

PHYSICS GRADs vs. PROFs CHALLENGE

For Physics Block Party on 11 September 2015:

ROUND 1:

This round has short answers of one-or-two words. The panelists are to just speak the answer out loudly, with the points going to the first person on either side to state the answer correctly. I instruct the audience to keep quiet, as your time will come later. The first correct answer is worth +2 points.

POINTS

AWARDED:

2-Grad (1) (2 points) What *branch of physics* is the specialty of the 'Bond Girl' Christmas Jones?

Nuclear physics

Hint (for 1 point): Christmas Jones met James Bond in the movie "The World Is Not Enough" at a Russian ICBM missile base

2-Prof (2) (2 points) Who was named as the Person of the Century by Time magazine in 2000?

Albert Einstein

no points (3) (2 points) Suppose that we have a simple pendulum 10 meters long and give it a small push. To within 10%, what is its period of oscillation?

6.345 seconds. ($P = 2\pi \cdot \text{SQRT}(L/g)$) Accept 5.710 sec to 6.979 sec

2-Grad (4) (2 points) What is the only element in the Periodic Table that is pronounced as six syllables?

Praseodymium (59) pray-zee-a-DIM-ee-um

2-Prof (5) (2 points) The very popular television show Bonanza, set in Silver City Nevada around the 1870s had one episode covering the early life of what famous US physicist?

Albert Michelson

Hint (for 1 point): (1 points) In the episode, Ben Cartwright got him an appointment to the US Naval Academy, where he went on to spend his career, working with Simon Newcomb, and measuring the speed of light.

2-Prof (6) (2 points) How many editions has the book Classical Electrodynamics by Jackson gone through?

Three (3) editions, the last in 1998.

2-Prof (7) (2 points) What physicist has won the Nobel Peace Prize?

Linus Pauling (1962, anti-nuclear-testing activism)

2-Prof (8) (2 points) Who is the other physicist that has won the Nobel Peace Prize?

Andrei Sakharov (1975, human rights in USSR)

Prof. Rau points out that Joseph Rotblat (1995 Peace Prize) is also a physicist.

- 2-Prof** (9) (2 points) What movie had Kip Thorne as a scientific consultant and executive producer?
Interstellar (plus many documentaries and TV series)
- 2-Grad** (10) (2 points) Here, I am wanting the exponent of a dimensionless number, that is the nearest power of ten to within one order of magnitude. How many electrons are there in my brain?
25 or 26. The typical human brain is 1400 grams. The composition is CHON, which will average to something like that of carbon, which has 12 grams per mole. So, approximately, the adult brain has 116 moles of carbon. With 6 electrons per carbon atom, we have 700 moles of electrons in a human brain. With Avagadro's Number (6×10^{23}), this is 4.2×10^{26} electrons. I'll accept 25 or 26.
- 2-Grad** (11) (2 points) Which signer of the US Declaration of Independence was known in Europe primarily as a physicist?
Benjamin Franklin.
- no points** (12) (2 points) For the current semester, what professor is teaching PHYS 7398?
Scott Marley
Hint (for 1 point): This is Grad-Lab
- 2-Grad** (13) (2 points) What is the element in the Periodic Table that is immediately after Uranium?
Neptunium.
- 2-Prof** (14) (2 points) What is the element in the Periodic Table that is immediately after Neptunium?
Plutonium.
- 2-Grad** (15) (2 points) How many planets are displayed on the Physics Department logo?
Eight. There is no Pluto. The logo and Nicholson were from 1939, with the discovery of Pluto in 1930.

END OF ROUND 1:
GRADs have 12 points
PROFs have 14 points

ROUND 2:

For this round, both teams are to consult together, write out their answers on a page, and then reveal their answers together. Each correct answer is worth 3 points.

POINTS

AWARDED:

no points (15) (3 points) To within two orders of magnitude, what is the Schwarzschild radius for an electron?

$$1.36 \times 10^{-55} \text{ cm} = 1.36 \times 10^{-57} \text{ m. } (R_{\text{Sch}} = 2 * G * m_{\text{electron}} / c^2) \text{ Accept } 10^{-53} \text{ to } 10^{-57} \text{ cm}$$

3-Grad (16) (3 points) Reportedly, Lady Stacy Bright made a fabulous and unexpected discovery that earned her the Nobel Prize in Physics in the year 2058. What was that discovery?

3-Prof

*Travelling faster than the speed of light
or Time travel to the previous night*

The well-known limerick is:

*There was a young lady named Bright,
Whose speed was far faster than light;
She set out one day,
In a relative way,
And returned home the previous night.*

As a side connection, an LSU undergraduate student named 'Stacey Bright' was widely known, and she now is in Sydney Australia as a graduate student working with Orsala de Marco (another frequent collaborator with LSU people).

no points (17) (3 points) What is the critical mass for U-235?

52 kg or 115 pounds (17-cm radius) To 10%, accept 46-57 kg or 104-127 pounds

Critical mass for U-233 is 15 kg (11 cm diameter)

Critical mass for Neptunium-236 is 7 kg (8.7 cm diameter)

Critical mass for Californium-251 is 5 kg (8.5 cm diameter)

This turned out to be an ill-posed question. During the Challenge, several of the profs objected to the above answer. Prof. Rau knew that the critical mass was much smaller, while Prof. Dowling used his phone to search and find a critical mass of 15 kg. The problem is with the definition of 'critical mass'. The values I quote above are for a spherical mass isolated from everything. This is arguably the best and most unique definition. (Even so, a simple 50 kg sphere brought together might go critical, but it will largely blow itself apart before much energy is produced and the bomb will be a dud.) But various conditions can make for smaller masses going critical. For example, if you put a heavy neutron-reflecting tamper around the uranium, then you only need 15 kg to go critical. For the smallest critical mass with the U-235 in aqueous solution with an optimal moderation, you only need 0.78 kg, even though this will not give much of an explosion. In all cases, the Professor's offered answer of "2 kg" was not acceptable.

3-Grad (18) (3 points) This Cadbury Easter Egg has 150 calories. If you are 100 kilograms in mass, how high would you have to climb to work off these calories?
3-Prof

600 meters = 2000 feet = 656 yards, accept anything from 400-800 meters, or 1300-2600 feet (up to half a mile)

For 100kg person (220 pounds); 150 kCal = 6.3×10^{12} erg = MgH.

$H = 6.3 \times 10^{12} / (100 \text{ kg} * 9.80 \text{ m/s}^2) = 6.4 \times 10^4 \text{ m} = 64000 \text{ m}$

The GRADs answer was 30 stories or floors, which is ill-defined yet meaningful. For a 10-25 foot height to a 'story' gives the unacceptable answer of 300 feet to 750 feet. Unfortunately, during the Challenge, I mistakenly said that the '30 stories' answer was acceptable, and they were awarded 3 points. Fortunately, this makes no difference in the outcome.

no points (19) (3 points) Riddle-me-this:

Newton used me to make attractive bodies

Newton also used me to make opposing forces

And in Lenz's Law, I make the currents run counter

In the Laws of Physics, I am the smallest part

Negative Sign

END OF ROUND 2:

GRADs have 18 points

PROFs have 20 points

ROUND 3:

For the third round, I will give a series of questions, often related, and I will alternate back and forth between teams. Each correct answer is worth +4 points.

For the third round, we will have 3 'lifelines', where a panel can try to get further help; **(1)** getting the audience to shout out answers for them, or **(2)** by explicitly asking one person in the audience, with this person being instructed to give their best possible answer, or **(3)** by asking for a hint from me. Each team gets to use each type of lifeline just once.

- 4-Grad** *** **(4 points each)** Name a physicist who has won *TWO* Nobel Prizes
Marie Curie - Physics in 1903 (radioactivity)
Chemistry in 1911 (radium & polonium)
Hint: *She won one of her Nobels in Chemistry in 1911*
- 4-Prof** *John Bardeen* - Physics in 1956 (invention of transistor) &
Physics in 1972 (BCS superconductivity model)
Hint: *He won two Physics Nobels, in 1956 and 1972*
- no point** *Linus Pauling* - Chemistry in 1954 (quantum chemistry)
Peace in 1962 (peace activism)
Hint: *He did not win his Nobel Prizes in Physics, but he was very big on taking megadoses of vitamin C*
- 4-Grad** *** **(4 points)** Xiaoyao Ma just earned his PhD in Physics in our Department.
What was his thesis topic?
Calculate ground states for Water, N₂ and F₂ molecules using Feynman path integrals
Hint: *He's a tall guy with short hair and wire-frame glasses who's always smiling, and I usually see him down at the end of that hallway. His thesis involves water and air gas.*
SIGN LEARNING KINK BASED QUANTUM MONTE CARLO APPLIED TO MULTIPLE LARGE SYSTEM H₂O, N₂, F₂
A Sign Learning Kink (SiLK) based Quantum Monte Carlo (QMC) method is used to calculate the ground state energies for H₂O, N₂ and F₂ molecules. This method has two stages. The first (learning stage) reduces the minus sign problem by optimizing the states which are used in the second (QMC stage). I test the method in Single, Double excitations (SD), Single, Double, and Triple excitations (SDT), and Full Configuration Interaction (FCI) vector spaces. I also perform exact diagonalization in those vector spaces as a benchmark. In each vector space and for each molecule, I perform SiLK QMC for different bond lengths demonstrating that the SiLK QMC is applicable to many systems.
- 4-Grad** *** **(4 points)** Who was his advisor?
Mark Jarrell
Hint: *He came to LSU in 2009, long after having earned his PhD from UC Santa Barbara in 1987. Dissertation: "Impurity Enhancement of Superconductivity"*
- 4-Prof** *** **(4 points)** Out of all the planets, dwarf planets, the Sun, and our Moon inside out Solar System, which one does not have an element named after it?
Mars

Hint: [Kim Stanley Robinson wrote a good SF book on this.](#)

Jupiter [point out the Thor=Jupiter equivalency, allow another answer]

Saturn [point out the Titan-->Cronus=Saturn, allow another answer]

Eris [an acceptable, but unlikely, answer]

Haumea [an acceptable, but unlikely, answer]

Sun	-	Helium (from Helios)
Mercury		Mercury
Venus		Phosphorus (referring to the Morning Star)
Earth		Tellurium
Moon		Selenium
Pallas		Palladium
Ceres		Cerium
Jupiter		Thorium? (Thor = thunder god= Jupiter equivalent)
Saturn		Titanium (one of the 12 Titans was Cronus=Saturn)
Uranus		Uranium
Neptune		Neptunium
Pluto		Plutonium

4-Prof *** (4 points) What exoplanet has the same name as an element?

Krypton

Hint: This planet was the home of Jor-el.

4-Grad *** (4 points) Our department has an active group working on the Pierre Auger Observatory in Argentina, for detecting the very highest energy cosmic rays. But what is the Auger Effect?

The Auger effect whereby an electron is ejected from an atom without the emission of an x-ray or gamma-ray photon as the result of the de-excitation of an outer electron to a vacant state in the inner atom (where the electron had been kicked out by an independent photon).

4-Prof *** (4 points) In the famous Alpher-Bethe-and-Gamow paper of 1948, who was the third person gratuitously added?

Hans Bethe

Hint: One of the authors resented the addition of such a big name, as people might think that the ideas and work were his

4-Prof *** (4 points) What was the subject of the α - β - γ paper?

Alpher's Ph.D. thesis under Gamow, on the creation of hydrogen and helium in the Big Bang

Hint: This is in the top three most important papers on nucleosynthesis

4-Grad *** (4 points) What is the largest European nation to not have an element named after it?

Ukraine [with or without the Crimea]

Hint: Recent wars might or might-not have changed the size of this country, but any such change has not shifted this country's rank in the sizes of European nations

Denmark [accept this if including Greenland area, Hafnium is named after Copenhagen]

Russia has 3,836,652 sq-km but has Ruthenium named after it,

Ukraine is second with 603,628 sq-km (including the Crimea)

France is third (551,695 sq-km) with Gallium & Francium

Spain is fourth (505,992 sq-km) with no elements

Sweden is fifth (449,964 sq-km) with Scandium & Thulium (Scandinavia)

Norway is sixth (385,155 sq-km) with Scandium & Thulium (Scandinavia)

Germany is seventh (357,168 sq-km) with Germanium

Poland is ninth (312,685 sq-km) with Polonium

Denmark has 42,916 sq-km, while Greenland has 2,166,086 sq-km

END OF ROUND 3 and FINAL RESULT:

GRADs have 38 points

PROFs have 40 points

The PROFESSORS won. Each was awarded a 'Tardis Box', as an emblem of their each being 'Master of Space and Time', with this to be placed proudly in display on their desks.