ACE QUIZBOWL CAMP 2017 – CHEMISTRY AND PHYSICS (Instructor: Joe Czupryn)

Quantities

Electronegativity

- This quantity describes an atom's ability to attract electrons
- The average energy of a free atom's valence electrons can be used to calculate this quantity
- Dividing the electron densities of atoms can be used to calculate this quantity
- The geometric mean of this quantity for each atom in a compound is equal to this quantity for the compound
- The Allred-Rochow scale measures this quantity
- The Mulliken scale measures this quantity
- The Pauling scale measures this quantity
- The Allen scale measures this quantity
- Fluorine has the highest value for this quantity (a 4.0 on the Pauling scale)
- This quantity can be defined in terms of effective nuclear charge
- This quantity can be defined as the ratio of atomic number to atomic volume
- Slater's rules are used to calculate this quantity
- Sanderson defined a version of this quantity
- Ionization energy and electron affinity are summed together to calculate this quantity for one scale

Entropy

- This quantity is the measure of a system's disorder
- This quantity is symbolized S
- Gibbs free energy is found by subtracting the product of this quantity and temperature from the enthalpy
- The Sackur-Tetrode equation is used to calculate this quantity
- The natural log of microstates (or accessibly states) is used to calculate this quantity
- Gibbs paradox is associated with this quantity
- This quantity is associated with the arrow of time
- This quantity can be decreased by the hypothetical Maxwell's demon
- This quantity will always increase in an irreversible process
- For a black hole, this quantity is proportional to the surface area of the event horizon
- Claude Shannon names one from of this quantity
- There is a Renyi type of this quantity
- The Ornstein Theorem deals with this quantity
- This quantity never decreases according to the Second Law of Thermodynamics
- There is a Kolmogorov type of this quantity
- Bernoulli schemes which have equivalent values for this quantity are isomorphic
- The von Neumann form of this quantity is given in terms of the trace of a density matrix times its log
- Taking the negative derivative with respect to temperature of Helmholtz free energy yields this quantity

Ferromagnetism

- The Barkhausen Effect deals with this property (audible clicks in the presence of an increasing magnetic field)
- Materials with this property display hysteresis
- This property disappears above the Curie temperature
- Materials with this property have Weiss domains (Weiss also studied these materials)
- Heusler alloys exhibit this property
- The Ising model explains this property
- The Potts model explains property
- This property occurs in regions separated by Bloch and Neel walls
- This property is the magnetism exhibited by iron and cobalt
- The Stoletov Curve relates this property to the magnetic field
- The anti-variety of this property disappears about the Neel temperature
- This property requires a shell with unpaired electrons

Resistance

- This quantity is an object's opposition to electrical current
- The quantum hall effect deals with this quantity
- The von Klitzing constant deals with this quantity
- This quantity is inversely proportional to the cross-sectional area of its namesake component
- This quantity is equal to voltage divided by current
- The values for this quantity add directly when components are in series
- The reciprocals of this quantity are added when components are in parallel
- This quantity is increased by the skin effect
- This quantity is increased by the proximity effect
- A Wheatstone bridge can be used to find the value of this quantity
- The Kondo Effect describes this quantity
- Matthiessen's Rule describes this quantity
- The inverse of this quantity is conductance
- When extended to AC circuits, this quantity is known as impedance
- This quantity diverges at very low temperatures (near absolute zero)

Specific heat

- This quantity is the amount of heat needed to raise the temperature of one gram of substance by one degree Celsius
- The Dulong-Petit law concerns this quantity
- Debye is associated with this quantity
- One law modeling this quantity deals with phonons in a box predicting a cubic temperature dependence
- This quantity can be calculated as three times Boltzmann's constant times particle number
- This quantity is the derivative of enthalpy with respect to temperature
- Water has a high value for this quantity with a value of 4.18

Torque

- This quantity is the rotational analogue of force
- This quantity is found in the Liouville equation
- This quantity is the time derivative of angular momentum
- This quantity is equal to the moment of inertia times angular acceleration
- This quantity is equal to the cross product of the dipole moment and electric field
- Precession deals with this quantity on an object
- The Varignon theorem states this quantity is additive when added at the same point
- Epicyclic ("planetary") gear setups results in high levels of this quantity
- The Landau-Lifshitz equation uses the Slonczewski form of this quantity and three other to give magnetization for a free layer of a ferromagnet

Viscosity

- This quantity is a measure of a fluid's resistance to flow
- Reynold's number gives the ratio of inertial forces to this kind of force
- The Prandtl number is associated with this quantity
- The Navier-Stokes equations can be simplified to Euler's equation with this quantity is zero
- This quantity has kinematic and dynamic types
- This quantity is constant for Newtonian fluids
- Thixotropic materials are time dependent on this quantity
- The ratio of sheer stress to the velocity gradient gives this quantity
- Sutherland's equation gives this quantity for ideal gases
- The Grashof number is inversely proportional to the square of this quantity
- This quantity can be measured in Poise
- This quantity can be measured in Stokes
- This quantity increases with temperature for gases but decreases for liquids as temperature increases

Gibbs Free Energy

- This quantity is represented G
- This quantity is used for isobaric and isothermal processes
- This quantity describes available useful work in a system
- This quantity is equal to enthalpy minus temperature times entropy
- When this quantity is negative, it indicates a reaction is spontaneous
- This quantity is equal to the negative product of the ideal gas constant, temperature, and the natural log of the equilibrium constant
- This quantity is the sum of chemical potential of each component of a system times the number of particles
- The partial derivative of this quantity is chemical potential
- For redox reactions, this quantity is equal to moles of electrons times Faraday's constant times electrical potential
- Surface tension is equal to change in this quantity over surface area
- Differentiating this quantity with respect to volume yields pressure
- This quantity is derived from the Legendre transform of the internal energy of a system

Angular Momentum

- This quantity is the product of the moment of inertia and angular velocity
- This quantity is the time derivative of torque
- The basis for Kepler's Second Law is the conservation of this quantity
- For atoms, this quantity is described by Russell-Saunders coupling
- This quantity is quantized in units of h-bar (operator is equal to -i times h-bar)
- This quantity's eigenvalues are equal to h-bar squared times its namesake quantum number times that quantum number plus one

Moment of Inertia

- This quantity is the rotational analogue of mass
- This quantity is symbolized I (in relation to motion)
- This quantity is an object's resistance to alteration of rotation
- This quantity is equal to mass times the radius squared
- This quantity can be found using the parallel axis theorem
- This quantity can be found using Steiner's Theorem
- The stretch rule about this quantity states it is unchanged if stretched parallel to its axis of rotation
- This quantity represents coefficients of the axes in the Poinsot ellipsoid (a rotating construct that is torque free)

Index of Refraction

- This quantity is the measure of the speed of light in a material to that in a vacuum
- This quantity is used in Snell's Law
- The arctangent of this QUANTITY gives Brewster's angle
- Birefringence occurs when an object shows two different values of this quantity
- This quantity is negative for metamaweakterials
- This quantity is equal to the square root of the product of a medium's permittivity and permeability
- Cauchy's formula relates this quantity to wavelength
- Sellmeier's formula relates this quantity to wavelength

Capacitance

- This quantity is the measure of stored electrical energy
- This quantity is charge divided by voltage
- The inverse of this quantity is elastance
- This quantity is additive in parallel
- In series, this quantity's reciprocals are summed
- This quantity is 4π times the electric constant times radius for an isolated sphere
- The Miller effect describes the amplification of this quantity
- This quantity has a parasitic form
- This quantity has a quantum form represented as the charge squared times the density of states

Surface Tension

- This quantity allows insects to skate across water
- This quantity allows for capillary action
- This quantity allows for meniscus formation
- This quantity is reduced by surfactants
- The Young-Laplace equation relates this quantity to pressure differences
- The gradient in this quantity causes mass transfer in the Marangoni effect
- The Eotvos equation describes this quantity's variance with temperature
- This quantity is measured with the de Nouy ring method,
- This quantity is measured with the Wilhelmy plate method, which relies on Langmuir-Blodgett
- Laplace's Law explains this quantity
- The drop-weight method can be used to measure this quantity

Potential Energy

- This quantity is stored in a system due to its configuration or position
- This quantity equals the mass times the acceleration due to gravity times the height (mgh)
- For a spring, this quantity equals one-half times the spring constant times the displacement squared
- This quantity has a Lennard-Jones type
- Force is given by the derivative of this quantity with respect to position
- For a charged particle, this quantity deals with being an infinite distance away from a nearby charge
- The gradient of this force is equal to a conservative force

Kinetic Energy

- This quantity is the energy of motion
- This quantity is equal to one-half times mass times velocity squared
- This quantity is conserved in elastic collisions, but not in inelastic collisions
- For rotating bodies, this quantity equals one-half times moment of inertia times angular velocity squared
- For an ideal gas, this quantity is equal to three-halves times Boltzmann's constant times temperature (3/2 kt)
- This quantity is equal to Planck's constant times frequency minus the work function for an electron in the photoelectric effect

Spin

- This quantity has half-integer values for fermions and integer values for bosons
- This quantity is the intrinsic angular momentum for a particle
- The Stern-Gerlach experiment observed this quantity
- Electrons with the same value for this quantity are forbidden to share an orbital by the Pauli Exclusion Principle
- Pauli matrices are associated with this quantity
- Firing a beam of silver atoms through a magnetic field was used to confirm this quantity
- Gouldsmit and Uhlenbeck explained this quantity
- This quantity causes fine structure splitting

Enthalpy

- This quantity is the measure of a system's heat content
- This quantity is represented H
- Hess's Law can be used to calculate this quantity for a multi-step reaction (by summing it for individual reactions)
- Gibbs free energy is equal to this quantity minus the product of temperature and entropy
- In the Joule-Thomson effect, this quantity is constant
- This quantity has units of Joules per kilograms
- This quantity equals internal energy plus the product of pressure and volume
- Negative values for this quantity indicate exothermic reactions, while positive values indicated endothermic reactions
- This quantity remains constant during throttling processes
- One form of this quantity is associated with a crystal lattice

Momentum

- This quantity is the product of mass and velocity
- Impulse is the change in this quantity
- This quantity is conserved in all collisions (elastic and inelastic)
- This quantity equals Planck's constant divided by the de Broglie wavelength
- Force is the time derivative of this quantity by Newton's Second Law
- Laplace's demon deals with this quantity
- This quantity's operator is negative i times h-bar times the gradient
- This quantity equals energy over the speed of light

Magnetic Field

- This quantity is symbolized B
- In the Meissner effect, this quantity is expelled from a superconductor
- The Hall Effect deals with this quantity (a potential difference is created when this quantity is applied perpendicular to current)
- The splitting of spectral lines by this quantity is the Zeeman Effect
- Biot-Savart's Law calculates the strength of this quantity
- In the Paschen-Back effect, this quantity causes a disruption
- This quantity is equal to the curl of the vector potential
- This quantity is used in the Lorentz force equation
- An electric current generates this quantity

Current

- This quantity comes in direct and alternative types
- This quantity is the flow of electric charge
- This quantity is symbolized I (in relation to electricity)
- This quantity equals voltage divided by resistance according to Ohm's Law
- An ammeter measures this quantity
- The displacement type of this quantity was added to Ampere's Law by Maxwell
- The Biot-Savart law explains how this generates a magnetic field

Power

- This quantity is the work done per unit time
- This quantity equals current squared times resistance (I^2R)
- This quantity equals current times voltage (IV)
- This quantity equals pressure times the volumetric flow rate
- This quantity equals torque times angular velocity
- This quantity equals force times velocity
- The dot product of force and angular velocity equals this quantity

Electric Field

- This quantity is symbolized E
- The Stark Effect deals with this quantity splitting spectral lines
- The cross product of this quantity and the magnetic field gives the Poynting vector
- The Kerr Effect deals with this quantity changing the index of refraction, causing birefringence
- This quantity can be measured in volts per meter
- This quantity can be measured in Newtons per Coulomb
- This quantity's flux through a closed surface as proportional to the amount of enclosed charge according to Gauss's Law
- This quantity's strength can be calculated using Coulomb's Law
- The divergence of this quantity equals charge density over permittivity
- Faraday's Law of Induction says a change in magnetic field gives rises to this quantity
- The Debye length/radii is associated with this quantity
- This quantity is used in a transistor contrasted with bipolar-junction transistors

Processes

Distillation

- This process separates components of a mixture based on their boiling points
- This process is based on principles of Raoult's Law
- A Vigreux column may be used in this process
- Azeotropes cannot be separated by this process
- A Perkin triangle may be used in this process
- The Fenske equation deals with this process
- This process has a "vacuum" type
- The most common form of this process is the "fractional" type
- The McCabe-Theil method relates to this process
- A Dean-Stark apparatus may be used in this process
- A Kugelrohr apparatus may be used in this process
- Glass beads are often added during this process to increase surface area

Brownian motion

- This process is the random motion of particles in a fluid
- This process was described in Annus Mirabilis by Einstein
- This process was first observed in pollen grains in water
- Random walks are used to describe this process
- Feynman's ratchet is a way to gain energy from this process
- This process is named after a Scottish botanist
- This process is a type of stochastic Wiener process
- Jean Perrin used this process to calculate Avogadro's constant
- The Langevin equation deals with this process
- Levy described the conditions for a continuous process to become this process

Titration

- This process is used to determine the concentration of a solution by adding incremental amounts of another solution
- There is an acid-base variety of this process
- This process uses indicators like phenolphthalein or bromothymol-blue
- This process finds the equivalence point
- This process uses a burette
- When done with polyprotic acids, this process will find multiple transition points on the curve
- The Karl Fischer type of this process measures moisture content
- The "Checkerboard form" of this process is done before ELISA
- The complexometric type of this process uses EDTA for metal ion detection
- The Zeta Potential Type of this process is used to find the flocculation point
- The redox type of this process uses a potentiometer
- Mohr's method uses this process and silver nitrate to detect iodine concentration

Fusion

- In this process, nuclei of atoms are joined together
- The proton-proton chain is a form of this process
- The CNO Cycle is a form of this process
- This process can occur via inertial confinement
- Stars turn hydrogen into helium using this process
- Fleishman and Pons attempted to develop a "cold" version of this but it failed
- A "Tokamak" features a current running through a magnetic field to model this process
- To occur, this process must satisfy the Lawson criteria
- To occur, this process must overcome the Coulomb barrier
- This process can occur in a "Stellarator"

Fission

- In this process, a large atomic nucleus breakdown into smaller parts
- Breeder reactors induce a "chain reaction" to cause this process
- This process often uses pressurized water for moderation
- The "Neutron Multiplication Factor" is required to sustain this process
- This process deals with the "Four Factor Formula" (one factor of which is thermal utilization)
- This process can be induced in lighter elements by gamma rays
- Sometimes beryllium is used as a reflector in order to lower supercritical mass in a reactor producing this process
- This process can be halted with xenon addition

Convection

- This process is the main method of heat transfer in fluids
- The Boussinesq approximation deals with this process
- Nusselt numbers can be calculated for this process
- The Churchill-Bernstein equations deal with this process
- Bernard cells are formed during this process
- This process occurs when the critical number exceeds the Rayleigh number
- The Grashof number decided the tendency toward this process
- The Prandtl number is associated with this process

Diffusion

- This process is the movement of particles from a higher concentration to a lower concentration
- Fick's Laws deal with this process
- When water undergoes this process, it is known as osmosis
- A facilitated form of this process takes place across the cell membrane
- A specific type of this is inversely proportional to the square root of the molar mass
- Graham's Law deals with a type of this process
- The denominator of the Thiele modulus is the rate of this process
- The Maxwell-Stefan model describes this process
- Ehrenfest's model describes this process
- Bohm names a type of this process
- This process is used in doping semiconductors
- Molecule undergo this process by Brownian motion
- The Smoluchowski model describes this process

Laws and Principles

Hooke's Law

- This law states F = -kx
- This law states that stress is directly proportional to strain
- This law is used to calculate the restoring force on a spring
- Cauchy generalized this law to three-dimensions
- Voigt notation is associated with this law
- Some forms of this law use the stiffness tensor
- Cross-sectional area over length times Young's modulus equals the force constant in this law
- This law can be written using Poisson's ratio
- This law only applies up to the yield strength/point
- There is an anisotropic form of this law
- Green's tensor (an 81 coefficient fourth order tensor) is used in one form of this law
- This law can be written use lame coefficients

Boyle's Law

- Law stating that pressure and volume are inversely related at constant temperature (PV=PV)
- Law independently discovered by Edme Mariotte
- Law named after the author of *The Skeptical Chemist*
- Deviations from this law are modeled by the Joule-Thomson effect
- The Carnot cycle is calculated using this law
- Law derived by Bernoulli with Newton's laws

Ideal Gas Law

- Law stating that PV=nRT
- The Redlich-Kwong equation is derived from this law
- This law was first derived by Emile Clapyeron
- The virial expansion/equation modifies this law
- The Peng-Robinson equation is an alternative to this law
- The acentric and compressibility factors can be used to modify this law
- The Soave equation/modification is related to this law
- The van der Waals equation is a generalization of this law that introduces a and b parameters
- This law is a combination of Charles', Boyle's, Gay Lussac's, and Avogadro's Laws

Pauli Exclusion Principle

- This states that no two electrons can have the same four quantum numbers
- This states that electrons in the same subshell have to have different spins
- This applies to fermions not bosons
- Electron degeneracy pressure of white dwarves are a consequence of this
- Slater determinants are used to ensure a system obeys this
- This calls for an even number of neutrons and protons according to the liquid drop model
- This governs the formation of the "Fermi-Level"

Heisenberg Uncertainty Principle

- This implies one cannot simultaneously know both position and velocity of a particle
- This was shown via a thought experiment using a gamma ray microscope
- The Bohr model of atom violates this due to assigning an electron a definite position,
- This can be shown using any operators that do not commute like energy and time (usually equal to h-bar over 2)
- This can be derived using the Robertson-Schrodinger relation
- This can be derived using the Cauchy-Schwartz inequality

Snell's Law

- This law that states the index of refraction of the medium being exited times the sine of the angle of incidence equals the index of refraction of the medium being entered times the sine of the angle of refraction
- This LAW can be derived to find Brewster's angle
- This law was originally discovered by Descartes under the name "The Law of Sines"
- This law was proven by Fermat's principle of least time
- Calcium's o-ray follows this law

Bernoulli's Principle

- This states that an increase in fluid velocity results in a decrease in fluid pressure
- This explains airplanes' ability to achieve lift
- This explains the Venturi effect
- This is applied in the creation of pitot tubes
- This is an integration of Euler's equation,
- This deals with the sum of kinetic and potential energy remaining constant along a streamline
- Toricelli's law is derived from this
- Kutta-Juokowski theorem is derived from this

Ampere's Law

- This law states that the path integral of the magnetic field is proportional to the current enclosed by the path
- This law was corrected by the addition of a displacement current by Maxwell
- This law includes the time derivative of the E-field (electric field)
- The Biot-Savart Law is equal to this law if current density is constant
- The Kelvin-Stokes Theorem relates the Integral and differential forms of this law

Second Law of Thermodynamics

- This law states that the entropy of the universe is always increasing
- This law states that heat cannot spontaneously flow from a cold body to a hotter body
- Clausius formulated one version this law
- Loschmidt's paradox deals with this law
- Boltzmann's H-Theorem deals with this law
- T-symmetry does not function because of this law
- Maxwell's demon is a thought experiment in which this law is violated
- Carnot formulated this law

Elements

Sulfur

- This element is found in amino acids like methionine and cysteine
- This element forms namesake bridges
- This element crosslinks to make rubber in vulcanization
- "Thiols" are functional groups with this element
- This element used to be called "Mercaptans"
- This element is extracted via the Frasch Process
- A solid allotrope of this element is an eight atom cyclic molecule
- This element has a well-known hexafluoride
- The Claus Process makes this element from natural gas
- Galena is a mix of this element and lead
- "Iron-this element" clusters are key to important enzymes (i.e. aconitase)

Phosphorus

- This element has red (matches), white, violet (named after Hittorf) and black allotropes
- This element is attached to three phenyls in the ylide used in the Wittig Reaction
- This element was discovered by Hennig Brand in his urine when he was trying to make gold
- This element is the central atom in the nerve gas "Sarin"
- This element is bonded to a bunch of sulfurs in the center of Lawesson's reagent
- This element is the center of the molecule reacted in Arbuzov's reaction
- This element's pentachloride breaks the octet rule

Calcium

- This element binds to troponin for muscle contraction
- This element is important for bone and teeth strength
- This element is increased by Vitamin D
- This element is increased by parathyroid hormone
- This element's carbonate form makes limestone
- This element is the prime component of "Calcite"
- This element is released from the sarcoplasmic reticulum
- This element is released when a ryanodine receptor is triggered
- The chloride form of this element is one of the products of the Solvay process

Boron

- This element is often placed in THF
- This element can add across alkenes in Anti-Markovnikov fashion
- This element with silica makes Pyrex (chemical lab glassware)
- This element is used in nuclear reactors to capture thermal neutrons
- This element often violates the octet rule
- Wade's Rule determines this element bonding with hydrogen
- Hydrides of this element include closo-, arachno-, and nido-
- This element is found in "Ulexite"
- Acids are of this element are used with a palladium catalyst in Suzuki Coupling
- This element is bonded to oxygen and nitrogen in the Corey-Bakshi-Shibata catalyst (CBS)
- This element is used in p-type dosing
- This element is in an alloy with neodynium
- This element and iron make a very strong magnet

Aluminum

- This element's oxide is extracted from bauxite
- This element is involved in the Bayer process
- The Hall-Heroult process is used to produce this element
- Compounds of titanium and this element form the Ziegler-Natta Catalyst

Sodium

- This element is bright yellow in a flame test
- This element's "Bicarbonate" is baking soda
- This element's "Chloride" is table salt
- This element's "Hydroxide" is lye
- This element's "Carbonate" is soda ash (which is produced by the Solvay process
- This element used to be produced by the Castner Process
- This element is produced via the Downs Process
- Ammonia, alcohol, and this element attack benzene in the Birch reduction
- This element produces a doublet known as a D line at 589 nm seen in the Fraunhofer lines of the sun

Nickel

- This element's un-pure form is reacted with carbon monoxide to give the pure form of this
- This element is processed by the Mond Process
- With aluminum, this element makes up the Raney Catalyst
- X-rays were fired at this element in the Davisson-Germer experiment to confirm wave particle duality
- This element's 48 isotope is doubly magic
- This element with chromium is used to make stainless steel corrosion resistant

Titanium

- The Kroll process is used to extract this element
- The Hunter process used to be used to extract this element
- This element is found with aluminum in the Ziegler-Natta catalyst
- This element is found in Tebbe's reagent
- The isopropoxide version of this element is used in the Sharpless epoxidation
- The dioxide version ("white pigment") of this element is extremely refractive, so it is used in some sunscreens
- This element causes asterism when introduced to sapphires
- This element's tetrachloride version is used in the Mukaiyama aldol condensation
- This element is used in McMurry coupling

Oxygen

- This element is the second most abundant in Earth's atmosphere
- This element is found in furan
- This element is found in epoxides
- This element is found in the bridge in an ether
- This element can form reactive radicals with unpaired electrons
- This element was called dephlogisticated air by Joseph Priestley
- The liquid form of this element is paramagnetic
- The red form of this element contains four atoms of it

Nitrogen

- This element is the most abundant in the Earth's atmosphere
- This element is found in amines, amides, azides and anything ending in "-ine" (ex: amino acids, nucleotides, hydrazine)
- This element is detected via the Kjeldahl method
- This element is found in products of the Gabriel synthesis
- One of this element's oxides is laughing gas
- This element is "fixed" into ammonia by bacteria (most commonly Rhizobia)
- This element goes through a process using an iron-molybdinum containing enzyme coded for by nif genes

Iron

- This element is referred to as ferric or ferrous based on charge
- This element and carbon are turned into steel via the Bessemer process
- Deficiency of this element leads to anemia due to being at center of hemoglobin
- This element is isolated from siderite and siderophores can bind it
- This element is found in magnetite and hematite
- Cytochromes contain this element in their active sites with sulfur
- Mossbauer spectroscopy is conducted on an isotope of this element
- This element is the heaviest nuclide that can be formed by star fusion

Lithium

- This element is used as a treatment for bipolar disorder
- This element is used to produce tritium
- This element and copper are found in Gilman reagents

Compounds and Molecules

Ammonia

- Compound with formula NH_3
- This compound is converted to urea for excretion in humans
- Tollen's reagent involves this compound that is used to dissolve a silver oxide precipitate
- The Ostwald Process combines this compound with oxygen to produce nitric acid
- The Haber-Bosch process is used to produce this compound
- Sodium is dissolved in this compound during the Birch reduction
- This compound produces a silver mirror in the presence of aldehydes
- An iron catalyst is used to synthesize this compound
- This compound is used in the Solvay process
- A test named for Nessler is used to detect this compound

Bose-Einstein Condensates

- These substances are referred to as the fifth state of matter
- These substances were first discovered in rubidium
- Tonks-Girardeau gases are an example of these substances
- The Gross-Pitaevskii equation can be used to describe these substances
- These substances can become a Mott insulator
- Cornell and Weimann discovered these substances
- Feschbach resonance can be observed in these substances
- The Thomas-Fermi equation is for these substances
- The Hamiltonian of these substances contains a term proportional to particle density
- Adding a revolving magnetic field to these substances generates vortices
- These substances are made up of the degenerate states formed near absolute zero from particles with integer spin

Benzene

- Aromatic compound with formula C_6H_6
- Compound with a ring-like structure that is described as a snake biting its own tail
- This compound is the primary ingredient in moth balls
- The Friedel-Crafts reactions either acylate or alkylate this compound using a strong Lewis acid
- The Birch reduction transforms this compound into 1,4-cyclohexadiene
- This compound reduces to cyclohexane
- Toluene is produced when you replace a hydrogen in this compound with a methyl group
- Phenol is produced when you replace a hydrogen in this compound with a hydroxyl group
- Aniline is produced when you replace a hydrogen in this compound with an amine group
- Pyridine is produced when one of this compound's carbons is swapped for a nitrogen
- Friedrich Kekule discovered the structure of this compound
- Huckel's rule describes this molecule's structure

Sulfuric Acid

- This compound is found in acid rain
- This compound is found in car batteries
- This compound is found in Venus's atmosphere
- This compound is made using the contact process
- This compound is made using a vanadium oxide catalyst
- This compound used to be made using Glover Towers in the Lead Chamber Process
- A solution of this compound is called "Oleum"
- This compound is also known as "Oil of Vitriol"
- The LeBlanc process USES this compound and sodium chloride
- The Mannheim process USES this compound and sodium chloride

Hydrochloric Acid

- This compound is a major component of gastric acid
- With nitric acid, this compound forms aqua regia
- The Clemmensen reduction proceeds in the presence of a zinc amalgam and this compound
- This compound is required for pickling steel
- This compound is a BY PRODUCT of the LeBlanc Process
- This compound is MADE BY the Mannheim Process

Nitric Acid

- This compound is mixed with hydrochloric acid to make aqua regia
- This compound is produced via the Ostwald process
- This compound is produced using a platinum rhodium catalyst
- Proteins turn yellow due to the reaction of this compound and tyrosine

Ozone

- This is a foul smelling, blue colored compound
- This compound has formula O_3
- This compound is found in a layer in the atmosphere to reflect UV layers – it currently has a hole in it
- Dobson units are used to measure the density of this compound
- This compound is depleted by CFC's
- This compound is formed during lightning
- This compound is the primary component of the Griesbaum reaction
- This compound reacts with alkenes to form Criegee intermediates
- The Chapman cycle shows this compound's production and degradation
- This compound oxidizes cyanide to cyanate
- This compound can crack certain kinds of rubber found in tires

Water

- This compound is the universal solvent
- This compound's solid-liquid phase boundary has a negative slope
- The triple point of this compound is used to define the Kelvin scale
- This compound's highest density occurs at 4 degrees Celsius
- This compound's solid phase is less dense than its liquid phase
- This compound forms an azeotrope with ethanol
- Combustion reactions produce carbon dioxide and this compound
- This compound forms an azeotrope with hydrochloric acid
- This compound has many special properties because of its hydrogen bonds
- This compound reacts with alkali metals in a violent reaction

Colloids

- These substances consist of a continuous phase and a dispersed phase where particles of one substance are dispersed in another
- Foams, emulsions, and gels are types of these substances
- Scattering of light by these substance appears bluish and is called the Tyndall effect
- These substances destabilize at the "double layer" at voltages under the zeta potential
- These substances undergo flocculation
- Stable aqueous form of these substance are termed peptization
- The stability of these substances is explained by DLVO theory,
- These substances are described by the Stern modified Gouy-Chapman model

Acetic Acid

- This compound has formula CH_3COOH
- This compound is found in vinegar
- This compound has a "glacial" form (forms ice like crystals)
- This compound is produced in the Cativa Process
- This compound is produced in the Monsanto Process
- This compound's anhydride is used in making aspirin
- One process used to make this used a rhodium catalyst
- One process used to make this uses an iridium catalyst

Particles

Protons

- The letter Z (atomic number) represents how many of these particles are in a single atom
- This particle combines with water to form a hydronium (H_3O^+) ion
- This particle is used in a namesake type of NMR spectroscopy
- This particle consists of two up quarks and one down quark
- In electron capture, this particle can be transformed into a heavier baryon
- When this particle decays, it produces a pion and a positron
- Two of these particles and two neutrons compose an alpha particle
- The Bronsted-Lowry definition defines acids as donators of these particles
- These particles make up most cosmic rays
- Their half-life/lifetime is over ten to the thirtieth power (somewhere between the 30^{th} and 35^{th} power)

Electrons

- This particle was discovered by J.J. Thomson
- The charge of this particle was measured in the Oil Drop Experiment by Robert Millikan
- This particle's antiparticle is the positron
- These particles are classified in the Balmer series
- An experiment involving this particle used two charged plates
- These particles were fired at a nickel target in the Davisson-Germer Experiment
- This particle is emitted in a cathode ray tube
- Hund's rule describes the placement of these particles
- The Aufbau principle describes the placement of these particles
- These particles scatter photons in the Compton Effect

Neutrons

- This particle was discovered by James Chadwick
- Isotopes have a different number of this particle
- This particle is composed of one up quark and two down quarks
- These particles catalyze a nuclear fission reaction
- This particle is used in a type of spectroscopy developed by Brockhouse
- The number of these particles equals the atomic mass minus the atomic number
- This particle has a lifespan of about fifteen minutes
- This particle is created by electron capture
- This particle undergoes beta-minus decay
- This particle may exist in free clusters of four
- This particle emits a proton, an electron, and an antineutrino
- Francisco-Miguel Marques studied this particle
- An experiment involving beryllium was used in the discovery of these particles

Quarks

- These particles have six types (up, down, top, bottom, charm, strange)
- Murray Gell-Mann proposed these particles
- George Zweig proposed these particles and called them "aces"
- Deep inelastic scattering gave evidence of these particles at Fermilabs
- These particles have fractional electrical charges of negative one-third or positive two-thirds
- These particles have color charge
- Color confinement states that these particles are never found in isolation
- The CKM matrix describes these PARTICLE'S decay
- These PARTICLES exhibit asymptotic freedom
- A phase of QCD matter deemed its namesake plasma has free floating these and gluons

Photons

- These particles are spinless, massless particles that carry the electromagnetic force
- These particles are quanta of light
- These particles are emitted when an electron goes from a high energy state to a low energy state
- Gamma radiation is a high energy type of these particles
- The Klein-Nishina formula deals with these particles
- In pair production, these particles generate an electron and a positron

Neutrinos

- The Homestake experiment attempted to count the number of these particles emitted due to fusion
- These particles can undergo flavor oscillation
- These particles were first proposed by Pauli
- These particles were proposed in order to conserve mass and momentum in beta decay
- The Super-Kamiokande is an observatory built to detect these particles
- Cowan and Reines detected these particles
- These particles emit Cherenkov radiation when they interact as observed at Sudbury
- The PMNS matrix models these particles
- These particles are near massless leptons with no charge that rarely interact with matter
- These particles come in tau, muon, and electron varities
- The MSW effect accounts for these particles
- These particles were detected in radiation from Supernova 1987A
- The reciprocal relationship between the eigenvalues of the mass matrix of these particles is termed the “seesaw mechanism”
- The sterile variety of these particles is a strong candidate for dark matter
- The Goesgen experiment dealt with these particles

Higgs Boson

- This is the so called "God particle"
- This particle is sought by the Large Hadron Collider
- This particle explains how particles like W and Z bosons acquire mass
- This particle has no spin and is thought to have a mass around 140 GeV
- This particle is not included in technicolor theories
- This particle has a nonzero vacuum expectation value
- This particle mediates its namesake quantum field
- This particle is thought to be produced when gluons decay into a top quark and anti-top quark

Alpha Particle

- This particle is composed of two protons and two neutrons
- This particle can be referred to as a helium nucleus
- A beam of these particles were fired in Rutherford’s Gold Foil Experiment
- The Geiger-Nuttall Law deals with these particles
- Geiger and Marsden worked with this particle
- Uranium decays by releasing this particle
- This particle is involved in a process that forms a beryllium INTERMEDIATE

Forces

Gravity

- Weakest of the four fundamental forces
- The Hulse-Taylor binary pulsar emits this force's namesake waves
- Cavendish found the universal constant for this force with a torsion balance
- Newton names an inverse-square law for this force
- LIGO and VIRGO are experiments dealing with this force
- This force cannot be renormalized by quantum field theory
- This force is a consequence of spacetime curvature in general relativity
- This force is mediated by an uncharged, massless, spin-2 particle that is yet to be discovered
- Eddington observed the bending of light by this force (its namesake lensing)
- This force causes an acceleration of 9.8 m/s^2
- This force names a lensing in general relativity
- The Pound-Rebka experiment found a redshift associated with this force
- This force has a namesake darkening that makes stars appear brighter at the poles

Strong Force

- Gluons carry this force
- This force confines color/exhibits confinement
- Hideki Yukawa first proposed this force
- This FORCE exhibits asymptotic freedom
- The exchange of pi mesons is involved in this force
- SU(3) gauge theory/group is associated with this force
- This force is modeled quantum chromodynamics

Weak Force

- W and Z bosons carry this force
- Glashow, Salam, and Weinberg worked with this force
- This force causes the flavor change of quarks
- This force can be described using the Cabibbo angle
- This FORCE is described by the CKM matrix
- The Cronin-Fitch experiment dealt with this force
- Wu conducted an experiment showing this force violates parity

Friction

- This force opposes motion when two surfaces touch
- This force has static and kinetic varieties that govern sliding, rolling, and stick-slipping
- This force's namesake coefficient is "mu"
- This force is directly proportional to the normal force
- The Couloumb model describes this force
- Two laws by Amonton deal with this force
- The Tomlinson model describes this force on an atomic scale
- The skin variety of this force occurs when a body interferes with a fluid
- This force causes "damping" in a harmonic oscillator
- The Stribeck effect describes this force as a function of velocity
- This force is measured with a tribometer and causes the triboelectric effect
- The Dahl effect describes this force over a small distance
- The Bilman-Sorine model deals with this force
- The Darcy-Weisbach factor deals with this force in a pipe
- The Archard model deals with this force
- The Bagnold formula deals with this force
- The Sommerfield number is related to decreasing this force

Equations

Nernst Equation

- This equation calculates the reduction potential of a cell in electrochemistry
- This equation can be transformed into the Butler-Volmer equation
- This equation can be transformed into the Tafel equation
- This equation can be generalized as the Goldman equation
- The namesake this equation also names a heat theorem
- A form of this equations gives the resting potential of cell membranes
- This equation does not account for Hofmeister effects
- The namesake this equation also names a molar flux equation with Planck
- The chord conductance equation contains a term calculated using this equation
- This equation can be symbolized $E = E_o - (RT/nF) \ln(Q)$ where R is the gas constant, F is Faraday's constant, and Q is the reaction quotient

Arrhenius Equation

- This equation relates the rate of reaction to activation energy
- This equation contains the "pre-exponential" factor
- This equation contains a term equal to the collision frequency times the steric factor
- This equation is similar to the Eyring(-Polanyi) equation
- The modified version of this equation shows Boltzmann's constant divided by Planck's constant

Henderson-Hasselbalch Equation

- Equation used to calculate the pH of a buffer solution
- Equation that includes the pKa and the log of the conjugate base over the acid
- The Hammet function is related to this equation
- This equation can be used to find the isoelectric point

Objects

Superconductors

- These objects have an electrical resistivity of zero
- The (London) penetration depth is associated with these objects
- The coherence length is associated with these objects
- These objects are linked with the formation of Cooper pairs
- YBCO is a notable example of one of these objects
- These objects expel magnetic fields in the Meissner effect
- BCS theory governs these objects
- Ginzberg-Landau theory models these objects
- These objects come in Type I and Type II varieties
- The Josephson effect describes a type of these objects

Effect/Phenomenon

Doppler Effect

- This effect has a “transverse” form
- Pulsars show a type of this effect called the Shklovskii Effect
- This effect can be used to estimate the distance and speed of galaxies
- The “relativistic” form of this effect applies to light waves and takes into account time dilation
- This effect describes the frequency change of a wave in relation to a moving observer
- Radar guns, weather radar, and sonar employ this effect
- This effect produces redshift and blueshift
- A canal ray tube was used to investigate this effect
- The Ives-Stillwell experiment investigated this effect
- This effect causes its namesake broadening in spectral lines
- The Tully-Fisher relation utilizes this effect
- The Lorentz factor is related to this effect
- An echocardiography uses this effect to measure the velocity of blood
- Buys Ballot tested this effect
- Mossbauer spectroscopy uses this effect

Photoelectric effect

- Heinrich Hertz was this first to discover this effect
- This effect deals with the quantity found by taking the work function over Planck’s constant
- Lenard studied this effect
- Albert Einstein won the Nobel Prize for his research on this effect
- This effect will not occur if incident light is not past the threshold frequency
- This effect states the incident light on the surface of a metal releases electrons

Refraction

- This effect is the bending of light upon the changing of mediums
- This effect is described by Snell’s Law
- Birefringence is a form of this effect
- This effect can happen in materials like calcite
- This effect can cause ordinary and extraordinary rays
- This effect is different for "left handed" meta-materials
- This effect occurs through the Kerr effect when an electric field is applied

Diffraction

- This effect describes how light bends upon encountering a small obstacle
- This effect was demonstrated in Young's Double Slit experiment
- Fresnel names a near-field version of this effect
- Fraunhofer names a far-field version of this effect
- This effect can produce Airy discs if the opening is circular
- This effect happens to X-rays going through crystals
- This effect is described by Bragg's Law
- This effect is rationalized by Huygens principle that states every point on a wavefront is its own source
- The Rayleigh criteria governs the resolution of this effect
- The Rayleigh-Sommerfield theory describes this effect
- The Davisson-Germer experiment shows that electrons undergo this effect
- The Schaefer-Bergmann form of this effect comes from interactions with crystals
- Sound waves in water result in this effect in the Debye-Sears effect

Reflection

- This effect is the rebounding of light waves from a medium
- This effect occurs when the angle of incidence equals the angle of reflection
- The **total internal** type of this effect occurs when the angle of incidence is greater than the critical angle
- This effect does not occur at Brewster's angle
- The specular type of this effect deals with smooth surfaces
- The diffuse type of this effect deals with rough surfaces
- The Phong model describes this effect
- The Lambertian model describes this effect
- The Oyen-Nyer model describes this effect
- The Bergeron diagram calculates the effects of this effect on an electric signal

Experiments

Michelson-Morley Experiment

- This experiment disproved the existence of the lumineferous ether (thought to be the bearer of light travel)
- This experiment was conducted at Case Western University
- This experiment used a marble slab in a pool of mercury
- This experiment utilized a beam of light split by a half silvered mirror
- This experiment used an interferometer
- This experiment was conducted by Dayton Miller again but failed to get different results
- Trouton and Noble confirmed this experiment's results
- Lorentz and Fitzgerald thought length contraction explained this experiment
- The Kennedy-Thorndike experiment followed up this experiment using a self-oriented capacitor
- The Sagnac effect was discovered from this experiment

Gold Foil Experiment

- This experiment discovered the positively charged nucleus
- This experiment is credited to Ernest Rutherford
- This experiment was carried out by Geiger and Marsden
- Alpha particles were fired at a material in this experiment
- A circular sheet of zinc sulfide was involved in this experiment

Oil Drop Experiment

- This experiment was conducted by Thomas Millikan
- This experiment measured the charge of an electron
- Stokes' Law was used for the calculations in this experiment
- Felix Ehrenhaft challenged the results of this experiment
- Gerald Holton challenged the results of this experiment
- Two parallel metal plates with an electric field in between were used in this experiment
- An incorrect value of the viscosity for error led to the original error in this experiment
- The person who carried out this experiment also verified Einstein's Photoelectric Effect
- Harvey Fletcher helped with this experiment