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Physics On the Hill
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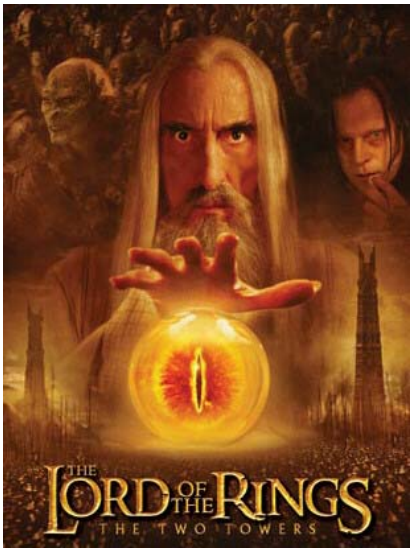
The 2004 Western Kentucky Physics Olympics

By Richard Gelderman

On **Saturday, February 21st, 2004** the WKU Dept of Physics and Astronomy is inviting each high school in the region to send one or more teams of four to compete in the Western Kentucky Physics Olympics. The Western Kentucky Physics Olympics will be every bit as much fun as it will be educational.

The Lord of the Rings is the theme for this year's Western Kentucky Physics Olympics, a half-day competition consisting of a pentathlon of challenging problem-solving activities that reward teamwork, creativity, and communication. For the ***Least Massive Tower*** each team will design and construct a 1.5-meter tall tower capable of supporting a 1 kg mass for at least 20 seconds. The ***Seige of Osgiliath*** competition requires each team to design, construct, and use a small siege engine capable of hurling projectiles over a wall to hit a target. ***Travels of the Ring Bearer – a vector navigation problem*** is the Calculation/Communication Challenge, requiring two members of the team to make a series of measurements and the other two members to use that data to calculate the desired result. The final two events -- the "On-the-Spot Activity", a mostly hands-on, impromptu challenge, and the "Order-of-Magnitude Quiz", a brain teaser which asks contestants to quickly estimate answers for extreme situations -- will remain cloaked in secrecy until those events actually begin.



Teams must register before the closing date of February 12 using the form at http://physics.wku.edu/olympics/. Event details may be found on page 8.

Greetings from the Chair

By Richard Hackney

Greetings from the Department of Physics and Astronomy. I am serving as interim head this year, as we search for a new department head. Our former head, Dr. Charles McGruder, stepped out of the headship after 9 years of service to assume the responsibilities of the McCormack Endowed Professorship. Congratulations to Charles on his new position, in which he will be pursuing research in detecting extrasolar planets in the STARBASE program and developing the Kentucky Academy of Mathematics and Science at WKU.

Our newsletter is sent periodically to alumni and friends of the Department to update you on our people and their activities and accomplishments. For more frequent updates, we invite you to visit our website at http://www.physics.wku.edu. There you can always learn about the most recent activities of our faculty and the current students in the program.

I want to introduce you to our newest faculty member, Dr. Gordon Smith, who joined us this year after receiving his PhD from the University of Mississippi. Gordon's area of research is thermoacoustics, which deals with the interplay between heat and sound. He has assembled a laboratory full of equipment for his research, with opportunities for involvement of students. Among his intended studies, he is working on practical applications in his field, beginning with an environmentally friendly thermoacoustic refrigerator with no moving parts. For more details about Gordon and his projects, please read his feature article in this newsletter.

In 2001, Dr. George Vourvopoulos retired from the department after serving 18 years on the faculty. During his years at Western, George and his colleagues and students established the Applied Physics Institute (API) and developed several major physics applications that benefit the nation and the world. These include devices for the on-line analysis of impurities in coal, for detecting drugs and explosives in containers such as suitcases, and for detecting unexploded ordnance such as buried land mines and artillery rounds. In his retirement from Western, George continues to work with a company to produce and market these devices. Dr. Phillip Womble is now directing the API and is working with the staff to develop new applications of physics. We wish all the best for George in his retirement, and for Phil as he leads the API into the future.

Of course, the ultimate success of our Department is reflected in the success of our graduates. We are always happy to hear from former students and to learn where they are, what they are doing now, and how their careers have developed after preparing in our program. We invite you to call, write, or email at any time to let us hear from you. In general, the email address for a faculty member at Western is based on the name as first.last@wku.edu. We would like to add your email address to our list to be able to keep you up-to-date with Department happenings. Please let us hear from you and let us know what you are doing.

The WKU Department of Physics and Astronomy congratulates Fall 2003 graduate Whitney Wills.

The WKU Department of Physics and Astronomy congratulates its "Class of 2003" graduates. Lindsay Hopper, Tala Monroe, Josh James, Wes Ryle, Ashley Atkerson (not pictured)

In early January 2003, Allen Glass, a WKU freshman, received his telescope operator certification from Drs. Carini and Barnaby of the Department of Physics and Astronomy . Allen completed the 40-hour training course and is now a member of the observatory staff, gathering long-term observation data.

PELAN Purchased by UN to Find "Silent Menace"

By Phillip C. Womble (some material contributed by Dr. M. Samiei of IAEA)

The PELAN system for explosives detection was purchased by the International Atomic Energy Agency (IAEA). The IAEA's goal is to use nuclear techniques to find abandoned landmines—landmines that are still dangerous years or decades after the conflict is over.

The PELAN was selected by a group of international experts from numerous nuclear-based techniques as the most promising nuclear sensor for landmine detection. In 2001, the IAEA started a project with one goal: to optimize the PELAN for humanitarian de-mining.

PELAN uses neutrons to detect explosives. The neutrons interact with the materials in the soil and the resulting gamma rays indicate what elements are present. The gamma rays can also indicate how much of an element is in the soil. Explosives are composed of hydrogen, carbon, nitrogen, and oxygen but the relative amounts of these elements is quite different in explosives when compared to innocuous materials. WKU professor George Vourvopoulos invented PELAN. Since 1998, he and Dr. Phil Womble have been developing applications based on the PELAN technology. WKU alumni, Jon Paschal plays a major role in the PELAN development by creating software and electronic systems.

Dr. George Vourvopoulos (back to camera) demonstrates PELAN's controls to IAEA Director General Mohamed ElBaradei (right).

In February 2002, the IAEA demonstrated PELAN at briefings organized for invited experts from organizations engaged in demining efforts in affected countries, to familiarize them with its capabilities and development. Demonstrations and project

Scientists "plant" a landmine in front of PELAN as part of the demonstration.

briefings also were held for Vienna-based staff from Member States having Permanent Missions to the IAEA, including a session attended by the Agency's Director General Mohamed El Baradei.

Several IAEA Member States are requesting initiation of a project for field-testing and demonstration of the suitability of a pulsed neutron probe method for humanitarian de-mining. The USA already has provided $212,000 for the purchase of PELAN, and the IAEA now is evaluating proposals from leading laboratories in the USA, Russia, and European Union for optimizing the instrument. Once the instrument is more fully developed and tested under field conditions, it can become an important complementary instrument in a de-miner's kit to help teams probing for landmines find the explosives before they injure or kill more people.

A website with a video is located at http://www.iaea.org/worldatom/Press/News/landmines.shtml.

Josh James & Wes Ryle at Spring 2003 commencement.

Class of 2003 Graduate Receive Top Honors

By Doug Harper

The WKU Department of Physics and Astronomy congratulates the members of the graduating class of 2003. As is the custom in our department, the Physics graduates were once again small in number but very large in terms of quality. The five students who completed the requirements for a Physics degree in 2002-03 were all members of the national physics honor society Sigma Pi Sigma, were very successful in the classroom, were active in undergraduate research, and made several presentations of their work at local, state and national scientific meetings. The graduates are:

- *Ashley Atkerson* graduated with an emphasis in secondary education and is teaching science at Old Union School in Warren Co.
- *Lindsay Hopper* is working as Research Assistant at the WKU Applied Physics Institute.
- *Joshua James* was named scholar of the Ogden College of Science and Engineering and received the Ogden Trustee Award for completing his studies with a perfect 4.0 GPA. He is pursuing a graduate degree in Medical Physics at the University of Wisconsin, Madison.
- *Talawanda Monroe* is currently pursing a graduate degree in Astrophysics at Indiana University.
- *Wesley Ryle* was named scholar of the Ogden College of Science and Engineering and received the Ogden Trustee Award for completing his studies with a perfect 4.0 GPA. He is pursing a graduate degree in Astrophysics at Georgia State University.

In addition, Wes and Josh were named co-recipients of the 2003 George V. Page Award for Excellence in Physics Scholarship, Wes and Lindsay were co-recipients of the 2003 Randall Harper Award for Excellence in Physics Research, and Tala received the Yarbrough Award for the Outstanding Senior Mathematics Major.

Applied Physics Institute Gets New Director

By Phillip Womble

Dr. Phillip C. Womble was appointed the new Director of the Applied Physics Institute at Western Kentucky University on July 1, 2002. He replaces Dr. George Vourvopoulos, who retired in June and took a position with Science Applications International Corporation.

Dr. Womble, a 1988 graduate of WKU, received his Masters and PhD from Florida State Univ. He held a position as Senior Technical Advisor at the Waste Examination and Assay Facility at Oak Ridge National Laboratory and was a subject matter expert on Uranium and non-destructive analysis at the Y-12 Plant in Oak Ridge. While at Oak Ridge, he worked closely with the Applied Physics Institute at WKU and its staff.

In 1997, Dr. Womble left Oak Ridge and became Senior Research Scientist at WKUAPI. In 2000, he became an assistant professor in the Dept of Physics and Astronomy.

WKUAPI is world-renown center on non-destructive analysis using neutrons. It developed both an on-line coal analyzer and an explosives detection device called PELAN. Dr. Womble was instrumental in the success of both of these projects.

As director, Dr. Womble wants to expand WKUAPI's core expertise from neutrons and nondestructive analysis. For example, a program to sterilize small packages for pathogens is beginning at WKU.

McGruder Named McCormack Professor

Courtesy Office of Media Relations

Dr. Charles H. McGruder has been named the first William McCormack Professor in Physics. Dr. McGruder, who joined Western in 1993 as a professor and head of the Physics and Astronomy Department, said the appointment is a "gratifying honor. It gives me ample time to do the research that would like to do." In addition, Dr. McGruder will continue working on the proposed Kentucky Academy of Mathematics and Science. The academy would bring the brightest high school juniors and seniors to campus to finish their high school work while earning 60 college credit hours.

The McCormack Professorship was created in 2000 through a $500,000 gift from Dr. William McCormack, a 1957 WKU graduate and retired radiologist. That gift was matched through Kentucky's Regional University Excellence Trust Fund to create the $1 million endowment.

WKU President Gary Ransdell said professorship endowments allow the University to retain and attract quality faculty to enhance already strong academic programs. "The foundation for a quality academic experience for students is directly related to the presence of quality faculty in the classroom," he said. "When teachers are providing outstanding instruction for students, the students will find ultimate educational and professional success.

Dr. McGruder has a bachelor's degree in astronomy from the California Institute of Technology and a doctorate from the University of Heidelberg in Germany. In accepting the appointment, Dr. McGruder stepped down as department head. A search for his replacement has begun.

Thermoacoustics Comes to Western

By Gordon Smith

The newest faculty member of the physics department is Dr. Gordon Smith, who brings a new research thrust for the department.

Dr. Smith received his doctorate in Physics from the University of Mississippi in 2000. Upon graduating, he took a series of Visiting Assistant Professor positions at Hampden-Sydney College and Appalachian State University before accepting a tenure-track position here at WKU.

His research specialty is in the niche field of thermoacoustics. Thermoacoustics is the study of how heat and sound interplay. In the standard university physics courses, sound behavior in a resonator is simply described as depending solely on where one is along the length of the resonator. This neglects an important reality of gases – namely that they are viscous. We also typically neglect the thermal effects included when you compress or rarefy a gas.

When these effects are included, though, there is a slight, but important change in the gas behavior. Near the wall (close enough for a thermal effect to be seen, but far enough away that viscosity doesn't dominate), the oscillating gas trades heat back and forth with the wall. Outside of this region (or about the remaining 99% of the system), the gas pretty much behaves as described in the university physics sequence.

Thermoacoustics takes a small region in the resonator, and replaces the empty resonator with a porous material that is effectively all wall, so that the thermoacoustic exchange is effectively utilized. This material is referred to as a "stack."

Applying a temperature gradient across this stack creates a prime mover class of heat engine, resulting in the thermoacoustic generation of sound. Gas moves toward the warmer end of the stack, expanding and jostling neighboring gas parcels. Gas moving toward the cooler end contracts, and also jostles the neighboring parcels. As this is in a resonator, the random motion is amplified at the resonating frequency of the system, and the gas rapidly transitions from low-amplitude, random oscillation to a large amplitude resonant oscillation.

It's a neat party trick.

The importance of thermoacoustics arises when one considers the reverse of a prime mover – a refrigerator. Consider an acoustic system with a stack in the resonator. The acoustics forces the gas back and forth, oscillating the temperature as it compresses and rarefies. These temperature fluctuations induce a thermal exchange with the wall, and the net effect is similar to a bucket brigade model, where the gas picks up heat from one end of the wall, transports it, and drops it of on the other end. This results in one end of the stack cooling off and the other end warming up.

Using a thermoacoustic prime mover to drive a thermoacoustic refrigerator, one can create a refrigerator that operates with no moving parts, without environmentally hazardous gases.

The Physics Department is excited to explore this innovative technology.

A heat-driven refrigerator begins to take shape in the laboratory.

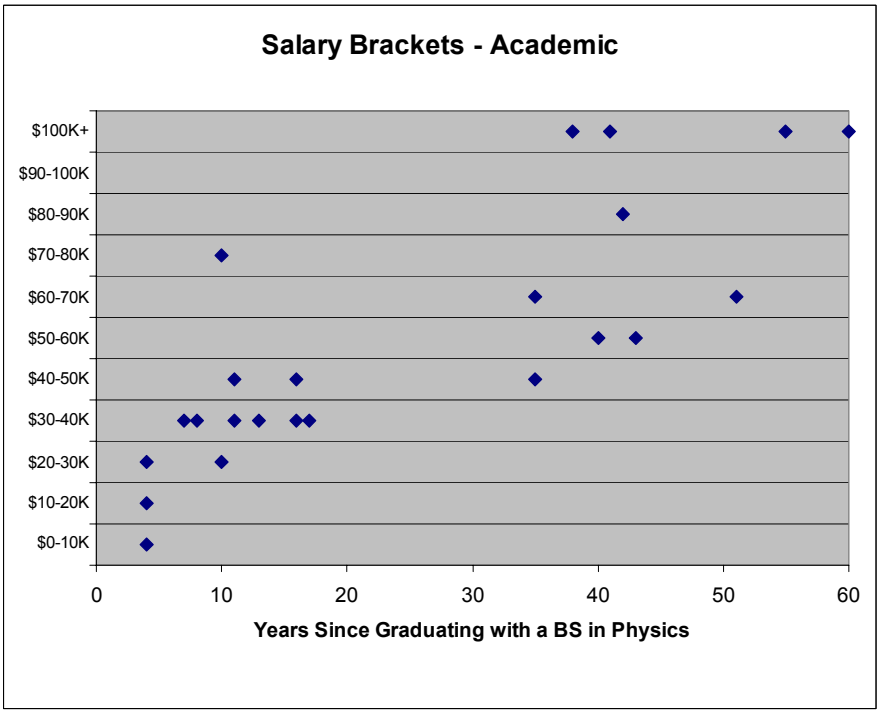
Where Does a WKU Physics Degree Lead?

Over the summer, we composed a survey for our graduates. The questions were designed to find out how useful a physics degrees was, what careers could be had with a physics degree, and of course, the all important money factor. We started on this in response to the continued misperception of what you can do with a physics degree, as most students coming though our halls were not thrilled with the possibility of being a "nerdy geek."

We are deeply indebted to those who took the time to reply, and present the following picture of our graduates.

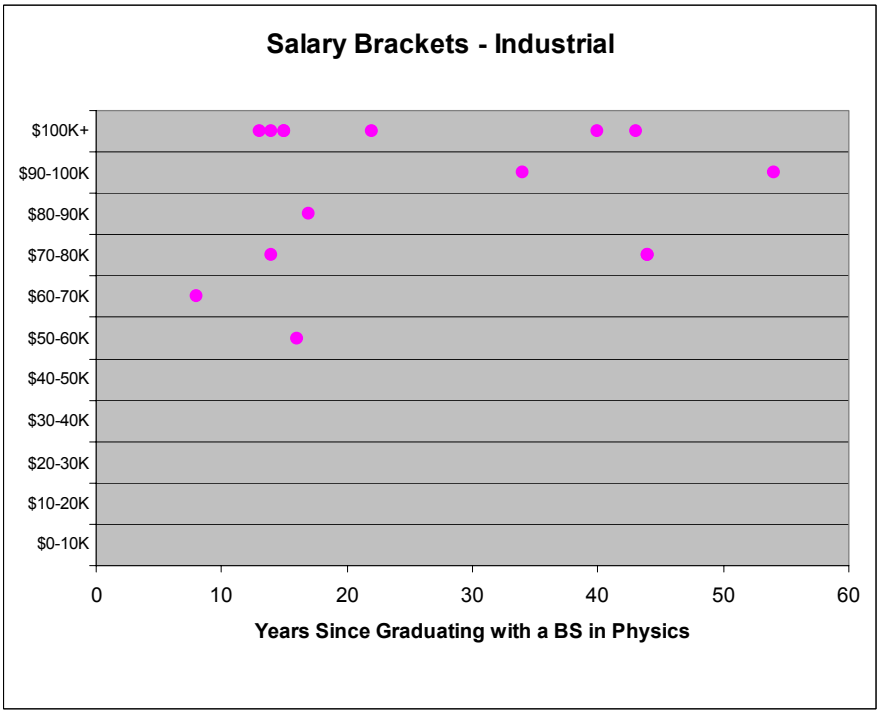
Academic Job Titles

Adjunct Professor
Associate Department Chair
Department Chairperson
Division Chair
Facility Manager
Graduate Research Assistant
Graduate Teaching Assistant
Laboratory Supervisor
Math Teacher
Physics & Math Teacher
Physics Teacher
Physics Teacher & Science Department Head
Professor of Chemistry
Professor of Civil Engineering
Professor of Mathematics
Professor of Physics



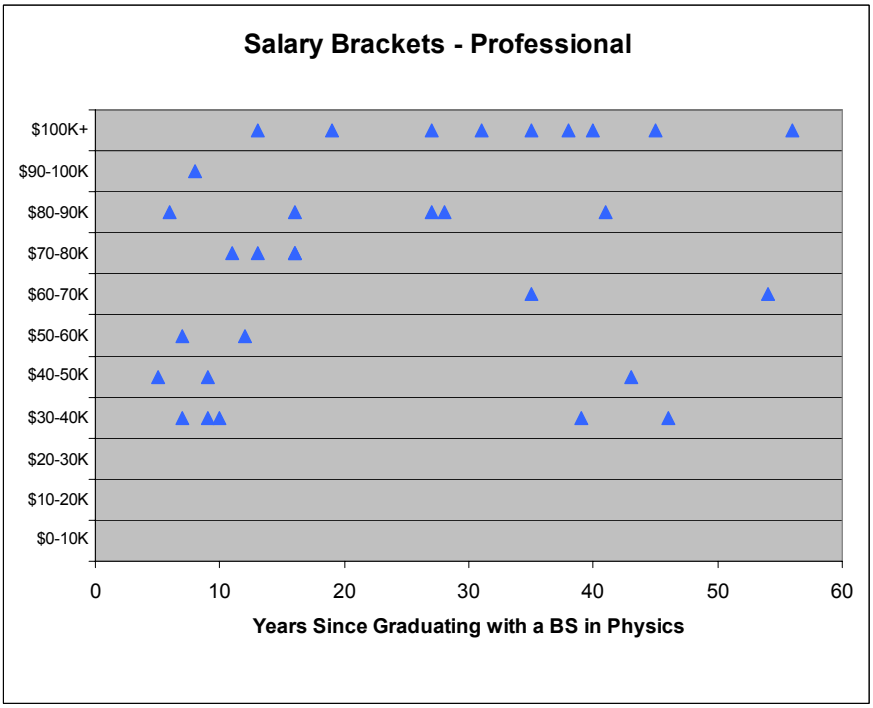
Industrial Job Titles

Associate Research Chemist
Associate Research Scientist
Chief, Analytical Bacteriology Unit
Commercial Press Manager
Defense Contractor
Development Associate
Engineering Manager
General Engineer - Electro-Optical System/ Sensor Research and Program Management
Health Physicist
Medical Physicist
Operations and Production Manager
President of Private Company
Product Engineering Supervisor
Project Manager
Radiation Safety Officer
Senior Medical Physicist
Senior Scientist



Professional Job Titles

Assistant Director
Attorney at Law
C130 Master Navigator
Cartographer
CG Supervisor
Computer Technician
Consultant
Electrical Engineer
Executive Vice President
Financial Consultant
Independent Consultant
Network Security Administrator
Oral Surgeon
Postal Clerk
Project Manager
Radar Analyst
Radiation Oncologist
Regulatory Consultant
Sales Analyst
Senior Application Developer
Senior Optical Development Engineer
Senior Software Engineer
Senior Staff Engineer
Senior Tax Instructor
Software Engineering Manager
Supervisory Electronics Engineer
Technical Support Engineer
Transportation Engineering Technologist
Vice President



Most Interesting Thing One Has Been a Part of as a Result of Having a WKU Physics Degree.

"To be honest, the WKU physics degree has helped in almost everything I've done. The training I received in how to break down problems into their smallest components and solve them individually has been invaluable. The most recent job I've done where physics was "directly" involved was when some…personnel were hired in the mid 1990's as subcontractors at NASA's Jet Propulsion Laboratory to work on the Deep Space Network (DSN)."

"Made two trips to Russia for US Government to conduct radiation surveys of abandoned strategic missile sites, and heavily contaminated sites chosen for dismantlement of nuclear weapons"

"Supersonic flight test probing of the SR-71's sonic boom signature utilizing a F-16XL flying in close formation."

As can be seen in the plots, there is some influence on what you want to do with your physics degree as to how much money you make. Industry and professional jobs typically pay more than academic (though that can't be said to be surprising). However, the key point that can be made is that in many instances, "physics" is not ostensibly a part of the job title!

Physics is not the stereotype that involves long hours in a sterile lab with no human contact gazing at incomprehensible equations. It teaches a broad approach to problem-solving, and those skills, as our graduates can testify, can be applied in a wide variety of disciplines.

Scheduled Events for the 2004 Western Kentucky Physics Olympics

Least Massive Tower – the Do-Ahead Project

There are some amazing towers in Middle Earth – Minas Anor, Minas Ithil, Barad-dur, and Orthanc (which two are the *Two Towers*?). The goal of this competition is to design, build, and bring to the competition the lowest mass 1.5-meter tower capable of supporting 1 kg. There are no restrictions on the material with which the tower may be constructed, except that no kits or pre-fabricated construction materials are permitted. A hook or eyelet must be provided and the tower constructed to allow the tower to be suspended from a balance scale to measure its mass before its ability to support the 1 kg is demonstrated. Towers that support the mass for 20-seconds will be receive a ranking order based on the mass of the tower. The judges' subjective assessment of the tower's aesthetics will be used to break ties. The complete rules are posted at http://physics.wku.edu/olympics/.

Siege of Osgiliath – the Plan-Ahead Project

The Steward of Gondor requires immediate assistance designing siege engines to lead the counter attack and retake control of Osgiliath. Sauron's Orc hordes must be driven from the Citadel of the Stars, but the rest of Osgiliath needs to be left undamaged for the eventual reoccupation by Gondor. The goal of this competition is to construct a siege engine (catapult, trebuchet, or mangonel) and accurately launch projectiles from two distances over the simulated ramparts of Osgiliath to hit a circular target representing the Citadel of the Stars. The complete rules are posted at http://physics.wku.edu/olympics/.

Travels of the Ring Bearer (vector navigation) - Communication/Calculation Challenge

Students will use teamwork, communication and calculation skills to achieve the specified goal. Two members of the team will be presented a set of measurements to make. The remaining two team members will be presented with this set of measurements and be required to compute the desired properties from the data with no additional communication. Finally, the judges perform the test and score the team's effort according to the announced guidelines.

Impromptu Team Physics Activity – Mastery of Impulse and Momentum

Activity is the key word for this competition, with the goal being for each team to achieve the desired result as quickly as possible. The situation is designed to reward teamwork and common sense thinking as well as knowledge of physics. Every team will come away with smiles and good memories regardless of how well they master the particular challenge.

Students from Warren Central High School display their "Potato Launchers" at the start of the 2003 Western Kentucky Physics Olympics. The teams were coached by Doug Jenkins and Kenny Lee.

Order-of-Magnitude Quiz

Also known as Fermi Questions, arrive at a reasonable approximation for the value of a complex situation with very little to no information available to directly compute the answer. In this quiz, the contestants will need to quickly make assumptions for values to use in simple calculations in order to arrive at the "correct" answer, stated as the power of ten of the number that fits the accepted value. Teams will receive 5 questions to complete within 15 minutes. Answers will be judged according to how many orders of magnitude the team's answer is from the judge's solution, the lowest score wins.

Examples of Fermi Questions include:

- How many electrons enter the starter motor when a new, full-sized pickup starts?
- How many times would a tire of a Ford Taurus rotate when driven from NYC to LA?
- Estimate the number of gallons used annually by all the cars in the USA.