This Tournament Goes To Eleven III: Smell the Glove

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(Astro)Physics (by Erik Johnson [Iowa])

1. In the 1720s, Samuel Molyneux and James Bradley discovered this property of stars. They were unable to explain it until Bradley observed a streamer on the mast of a boat on the Thames. With this realization, he was able to explain the shift of 40 second of arc, and thereby showed the first evidence of Earth's revolution around the Sun. FTP, the two discovered what property of starlight, which is also shown when the Moon turns red during lunar eclipses.

aberration of starlight

2. Explained by the three creators of BCS theory, this occurs in 26 metallic elements and many compounds, and is reached when a substance goes below the transition temperature. First discovered in mercury in 1911, this phenomenon awarded three men a 1972 Nobel Prize in Physics. FTP, name this phenomenon which is the absence of measurable electrical resistance in substances close to zero Kelvin.

superconductivity

3. He used paraffin to slow the neutrons, obtained from radioactive beryllium, with which he bombarded uranium. He never returned home after going to Sweden with his family to accept the 1938 Nobel Prize in Physics, having no love for fascism. FTP, who led a team of scientists working in a former squash court in the basement of Stagg Field at the University of Chicago in creating the world's first self-sustaining chain reaction?

Enrico Fermi

4. His theory of scattering was the first correct explanation of why the sky is blue. While sailing down the Nile, he began writing his famous text, The Theory of Sound. He succeeded Maxwell as the second Cavendish professor of physics at Cambridge. There, he was able to experimentally determine the ohm. However, he is most known for his work with Sir William Ramsay in developing a new family of elements on the periodic table. FTP, identify this man who won the 1904 Nobel Prize in Physics for his discovery of argon.

John William Strutt, Lord Rayleigh (accept Strutt, I guess)

5. A further examination into this can possibly explain the Titius-Bode relation of planets. When the object comes into conjunction, the orbit becomes elongated and pulled into a elliptical orbit away from the resonance. First observed in 1886, these occur at orbit ratios of 1:2, 2:1, 7:3, 5:2, and 3:1, with the second value of orbits belonging to Jupiter. FTP, what are these locations in the asteroid belt called, where a lack of asteroids may be due to the presence of the fifth planet?

Kirkwood Gaps

6. For a mass-spring system in simple harmonic motion it is two pi times the square root of the quantity m over k, where m is the mass and k is the spring constant. For a simple pendulum it is two pi times the square root of the quantity L over g, where L is the pendulum length and g is the acceleration of gravity. For a simple pendulum it does not depend on amplitude, a fact used in making early clocks. FTP, identify this quantity, the length of time between two successive wave crests.

period

7. His work confirmed William Gilbert's 200 year old hypothesis, and laid the groundwork for André Ampere. The cgs unit of magnetic field strength is named after him. While at the University of Copenhagen, he first found the relation between electricity and magnetism. FTP, name the Danish physicist, who found that an electric current flowing through a wire deflects a magnetized compass needle.

Hans Christian Ørsted

8. He published "On the New and Never Previously Seen Star" about a supernova he observed in Cassiopeia, which is now attributed to him. In Wittenberg, he lost part of his nose in a duel, and wore a metal insert for the rest of his life. He built Uraniburg on the island of Hven, and from there, he constructed instruments, through which he made observations accurate to perhaps two arc minutes. FTP, name this 16th century Danish astronomer, whose observations helped Kelper derive his laws of planetary motion.

Tycho Brahe (accept Tycho?)

9. It is able to open and shut a partition dividing two volumes of a gas in a container when both are initially the same temperature. The partition is only opened to allow fast moving molecules through, and temperature of gasses containing these molecules is increased. The temperature of the remaining volume of gas would cool, making the entire system violate the second law of thermodynamics. FTP, name this evil sounding imaginary creature, suggested in a letter by the discoverer of electromagnetic radiation and named by Lord Kelvin.

Maxwell's Demon

10. His earliest work was concerned with the plane polarization of light and terrestrial magnetism. In 1889, he succeeded Berthelot as Life Secretary of the French Academy of Sciences, and within 14 years, inspired largely by a discussion he had with Henri Poincare on Röntgen vacuum tube phosphorescence, he would win a Nobel Prize for physics for his experiments on uranium salt emissions. FTP, name this French physicist who died at Le Croisic in 1908, considered the father of radioactivity.

Antoine Henri Becquerel

11. George Airy and James Challis shared similar skepticism, and did not complete the task in time. This prevented John Couch Adams from receiving much of the credit. Airy, upon learning of the oversights of Lalande, and, upon later investigation, Galileo, chose not to blame Challis for not examining his data. On September 23, after 30 minutes of searching, Johann Galle found what Le Verrier was looking for. FTP, these events, which took place in 1846, concerned discovering what planet?

Neptune

12. In mathematics, a three-dimensional field of this type can have a divergence and a curl, but not a gradient. In biology, it describes an agent that transmits a disease to other organisms. Examples in physics include dipole moment, electric field, and velocity. FTP, identify this word which in physics signifies a quantity with magnitude and direction.

vectors

14. Of the 26 brightest stars in the sky, it has the largest absolute magnitude of –8.1, due to it being over 1000 light years away. Also known as Algebar, it is a triple star system, but the other two can only be viewed with telescopes. This star ranks seventh behind Capella in visual brightness. Its name comes from Arabic, meaning "foot" of al-jauza. FTP, although it is known as Beta Orionis, what star is actually brighter than Betelgeuse?

Rigel

15. Observed with atoms of rubidium and lithium, it only takes place in a large number of bosons at low temperature whose total number is consumed in collision, and where a large fraction occupy a single quantum state of lowest energy. Ketterle, Wieman, and Cornell, the 2001 Nobel Prize winners, were the first to show its existence. FTP, what is this phenomenon, named after an Indian physicist and the winner of the 1921 Nobel Prize in Physics.

Bose-Einstein condensation

16. In 1850, he used Joule's experimental data, and devised the nature of free and latent heat to disprove the two axioms of caloric theory. He was the first to recognize the invariant property in the Carnot cycle. The equation relating vapor pressure to the heat of vaporization in liquids is attributed to him and Clapeyron. FTP, identify this German mathematical physicist, who first defined the concept of entropy and developed two laws of thermodynamics.

Rudolf Clausius

17. After he received his Ph.D., A.A. Michelson invited him to become his assistant at the University of Chicago in 1896. Much of his research at CalTech concerned extraterrestrial radiation, which he called "cosmic rays." While at Chicago, he verified Einstein's photoelectric equation, and experimentally determined the value of Planck's constant. FTP, name the man who won the 1923 Nobel Prize by determining the charge of an electron with his oil-drop experiment.

Robert Millikan

18. During a lecture on quasars by Hoyle, he had humiliated him by stating that quasars cannot be supermassive stars. His research on the Challenger disaster showed the inelastic properties of the O-rings, which he demonstrated on live televsion. His work with Gell-Mann discovered the nature of weak decay, which can be visualized by his namesake "diagrams." FTP, name this formulator of quantum electrodynamics and author of Lectures on Physics.

Richard Feynman

19. His professional work began as he assisted Robert Boyle in the construction of the air pump. His Law of Inverse Squares allegedly was used by Newton in publishing Principia, without the former receiving any credit. His Micrographia contains his observations as the first person to use a microscope, and he coined the term "cell." However, FTP, what English scientist is better known in physics for his law of elasticity?

Robert Hooke

20. He noticed the analogy between the commutators in Heisenberg's uncertainty principle and Hamiltonian mechanics, allowing him to combine them with his "bra-ket" notation. He also found the relation between quantum mechanics and relativity, which helped him formulate his spin ½ equation. Atoms obeying the Pauli exclusion principle obey statistics attributed to him and Fermi. FTP, name this man who shared the 1933 Nobel Prize for his research into electrons, along with postulating an anti-matter counterpart.

Paul Dirac

----------END OF ROUND----------

21. Sagredo is an open-minded Venetian and is initially neutral. Salviati is a Florentine committed to the modern idea. Simplicio is defender of the Ptolemaic theory and eventually loses the argument. The book this event takes place in was written in Italian to reach a wider audience, much to the disdain of the Church. FTP, idenifify this work of Galileo showing his proof of the heliocentric theory.

Dialogue Concerning the Two Chief World Systems

22. While experimenting with electrons, its namesake observed a faint blue glow. Three years later, Ilya Frank and Igor Tamm explained that this event is caused by electromagnetic pulses emitted after water molecules are reoriented into their normal charge distribution. All three men shared the Nobel Prize for Physics in 1958 for this discovery. FTP, identify what is produced when charged particles pass through an optically transparent medium at speeds greater than that of light in the medium.

Cherenkov radiation (pronounced like care, also spelled Cerenkov)

Bonus questions

1. Given the description, identify the device used in particle physics FTP each.

a. Invented by D.A. Glaser, it contains liquid kept slightly above boiling point at pressure high enough to prevent boiling. Right before the passage of ionizing particles the pressure is reduced, causing the particles, like neutrinos, to be photographed.

bubble chamber

b. A row of alcohol-soaked strips is placed on top of a container, while the bottom is cooled by solid CO_2. Vapor diffuses downward with a center continuously sensitive to the presence of ions made by radiation.

diffusion cloud chamber

c. SImilar to the diffusion cloud chamber, this container has air and ethanol cooled suddenly by adiabatic expansion, hence the name, causing vapor to become supersaturated. The excess moisture is deposited in drops on tracks of ions created by the ionizing radiation.

Wilson expansion cloud chamber

2. Identify these angular quantities, FTP each.

a. This is the change in angular position with respect to time.

angular velocity

b. This is the sum of each mass element, times the square of its perpendicular distance from the axis of rotation.

rotational inertia

c. This is the force applied to a rotating body, times the perpendicular distance from the axis of rotation to the point at which the force is applied.

torque

3. Identify these ancient contributors to astronomy FTP each.

a. He calculated the distance from the Earth to the Moon, found that the Earth's axis precesses, and made a catalog of approximately 850 stars that is the earliest known.

Hipparchus

b. He set up a system of magnitudes of stars, and he wrote, "Almagest," the most detailed book on astronomy for centuries. His geocentric model of the solar system was in place until the Renaissance.

Ptolemy

c. Using the obelisk in Alexandria, a vertical pit in Syrene, and the summer solstice, he calculated the size of the Earth.

Eratosthenes

4. Pencil and paper ready. Answer the following questions for the stated number of points. You will get ten seconds per part.

5: A 10-kilogram mass is moving north at 10 meters per second. What is the mass's kinetic energy?

500 joules

10: A second mass of 6 kilograms moving south at 6 meters per second runs into the first mass. The two masses stick together. What is the new velocity of the masses?

4 meters per second, north

15: How much kinetic energy is lost by both masses in this completely inelastic collision?

480 joules (608 joules before, 128 joules after)

5. Sure, you know that electroweak theory exists, but do you know what it entails? For the stated number of points, answer these questions about the ramifications.

For five points each, what three particles, grouped together as weakons, were predicted to exist according to the theory?

W plus (W^+), W minus (W^-), Z (Z^0)

FTP, in 1983, Carlo Rubbia and coworkers discovered the W and Z particles at what facility?

CERN

F5P, this theory grouped together those force carriers with what other gauge boson?

photon

6. 30-20-10, identify the scientist from clues.

30: His treatise on the theory of binary mixtures applied the Second Law of Thermodynamics and works by Gibbs on heterogenous substances to explain the liquid/vapor state of the solution.

20: The intermolecular forces between electrically neutral molecules, including London, dipole-dipole,and dipole-induced dipole, are named after him.

10: His work on the equation of state of gases and liquids won him the Nobel Prize in 1910, and the equation, used for real gases, is named after him.

Johannes van der Waals

7. Here is a bonus about telescopes. Of course, you can't exactly look through some of these.

a. A relic from before reflecting telescopes came into prominence, this telescope in Williams Bay, Wisconsin is the largest refractor in the world.

Yerkes Observatory

b. Located in Puerto Rico, this radio telescope has the largest dish in the world. Unfortunately, it is built into the ground and can only view a few degrees from the ~~azimuth~~ zenith.

Areceibo

c. Consisting of 10 radio telescopes from Hawaii to the Virgin Islands, this includes the VLA and has a resolution equivalent to a dish with diameter equal to the Earth.

Very Long Baseline Array

8. Answer these questions about very large facilities used to find very small objects for ten points each.

a. This detector, located in a mine in Japan, has 50,000 tons of water in the tank, and detects neutrinos and other elementary particles. It detected an amazing 12 neutrinos from the 1987 supernova in the Large Magellanic Cloud.

Super-Kamiokande Detector

b. CERN currently has this under construction. When it is completed in 2005, it will contain the highest energy collisions in the world.

Large Hadron Collider

c. The Tevatron at this facility was the first collider to achieve collision energies greater than 1 tera-electron-volt. No wonder they found the top quark.

Fermilab accept (Fermi National Accelerator Laboratory)

9. Answer these questions about cycles of engines for fifteen points each.

a. This cycle of the four-stroke internal-combustion engine has the gasoline-air mixture undergo adiabatic compression. After the spark plug ignites the mixture, it adiabatically expands against the piston, which is called the power stroke. The gases are exhausted during the intake of another mixture. The cycle is named after the inventor of the gas motor engine.

Otto cycle

b. This cycle has air compressed to a high temperature. The fuel injector injects fuel, which ignites in the high temperature, causing isobaric expansion. While the gas combusts, it undergoes adiabatic expansion, and is exhausted in the same manner as the Otto cycle. This cycle is far more efficient, and is named after the engine that employs it.

Diesel cycle

10. Answer these questions about an electron in the hydrogen atom for the stated number of points.

5: Who made the first definitive mapping of absorption lines in the photospheric spectrum of the Sun? These were attributed to the excitation of electrons in hydrogen and the lines are named after him.

Joseph von Fraunhofer

10: What Swiss schoolteacher noticed that the wavelengths of emission lines of hydrogen could be calculated with a simple formula involving an integer n?

Johannes Balmer

15: What energy is required to ionize an electron in the ground state from a hydrogen atom?
13.6 eV (electron-volts)

11. This bonus contains questions about an array of stars that isn't exactly a constellation. Answer the following for the stated number of points.

5: Usually high in the night sky a certain time of year, this arrangement of the alpha stars from three constellations is called what?

Summer Triangle

For five points each and a bonus five for all correct, what are the three stars that make up the summer triangle?

Vega, Altair, Deneb

For the final five, Deneb is the alpha star of Cygnus. Some of the stars of Cygnus make up what arrangement of stars?

Northern Cross

12. Identify these effects for ten points each.

a. In solid radioactive materials, this is the recoil-free emission of gamma radiation. It is named after the man who shared the 1961 Nobel Prize.

Mössbauer effect

b. This effect is due to a superconducting material being cooled below the critical temperature in an external magnetic field. The superconductor generates current loops to expel the magnetic field, creating an opposing magnetic field which levitates the magnet.

Meissner effect

c. An external magnetic field affects the wavelength of the spectral lines of an atom due to the interaction of the orbital magnetic moment. This splitting of spectral lines was found by the man who shared the 1902 Nobel Prize.

Zeeman effect

13. Answer these questions about induction for the stated number of points.

Five for one, 15 for both, what two scientists independently discovered that chagning magnetic fields induces a current in a wire?

Michael Faraday, Joseph Henry

The unit of inductance was named after Henry, but for five points, what unit of measurement was named after Faraday?

capacitance

For a final ten points, what states that an induced current or emf is in a direction opposing the change of flux?

Lenz's law

14. To follow up a bonus on electrodynamics, here is a bonus on magnetostatics. Answer these questions for the stated number of points.

15: This equation gives the magnetic field produced by a steady current and is analogous to Coulomb's law in electrostatics.

Biot-Savart law

10: Analogous to Gauss's law, this relates a current to the integral of the tangential component of B about a closed loop.

Ampère's law

5: Who fixed Ampère's law after he noticed in his research that the curl of B requires a displacement current to ensure that the divergence of the curl equals zero?
James Clerk Maxwell

15. Remember that problem with the masses in motion? I'll give the data again in these questions for ten points each.

a. A ten-kilogram mass is moving north at 10 meters per second. A six-kilogram mass is moving south at 6 meters per second. What is the momentum of the system? You have 10 seconds.

64 kilogram-meters per second, north (must have all parts)

b. What is the momentum of the system after the collision?

64 kilogram-meters per second, north (must have all parts)

c. If the force due to friction is 10 newtons, how long would it take for the 10-kilogram mass to stop?

10 seconds

16. Given clues, identify these asteroids for ten points each.

a. In 1804, this asteroid was the fourth discovered, and is the only member of class V. It is the only asteroid that can be seen with the naked eye, which is due to its high albedo.

Vesta

b. This asteroid is found with a semimajor axis of 13.7 AU, placing it beyond the orbit of Jupiter. Its orbit is strongly affected by Saturn, and has been found to be surrounded by a large cloud of gas, suggesting its similarities with comets.

Chiron

c. Discovered by Giuseppe Piazzi on January 1, 1801, this was the first asteroid found, and is still the largest known.

Ceres

18. Answer these questions about stellar lifetimes for ten points each.

a. This is the current location of the Sun in stellar evolution. It is noted by the burning of hydrogen, and stars range in mass from 0.08 to 130 solar masses.

main sequence

b. This follows the asymtotic giant branch, where the gas and dust expelled during that time form a shell of ionized gas. The shell begins to glow, producing this.

planetary nebula

c. After the planetary nebula cools, the star fades dramatically and becomes this.

white dwarf

19. Did you honestly think you were done with the Balmer series in hydrogen? Well, yes. However, for ten points each, name any three of the spectral series of hydrogen from n=1 to n=5, Balmer excluded.

Lyman (n=1), Paschen (n=3), Brackett (n=4), Pfund (n=5)

20. Since you have answered all twenty tossups in the packet, you will now get some bad alliteration. Answer these questions that relate to relativity for ten points each.

a. The Lorentz transformations of space and time were improvements on the version used in classical relativity. The classical transformation was developed by what scientist?

Galileo Galilei (accept either)

b. While Casper stays on Earth, Amelia leaaves on a rocket ship at a fraction of light speed to a distant planet. When she returns, she sees that she has not aged as much as Casper. However, both of them noticed during the trip that the other person's clock was running slow. What does this situation describe?

twin paradox

c. The rate of the clocks' rotation is altered when they have a relative velocity to each other. The alteration of these frequencies can be attributed to what?

relativistic Doppler effect