Old Physics Teachers Never Die - They Just Cancel Out

TTGT11 VI: Lick My Love Pump
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Subject: Physics.

Tossups

1. His namesake method of combinatorics and probability theory is used to solve problems of distribution and occupancy. In 1944, he wrote the book *What is Life?* which inspired James Watson to study the gene. His famous differential equation involves partial derivatives (*) of both time and position. For ten points, name this Quantum Physicist, whose cat experiment outlines the inherent uncertainty of particle states.
    Erwin **Schrödinger**

2. Radiation emitted by this type of machine is caused by moving non-relativistic charged particles that are trapped in a magnetic field. (*) Its predecessors required impractically long vacated tubes, a need which this device did not have. For the points, name this Ernest Lawrence invention that accelerates charged particles in a circular path, a device much more compact than linear accelerators.
    Cyclotron *(do not accept "Synchrotron")*

3. This quantity for gasses can be defined, but it would be impractical to do so because it would depend on the process used to effect heat change. This quantity for aluminum is 0.900 and (*) is 2.46 for ethanol, and it usually has a unit of Joules per gram per degree Celsius. For ten points, name this thermodynamic quantity, defined as the amount of heat needed to raise one gram of substance one degree Celsius.
    Specific Heat Capacity *(Neither accept nor prompt on just "Heat Capacity")*

4. It was originally postulated by Wolfgang Pauli to explain away the apparent break of conservation of energy and momentum in certain beta decay processes. Originally postulated to be massless (*), recent evidence suggesting that these leptons can change their types implies otherwise. For ten points, name this particle which comes in three varieties: electron, muon, and tauon; and whose name—coined by Fermi—is Italian for "little neutral one".
    Neutrino

5. His namesake crosses results from the light of one galaxy being bent by the gravity of a second one, and his namesake coefficients can be used to describe the Radiative Transfer Equation. He also (*) helped describe the dynamics of particles with symmetric wave functions with the Indian physicist Satyendra Bose. For ten points, name this German theoretical physicist who won the 1921 Nobel Prize for his description of the Photoelectric Effect.
    Albert **Einstein**

6. "I'm thinking, y'know, eight-year-old white girl, middle of the ghetto, bunch of monsters, this time of night with quantum physics books?" the main character (*) responds when asked why he perceived little Tiffany as a threat. Its plot revolves around a secret organization whose job it is to regulate alien activity on Earth. For ten points, give me the name of this hit sci-fi movie, whose main characters, Agents Jay and Kay, played by Will Smith and Tommy Lee Jones, protect Earth from the scum of the universe.
    Men in Black

7. **A direct consequence of this phenomenon is the so-called "degeneracy pressure", which supports the constituents of White Dwarfs and Neutron Stars from collapse due to gravity. This postulate, logically equivalent to Fermi-Dirac Statistics, (*)** explains the placing of electrons into orbital shells when combined with Schroedinger's Equation. For ten points, name this law of quantum mechanics that states that no two fermions can occupy the same quantum state at the same time.

      Pauli Exclusion Principle *(Prompt on "exclusion principle")*

8. **The first working one was made by Theodore Maiman, but it wasn't continuous. Many utilize the three energy levels derived from Bloembergen. It's name was first coined by Gordon Gould, (*)** who also got the lucrative patent rights. For ten points, name this device, which creates a cohesive beam of monochromatic photons, utilized by Dr. Evil to hold Washington D.C. hostage in *Austin Powers*.

      Laser

9. **Gregorio Ricci first conceptualized the calculus used on them. The completely anti-symmetric 3-D one, also known as the Cevita-Levi symbol, can be used to define cross products. The stress energy (*)** one in General Relativity is equivalent to the curvature of space at a given point. For ten points, name these mathematical objects, a generalized form of vectors and matrices.

      Tensor

10. **In particle theory, the possibility of their existence arises from a topological glitch in the vacuum configuration of gauge fields. Charge quantization follows from their existence, but (*)** they have never been observed, despite the fact that the standard Big Bang model predicts them to be plentiful. For ten points, name these isolated positive or negative pieces of magnets, the electric analog of which would be the electron or proton.

      Magnetic Monopole (prompt on "monopole")

11. **The seat of Fullerian Professor of Chemistry at the Royal Institute was created for him by his mentor, John Fuller, and he was an assistant to Sir Humphry Davy. His namesake effect is observed when the plane of polarization (*)** of light is rotated when passed through a magnetic field, and he gave his name to a unit of charge corresponding to 96485 Coulombs. For ten points, name this physicist, who discovered two famous laws of electrolysis and discovered electromagnetic induction.

      Michael **Faraday**

12. **In number theory, it represents the Möbius function, and in Greek ciphers, it has a numerical value of 40. With a subscript of zero, it represents the (*)** permeability of free space, and it is also used to symbolize the reduced mass in the Two Body Problem. The twelfth letter of the Greek alphabet is, for ten points, this letter, which is used to denote one-millionth of a unit, or the coefficient of friction.

      mu

13. **It's shape was chosen as a result of the hairy ball theorem, which states that there is no nonvanishing tangent vector field on a sphere with a Euler Characteristic of two, but there is for this device's shape, which has a Euler Characteristic of zero. Its name comes from Russian for "Toroidal, (*)** chamber, magnetic", and its creators were Igor Tamm and Andrei Sakharov. For ten points, name this doughnut-shaped plasma containment device, which is capable of fusion reactions.

      Tokamak

14. The fact that Maxwell's Demon fails to decrease it for a system relates thermodynamics with information theory. Clausius was the first person to conceive of this idea, and postulated it to be the change in heat (*) over the temperature; and Boltzmann later defined it to be proportional to the log of the number of possible microstates of a system. For ten points, name this thermodynamic quantity denoted by S, a measure of the disorder in a system.

    entropy

15. The first experimental evidence of them were discovered at an electon-positron collider in DESY, a German electron synchrotron. There are only eight linearly independent ones, due to the possible combinations of the color (*) charge they carry. For ten points, name these gauge bosons that fundamentally act only between either two quarks or themselves, the carriers of strong force.

    gluons

16. It operates by generating an as-yet undisclosed subspace field, and the wormholes they generate are one-way for matter, but two-way for electromagnetic radiation. Usually, only seven (*) chevrons are used in the dialing sequence to connect to other ones, but eight have been used to connect to similar devices in different galaxies. For ten points, identify this fictional titular device of a 1994 film starring Kurt Russell or its hit sci-fi spinoff series, *SG-1* and *Atlantis*.

    Stargate

17. This law can be considered the magnetic analog of Coulomb's Law, and it is logically equivalent to Ampere's Law. The constant of proportionality in this law is defined as the (*) permeability of free space over four pi, and it was named for the two French physicists who discovered it. Name this law, FTP, which states that the magnetic field produced by a current is inversely proportional to the square of the distance from the wire through which the current flows.

    Biot-Savart Law

18. He learned to play a variation of the drums because "there was nothing to *do*" at Los Alamos, where he worked on the Manhattan Project. His namesake (*) diagrams help immensely in calculating and conceptualizing interactions between particles in space-time. Name this American physicist, for ten points, whose work in developing quantum electrodynamics won him the Nobel Prize in 1965. *Surely you're joking* if you haven't answered by now.

    Richard P. **Feynman**

19. In Algebra, it is a commutative ring, all of whose elements, with exception to the additive identity, have a multiplicative inverse. A scalar one results from the exchange of spin zero particles. The magnetic (*) and electric ones can be unified into a single tensor one. For ten points, give the name of this object, which assigns a value to each point in space, probably not related to Wrigley or SAFECO.

    Field

20. The modern formulation is due to Oliver Heaviside and Willard Gibbs, who used vector calculus to greatly simplify the 20 equations of its originator. The first is Gauss' Law (*) in partial differential form, and the last is a restatement of Ampere's Law. For ten points, name this set of four equations, named for a Scottish physicist, which relates electricity to magnetism.

    Maxwell's equations (accept equivalents to "equation")

21. A substance is anisotropic if the value for this property is dependent on the path taken through the substance. Snell's Law (*) states that this quantity times the sine of the incidence angle is constant at the boundary of two substances. For ten points, name this quantity, the ratio to the speed of light in a vacuum to the speed of light through a given substance.

    index of refraction

Bonuses

1. Given the SI unit, give the unit that is its inverse, 5-10-15.
(5) Hertz
Answer: **Second**
(10) Diopter
Answer: **Meter**
(15) Siemens
Answer: **Ohm**

2. There are too few questions about acoustics. Name these properties of sound, for ten points each.
(10) With units of watts per meter squared, this term is equal to the sound power per unit area.
Answer: sound **intensity**
(10) This logarithmic unit of sound intensity, named for the inventor of the telephone, is too big for practical use, so one tenth of this unit is more commonly used.
Answer: **bel** (do not accept "decibel")
(10) Consider a pipe one meter in length with one end closed. What is the wavelength of its fundamental tone?
Answer: **4 meters**

3. Given the type of radiation, name the most famous superhero(es) that derive their superpowers from them for ten, or for five if you need an extra hint.
(For 10) Electromagnetic radiation whose wavelength is about 510 nm.
(For 5) His birth name is Kal-El, and he was sent to Earth as a child to escape the destruction of his home planet.
Answer: **Superman**
(For 10) Gamma radiation.
(For 5) His alter ego is named Dr. Robert Bruce Banner.
Answer: The Incredible **Hulk**
(For 10) Streams of high energy electrons, protons, and neutrons, collectively known as cosmic rays.
(For 5) This foursome, including the Thing and the Human Torch got their start in 1961.
Answer: The **Fantastic Four**

4. Some physics words have very odd origins. Given the origin of the physics term, name it, for ten points each.
(10) This element's name is Swedish for "heavy rock". It was originally named for its hypothesizer, Peter Woulfe, who still lends his last initial to this element's atomic symbol
Answer: **tungsten**
(10) This word comes from the Greek for "unbreakable", but Leó Szilárd and Enrico Fermi proved that these are, in fact, very breakable.
Answer: **atom**s
(10) This word was first coined in James Joyce's *Finnegan's Wake*, which is odd, because the term meant 'to caw', not 'up', 'down', 'strange', 'charm', 'top', or 'bottom'.
Answer: **quark**

5. Whoever said "Diamonds are forever." was a dunce. Name the following about crystallography, for ten points each.

(10) The most common branch of crystallography makes use of the diffraction pattern of this type of electromagnetic radiation, presumably because its wavelength is comparable to the spacing in between atoms in a lattice.

Answer: **x-rays**

(10) What is the last name of the father and son team shared the 1915 Nobel Prize in physics for their development of X-ray Crystallography?

Answer: (William Henry and William Lawrence) **Bragg**

(10) The biochemists are always trying to steal methods physicists come up with. X-Ray Crystallography was used to determine the structure of myoglobin, and was used by James Watson and Francis Crick to determine the shape of this molecule.

Answer: **D**eoxyribo**n**ucleic **A**cid (**DNA**)

6. Name the following quantities from rotational dynamics, 5-10-15.

(5) This quantity, defined as the time derivative of angular momentum, is, in simple cases, equal to the cross product of the force vector and the displacement vector.

Answer: **torque**

(10) It can be considered the rotational analog of mass, and it is determined by taking the integral over the entire mass of the square of the distance from the origin with respect to mass.

Answer: **moment of intertia**

(15) This quantity, usually symbolized as a capital H, is one minus the ratio of the moment of inertia of a spheroid about its major axis to the moment of inertia about its minor axis.

Answer: **dynamical ellipticity**

7. Name this person, 30-20-10.

(For 30) He was tutored by John Dalton, and electricity so fascinated him that he and his brother experimented by shocking each other, and their servants.

(For 20) His ideas of energy were based on his extremely precise measurements, a concept new to physics at the time. His most famous experiment involved a falling weight spinning a paddlewheel inside an insulated barrel of water.

(For 10) This English physicist was among the first to propose that heat was random translational energy of very small particles, whose name is used as the SI unit of energy and work.

Answer: James Prescott **Joule**

8. 5 for one, 10 for two, 20 for three, 30 for all four, of 0th, 1st, 2nd, or 3rd, which one correctly identifies:

(A) Kepler's Law of Planetary Motion that states that "a line connecting a planet to its star will sweep out equal areas in equal times".

Answer: **2nd**

(B) The Law of Thermodynamics that states that, if two objects A and B are both in thermal equilibrium with a third object C, then A and B are in thermal equilibrium with each other.

Answer: **0th**

(C) The Law of Robotics, as created by Isaac Asimov, that says, that a robot may not harm a human being, or, through inaction, allow a human being to come to harm.

Answer: **1st**

(D) The Law of Thermodynamics tha t states that the change in internal energy of a system is the same as the change in heat of the system minus the work done by the system.

Answer: **1st**

9. It's time to think about taking a stretch. Give the following quantities from elastics, for ten points each.
(10) This quantity is defined as the ratio of stress to strain in a given substance.
    Answer: **Young's Modulus**
(10) In Elasticity theory, this quantity is shown to be equivalent to half the Young's Modulus over one plus the Poisson Ratio.
    Answer: **Shear Modulus**
(10) This quantity is defined as negative one times the volume times the derivative of pressure with respect to volume.
    Answer: **Bulk Modulus**

10. "E Pluribus Unum" seems to be more and more a motto of physicists nowadays. Answer the following questions about theories that try to unify the fundamental forces and theories behind physics, for ten points each.
(10) This theory, developed by Sheldon Glashow, Abdus Salam, and Steven Weinberg, unifies the force carried by the photon with that which is responsible for nuclear decay.
    Answer: **Electroweak** Theory
(10) This theory describes the interactions of charged particles in terms of quantum mechanical processes, and won Schwinger and Tomonaga the 1952 Nobel Prize.
    Answer: **Quantum Electrodynamics**
(10) This theory derives its name from a new concept, "color charge", which is derived from it. It unifies the strong force with the electroweak force.
    Answer: **Quantum Chromodynamics**

11. Name these things in physics, with something in common, for ten points each.
(10) This constant, which is symbolized with an uppercase R, has a value of 8.31 Joules per mole per Kelvin.
    Answer: **Universal Gas Constant** or **Molar Gas Constant**
(10) A capital R with a subscript of infinity is this constant, which is the constant of proportionality in Balmer's Formula, Lyman's Formula, Paschen's Formula, and Pfund's formula.
    Answer: **Rydberg's Constant**
(10) In Quantum Mechanics, a capital R represents this quantity, the ratio of the amount of non-transmitted radiation over a potential barrier to the radiation incident on the barrier.
    Answer: **Reflection Coefficient** or **Coefficient of Reflection**

12. It's long overdue for a bonus about Special Relativity. Answer the following, for ten points each.
(10) Special Relativity would never had developed if it weren't for this 1887 experiment, which showed that the velocity of light was invariant to the observer by use of an interferometer.
    Answer: **Michelson-Morley** Experiment
(10) Using the postulates of Special Relativity, Einstein proved that this man's length contraction, postulated to explain the null result of the Michelson-Morley Experiment, was, in fact, correct.
    Answer: (Hendrik) **Lorentz** or (George) **Fitzgerald** *(accept either)*
(10) This phenomenon, derived from Special Relativity, explains the twin paradox, whereby a change in time for a moving observer appears smaller than that of an observer at rest.
    Answer: **Time Dilation**

13. Five for one, Ten for two, Twenty for three, and Thirty for all four. Given a particle, identify whether it is a boson, has a positive charge, both, or neither.
(A) Alpha Particle
    Answer: **Both**
(B) Anti-Muon
    Answer: **Positive** charge
(C) Tauon
    Answer: **Neither**
(D) Photon
    Answer: **Boson**

14. Answer the following about antimatter, for ten points each.
(10) This physicist first theoretically derived the possibility of antimatter by modifying Schrödinger's Equation with Special Relativity definitions of energy and momentum.
    Answer: Paul **Dirac**
(10) Dirac predicted the existence of this antiparticle. A gamma ray of sufficient energy will split into an electron and this particle, the electron's antiparticle.
    Answer: **positron**
(10) When a positron and an electron do not have enough kinetic energy to escape the Coulomb force between them, the positron and the electron go into a death dance before they come into contact and annihilate each other, forming this deceptively named substance.
    Answer: **positronium**

15. Given the description of a circuit-component notation, identify the circuit for ten points each.
(10) A spiral or a connected set of semi-circles.
    Answer: **inductor**
(10) A jagged line between two pieces of circuits
    Answer: **resistor**
(10) Two straight line segments perpendicular to the circuit path, with a space in between them.
    Answer: **capacitor**

16. Answer the following about black body radiation, for ten points each.
(10) When analyzed classically, the amount of energy released from a black body at a given frequency is proportional to the square of the frequency, and implies this contradiction, that the energy emitted from a black body is infinite.
    Answer: **ultraviolet catastrophe**
(10) This man proposed, self-doubtfully, that the energy of the harmonic oscillator was quantized, thus solving the Ultraviolet Catastrophe, and forming a correct model for black body radiation.
    Answer: Max **Planck**
(10) The peak wavelength of light can be derived from this law, that states that the peak wavelength emitted from a black body radiator varies inversely with temperature.
    Answer: **Wien's Law**

17. Just because a quantity is unitless does not mean it isn't manly. Name the following important physical quantities that happen to be unitless, 5-10-15.
(5) This dimensionless number is the ratio of the speed of an object in a given medium to the speed of sound in that medium.
    Answer: **Mach** Number
(10) This number, named for an Italian physicist, is the ratio of the number of molecules per mole of a substance.
    Answer: **Avogadro's** Number (or Constant)
(15) One of the most important constants in fluid mechanics, it is a fluid's mean velocity times the length of the pipe through which it flows over the fluid's velocity. Above 2300, fluid flow is turbulent, and below 2300, it is laminar.
    Answer: **Reynolds** Number

18. Is it getting hot in here, or is it just this bonus on thermodynamics? Answer the following, for ten points each.
(10) This is the name given to the thermodynamic process in which the internal energy of the system does not change.
    Answer: **adiabatic** process
(10) This theoretical engine, named for a French Physicist, is at its optimum theoretical efficiency. It operates on a reversible cycle between two adiabats and two isotherms.
    Answer: **Carnot** engine
(10) A process can occur naturally if and only if this thermodynamic quantity is negative. It is usually given in terms of the heat, the entropy, and the temperature of a system.
    Answer: **Gibbs Free Energy** Equation

19. What do Cygnus X-1 and my mother in law have in common? Here's a hint: Answer the following about black holes, for ten points each.
(10) This man argued that special relativity demonstrated that any non-radiating body over about 1.4 solar masses, a limit that is now named for him, would collapse into a black hole.
    Answer: Subrahmanyan **Chandrasekhar**
(10) This guy solved Einstein's field equations, and showed that any information within a certain radius of a point mass would be unable to escape, including light.
    Answer: Karl **Schwartzchild**
(10) This man proved that the area of a black hole's event horizon area can never decrease, because it is proportional to its entropy. The theoretical existence of his namesake radiation, on the other hand, is still under review.
    Answer: Stephen **Hawking**

20. Is this real? Or is it fan-ta-sy? Right now, no one knows. Identify these things that, as of right now, are real only in theory, for ten points each.
(10) This particle, named for the British physicist who predicted its existence in the 1960's, propagates a field, which is also named for him, which is thought to give mass to other particles.
    Answer: **Higgs** boson
(10) This gauge boson is the only of the predicted gauge bosons yet to be verified experimentally. The fundamental force it propagates is the weakest of the four.
    Answer: **Graviton**
(10) Though it has yet to be observed in the real world, this type of unifying theory assumes that for every fermion, there exists a boson of equal mass that is its partner, and vice-versa.
    Answer: **Supersymmetry** Theory

21. Answer the following related questions of particle physics, for ten points each.
(10) These particles which come in positive, negative and neutral varieties were first discovered in a weather balloon that had been subjected to cosmic rays by Cecil Powell. They are collectively named for the 9th Greek letter.

Answer: **Pi**ons

(10) Pions are a subset of this class of particles, named for their "in between" mass.

Answer: **Mesons**

(10) All Mesons are a part of this even larger class of particles, most generally stated as all particles that experience strong nuclear force.

Answer: **Hadrons**

22. Answer the following gnarly questions about waves for ten points each, dude.
This is the term given for a wave whose oscillations are perpendicular to its direction of motion.

Answer: **Transverse** wave

The wave equation is a partial differential equation that sets the second partial derivative of a wave function proportional to this operator acting on the wave function.

Answer: **Laplace** operator, or **Laplacian**

Because the ripples on a pond are a combination of transverse and longitudinal waves, the trajectory of a ball floating on top of a rippling pond will make this shape.

Answer: **Ellipse**