all of our degree recipients. Great work!
We wish you well in the future!

Honors, Recognition, and Activities

The official **Klein Bottle** of the Math Department was unveiled at the Math Tea this year. The bottle, a three-dimensional projection of a four-dimensional surface, was constructed by artist **Clifford Stoll**, astronomer, author, and teacher as well as part-time electronic musician; the photo here is by Bryan Hester. The Klein Bottle is guaranteed non-orientable and one-sided. If you cut it in half, you get two Möbius strips, but Dr. Cruz-Uribe asks that you not try this on our Klein Bottle, since we already have enough Möbius strips to—heh, heh—go around!

On a related note, if you haven't checked it out yet, you should also peruse the Mathematical Genealogy chart in the Math Lounge. How many degrees of separation from you to, say, Carl Friedrich Gauss?

Product Placement Department: Yes, the much-anticipated **Math Department T-Shirts** are here! For a mere **ten dollar donation** to the Math Department Gift Fund, one of these coveted souvenirs can be yours, from Miss Marcia's Bargain Emporium in Room 345 Gordon Palmer. These trendy items are sure to be the height of fashion during the coming academic season, so everyone will want at least one to wear to football games, exams, math teas, and everywhere else! Get a couple of extras for the kids, too! Here's a photo of one of these classic shirts being worn by **Makenna Morris**, Math office mainstay and matchless model. (Hey, check out the alliteration! Who says we ain't literary?) We expect knockoffs of these shirts to hit Wal-Mart and Amazon soon, and probably next season's Christian Dior lineup. And we expect to see Makenna on the runway!



Transitions

Dr. Roger Sidje was promoted to Full Professor. Roger, of course, also serves as Associate Dean for Diversity, giving the Math Department a double presence in the Dean's Office. Roll, Roger!

Dr. Kabe Moen was promoted to Associate Professor with tenure. In the bargain, Dr. Moen is also the recipient of a five-year, $35,000 grant from the Simons Foundation for work on *Weighted Estimates in Harmonic Analysis and PDE*. Check out the *Lighter Side* (at the end of the newsletter) for another contribution from Kabe.

The new Graduate Advisor in the department is **Dr. David Halpern**.

The new Undergraduate Advisor is **Dr. Jim Gleason**.

Retia Boone completed her Bachelor's Degree in Social Work. Upon her return to the department, she will hold the position of Office Associate Senior. During her absence, **Amanda Wilson** staunchly took over Retia's duties. Amanda was such a popular replacement that she will join the MTLC in a permanent position this year.

Speaking of the **MTLC**, for the sixth year in a row it served over ten thousand students. Yep, no misprints there—that's 10^4! The MTLC is the face of the Math Department for many students!

Awards

Undergraduates

The highest ranking senior in the mathematics department is annually awarded the B.B. Comer Prize. This year the award went to **Daniel Brown**, a worthy recipient indeed! Daniel hails from Vestavia Hills and is majoring in Mathematics and Economics. He is a Presidential Merit Scholar and, for the past three years, has also been awarded a Fred A. and Francis Pickens Lewis Scholarship. Way to go, Daniel!

The Hugh Lawrence Quarles Mathematical Scholarship was bestowed on **Feras Awad** and **Lauri Spring**.

The Pearson Endowed Scholarship was received by **Anna Tezlaff**.

Alex Mathers, a double major in Mathematics and Physics, was accepted into the prestigious Math in Moscow program for Fall of 2016. Unfortunately, this means Alex won't be able to take the Putnam Exam in December, but we will excuse him just this once. Hey, Michael, if you're reading this, здравствуйте!

Math major **David Dai** was awarded the Outstanding Junior Award given by the College of Arts and Sciences.

Graduate Students

Brendan Reid was awarded a Graduate Council Research Fellowship for 2016—17. Brendan is writing his dissertation on computational mathematics with Dr. Sidje.

Duc Nguyen, who received his Ph.D. in 2015 under the direction of Dr. Shan Zhao, received the College of Arts and Sciences Outstanding Dissertation Award.

19 of our graduate students received Graduate Research Travel Awards from the Graduate School and from Arts and Sciences: **Brandon Reid, Huy Vo, Kaitlyn Perry, Keisha Cook, Khanh Dinh, Anne Duffee, Mengpu Chen, Mingwei Sun, Noufe Aljahdaly, Phylisicia Carter, Qing Xiao, Summer Atkins, Tania Hazra, Toyin Alli, Veny Liu, Wei Cui, Xin Luo, Xuan He,** and **Zhihan Wei.**

Toyin Alli received the award for Outstanding Teaching by a Graduate Student.

Noufe Aljahdaly receives the Outstanding Research by a Doctoral Student award. Noufe is working under the supervision of Dr. Layachi Hadji.

The Edith and Richard Ainsworth Endowed Scholarships this year go to **Keisha Cook, Khanh Dinh, Cong Hoang, Madeline LeBoeuf , Brandon Reid,** and **Huy Vo.**

Four incoming graduate students received Enhanced GTAs with a reduced teaching load and summer research support: **Hongsong Feng, Arum Lee, Gokul Pokharel,** and **Linda Wood.** The National Alumni Associate Graduate Fellowship for 2016—17 was accepted by **Alyssa Barnett**.

These awards are all given to extremely worthy candidates. We are proud of you! Congratulations, all!

Activities

Usha Midkiff is serving on the Pearson Digital Advisory Board. The Board consists of fifteen faculty members from across the United States, whose job is to review products and provide feedback on digital development at Pearson. They meet virtually during the year with Pearson developers, and once a year at a summit meeting at Pearson headquarters.

Martyn Dixon and Martin Evans were both invited to speak at the prestigious international group theory conference in Ischia, Italy, during late March and early April.

Shan Zhao presented an invited talk at the Fields Institute during the 10th International Conference on Scientific Computing and Applications in June 2016.

on the lighter side

Infinitesimals

1. Two Auburn students (all right, the original joke was told about two females of a particular hair color, but we are nothing if not politically correct. Well, not that either…) decided to have a contest: the winner would be the one who could name the largest number. The first one thought for a long time and finally said, "Three!" The second one thought…and thought…grimaced…thought some more…fidgeted…thought a little longer…and finally said, dejectedly, "You win."

2. You heard about the poor statistician who perished, crossing the river? He was sure he could walk across because it was only three feet deep. On average.

3. What is the formula for the volume of a thick crust pizza with radius ***z*** and height ***a*** ?
   Answer: $pi \cdot z \cdot z \cdot a$.

4. What does the *B.* in *Benoit B. Mandelbrot* stand for?
   Answer: *Benoit B. Mandelbrot*

Items 2, 3, and 4 were all copied (with minor alterations) from BusinessInsider.com. True fact. And you thought businessmen were all solemn drudges! Then again, they probably think mathematicians are humorless.

5. Another sad tale: A programmer got stuck in the shower and starved to death. Police discovered him clutching a shampoo bottle whose directions read: *Lather. Rinse. Repeat*.

6. What is a French mathematician's favorite pick-up line?
   Answer: *Voulez vous Cauchy avec moi*.

7. What-does-100%-mean department: Nice to know that someone was paying attention in seventh grade when they talked about percent differences…

8. *Jeopardy Department*: The photo in the newsletter of Makenna with the T-shirt is a little small; it is hard to see what she has written on the board. Microscopes show that her message is this:

$$\frac{my + x = b^2}{\sqrt{47}}$$

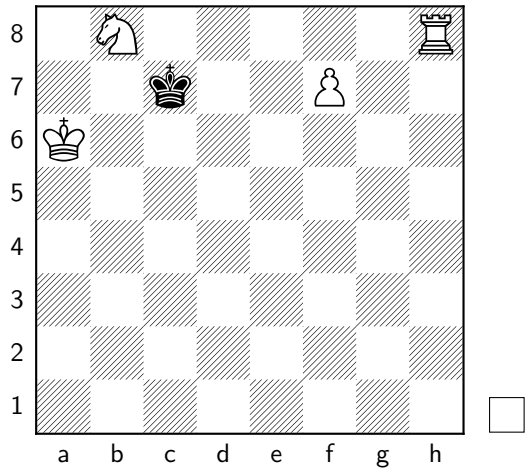
Challenge: construct a reasonable problem in which this line is a plausible step. It doesn't have to be the final answer, just one of the steps. I said *reasonable*.

9. And now, the *pièce de résistance:* for those of you who know what a fianchetto is… With everything else that **Kabe Moen** does for the department, who knew that he also composes chess mating problems?! Some of his efforts start on the next page. Warning: these are not easy…also, the answers are on the last page, so no peeking!

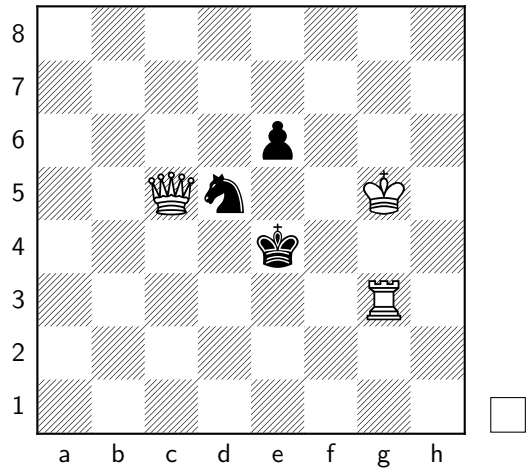
Problems for Math Newsletter

Chess puzzles are one of the most beautiful types of problems. They are more accessible than many mathematical problems(!) and do not have the confines of language that crossword puzzles have. The diagrams below are called two move *directmate problems* meaning that it is White's move and he or she is trying to checkmate Black on the second move. White will move, then Black will move, and no matter what Black does White will be able to checkmate Black on the next move. All of the problems are sound meaning there is a unique initial move, called the key. The checkmate must come on the prescribed number of moves - in most of the positions White would eventually win with other moves, but there is only one move that will let white checkmat in exactly two moves. In the problems below White is playing up the board. For example, the pawn in the first problem can promote on the first move. It cannot promote to a queen because this would stalemate Black and the point is to checkmate Black. Also, the key is usually a subtle move and in the case of the problems below will not be a check or a capture.

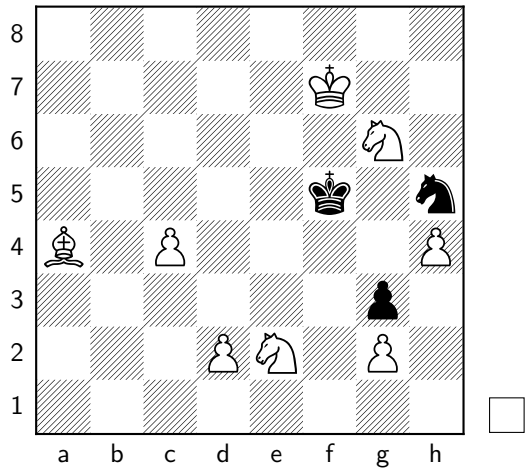
1. White to play and mate in two moves.



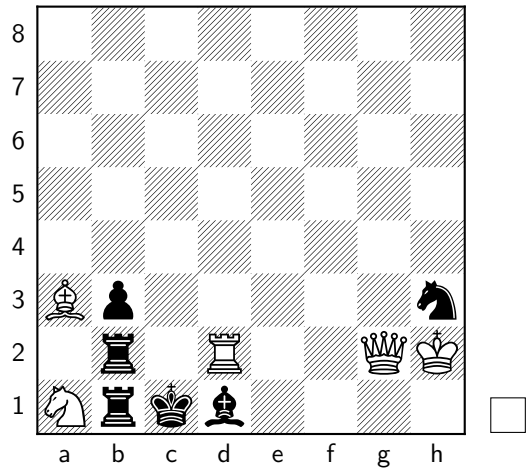
2. White to play and mate in two moves.



3. White to play and mate in two moves.



4. White to play and mate in two moves.



Solutions:

1. The key move is to promote the pawn to a bishop: 1.f7-f8=B. One way to solve these problems is to look at Black's moves and try to do something about them. Here black only has one move Kc7-d6, and White must do something about this because this frees the black king. Since promoting to a queen would stalemate, white promotes to a bishop which blocks the rook's guard on the squares b8, c8, and d8. If the black king moves to any of these squares then the bishop can checkmate on d6: 1.f7-f8=B Kc7xb8 2.Bf8-d6#. This is called under-promotion and of all of the pieces a bishop is the hardest to promote to (why?).

2. Again we can consider what happens if Black moves first. In this case there is a set response to every Black move: 1...Ke5 (pinning the knight) 2.Rg3-e3#, 1...Nc3 (or any move of the knight) 2.Rg3-e3#, 1...Pe6-e5 2.Qc4#. Since every move of Black has a response White must just find a way to wait it out. 1.Rg3-h3 does just that and White can mate after black moves.

3. The key move is 1.Ba4-d1. The bishop hides behind the knight and waits for the king to move or the black knight to move. 1...Ke3 2.Bc2#, 1...Kg4 2.Nd4#, 1...Nf4 2.Nxg3#.

4. The problem answers a question that beginners often have: is it possible for a pinned piece to deliver checkmate? The key is 1.Rd2-d3 pinning the white queen but threatening to move her to d2 to checkmate (a pinned checkmate). Black can block her path with the bishop or knight but these free her from the pin: 1...Ng2 2.Qg5# 1...Be2 2.Qc6#. I'll let you figure out why the rook must go to d3 and not say d4, d5, etc.