2019 NA ChemE Jeopardy Clues/Responses

Preliminary Round

Single Jeopardy:

Thermodynamics

100: $C_p - C_v$ equals this for an ideal gas.

What is R (the gas constant)?

200: This, according to the Gibbs' Phase Rule, is the degrees of freedom for pure liquid water (1 phase).

What is 2? ($F = 2 - \pi + N = 2 - 1 + 1 = 2$)

300: An enthalpy-entropy diagram is commonly called this in recognition of its creator.

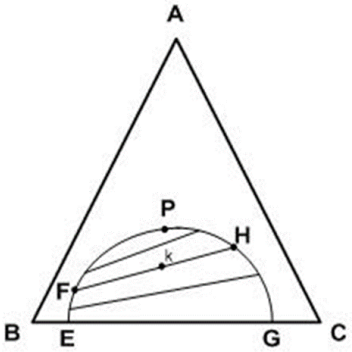
What is a Mollier diagram?

400: This parameter is given by

$$-\left(\frac{\partial G}{\partial T}\right)_P$$

What is entropy (S)?

500: This is point "P" on the following representation of LLE data.



What is the Plait Point?

Chemical Reaction Engineering

100: Radioactive decay is this order of reaction.

What is First Order?

200: The constant K_m in the following equation was named after this scientist.

$$V_1 = \frac{V_{max}[S]}{\{K_m + [S]\}}$$

Who is Leonor Michaelis?

300: This is defined as the ratio of desired to undesired product.

What is the Selectivity?

400: The reactor type and reaction order for this performance equation:

$k \cdot \tau = (C_{A0} - C_A)/C_A = X_A/(1 - X_A)$
What is a CSTR with a first-order reaction?
500: This is the probability distribution function that describes the ages a fluid element spends in the exit stream.
What is the residence time distribution?

Material and Energy Balances
100: When a vapor is cooled slowly at constant pressure, this is the temperature at which the first liquid droplet forms.
What is the dew-point temperature?
200: This is the number of moles (to 3 significant figures) of nitrogen per mole of oxygen in air that is used when conducting combustion reaction calculations.
What is 3.76?
300: This is the primary reason that a purge stream is used in a reactive process.
What is avoiding the accumulation of an inert substance?
400: The specific gravity of a liquid or solid is based on the density of water at this temperature.
What is 4ºC (39ºF)?
500: This equation is given by the following:

$$\ln(P^*) = -\frac{\Delta \hat{H}_v}{RT} + B$$

What is the Clausius-Clapeyron Equation?

Microbiology
100: The Gram stain differentiates between bacteria based on the composition of this.
What is the cell wall?
200: A small ring of DNA independent from the bacterium's main genome that can be taken in and expressed by bacteria.
What is a plasmid?
300: Plasmodium is a type of sporozoan that causes this disease.
What is malaria?
400: Okazaki fragments are associated with this essential process.
What is DNA replication?
500: LPS, an endotoxin that is found on the outer membrane of Gram-negative bacteria, is an acronym for this.
What is a lipopolysaccharide?

Calculus
100: The value of the slope of a tangent line at a particular point in a function.
What is the Derivative?
200: The rule used to find the limit of a function when

$$\lim_{x \to 0} \frac{f(x)}{g(x)} = \frac{0}{0}$$

What is L-Hospital's Rule?
300: The test used to determine the concavity of a function at a particular point.
What is the second derivative test?
400: The value of the area underneath a function between two points.
What is the definite integral? (Ask for more information if response is "What is the integral?")?
500: This theorem is given by

$$\int_a^b f(x)dx = F(b) - F(a)$$

What is the Fundamental Theorem of Calculus?

Disney Movies
100: Name of the car shown here that starred in the Disney Love Bug movies.

What is Herbie?
200: The lead character in the animated Robin Hood movie was this type of animal.
What is a fox?
300: The names of the fox and hound in The Fox and The Hound movie.
Who are Tod and Copper?
400: This actor was the first to receive a Gold Globe nomination for Best Actor for providing a voice in a Disney animated movie.
Who is Robin Williams? (Genie in Aladdin)
500: Names of the three fairies in the Sleeping Beauty movie.
Who are Flora, Fauna and Meriwether?

Preliminary Round
Double Jeopardy:
ChemE Economics
200: Term for a uniform series of cash transactions.
What is an annuity?
400: The total capital investment is the sum of these two types of capital.
What are fixed capital and working capital?

600: This depreciation system, created after the release of the Tax Reform Act of 1986, is currently used by businesses for federal taxes.
What is MACRS? (Modified Accelerated Cost Recovery System)
800: CEPCI is the acronym for this.
What is the Chemical Engineering Plant Cost Index?
1000: These costs represent operating expenses that vary with production rate.
What are Direct Manufacturing Costs? (Request more detail if response is "What are Manufacturing Costs?")

Bioseparations
200: The two methods used to remove insolubles, including biomass, from the fermentation broth.
What are filtration and centrifugation?
400: This law provides the design equation upon which batch dead-end filtration is based.
What is Darcy's Law?
600: IEF is an electrophoresis technique that separates proteins based on this.
What is the protein's isoelectric point (pI)?
800: This type of chromatography utilizes specific interactions between a solute molecule (e.g., protein) and second immobilized molecule (e.g., an antibody).
What is affinity chromatography?
1000: These 3 steps are commonly used to purify a recombinant protein using chromatography.
What are bind, wash and elute?

Electrical Circuits
200: This type of current experiences sinusoidal voltages and occasionally changes direction.
What is alternating current?
400: This component stores electrical charge and produces a potential difference across two plates.
What is a capacitor?
600: One part of this "Law" is that the sum of currents entering a junction is equal to the sum of the currents leaving the junction.
What is Kirchhoff's Law?
800: This is defined as the property of an electric conductor or circuit that causes an electromotive force to be generated by a change in the current flowing.
What is inductance?
1000: This is the SI unit for inductance.
What is the Henry?

Elements and Periodic Table
200: These are the only elements that are liquid at room temperature (20-25°C) and atmospheric pressure.
What are Mercury and Bromine?
400: This is the most common metal element in the Earth's crust.
What is Aluminum?
600: While the modern periodic table orders the elements by increasing atomic number, Mendeleev's table arranged the elements by this.

What is increasing atomic weight?
800: This is the hardest naturally occurring metal element based on the Mohs scale for hardness.
What is Chromium?
1000: This is the first artificially produced element that was isolated in 1937 by Carlo Perrier and Emilio Segrè.
What is Technetium? (Atomic number 43; has never been found to occur naturally on earth)

Electrostatics in Safety
200: For industrial operations where flammable vapors may be present, any charge accumulation exceeding this energy level is considered dangerous.
What is 0.1 mJ?
400: The type of discharge depicted here.

What is a spark discharge?
600: Process used to reduce the voltage difference between two conductive materials to zero.
What is bonding?
800: Parameter determined using the following equation.
What is the streaming current?
1000: The τ (tau) in the following equation.

$$I_s = \left[\frac{10 \times 10^{-6}\ \text{amp}}{\left(\text{m}/\text{s}\right)^2 (\text{m})^2}\right](\text{ud})^2\left[1 - \exp\left(-\frac{L}{u\tau}\right)\right]$$

What is the (liquid) relaxation time?

State Capitals
200: This is the most populous state capital.
What is Phoenix, Arizona?
400: Largest state capital by land area.
What is Juneau, Alaska?
600: This state capital has the highest elevation above sea level.
What is Santa Fe, New Mexico?
800: These two state capitals lie on the 45th parallel.
What are Salem, Oregon and St. Paul, Minnesota?
1000: This is the northern most state capital in the contiguous 48 states.
What is Olympia, Washington?

Preliminary Round

Final Jeopardy Category: Bioreactor Design

These are the three dimensionless numbers that are used to determine the agitator power consumption in a well-designed sparged bioreactor.

What are the Reynolds, Power and Aeration numbers?

Semi-Final Round

Single Jeopardy:

Mass Transfer

100: This important law relates flux of a species to the diffusion coefficient and concentration gradient.

What is Fick's First Law?

200: The Wilke-Chang equation for diffusion is valid for this phase.

What is the Liquid Phase?

300: This type of diffusion happens in small pores where the diameter is smaller than the mean-free path of the gas molecules.

What is Knudsen Diffusion?

400: This equation is often used to solve for the diffusion coefficient of large solute molecules in liquids.

What is the Stokes-Einstein Equation?

500: This mass transfer theory, characterized by viewing solvent as small pockets, is used to determine flux under turbulent conditions.

What is the Penetration Theory?

Dimensionless Numbers

100: The ratio of speed of an object to the speed of sound in the object's medium.

What is the Mach Number?

200: The ratio of reaction rate to diffusive mass transfer rate.

What is the Damköhler Number?

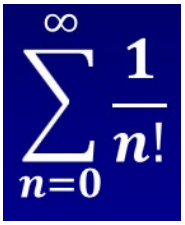
300: The ratio of the momentum diffusivity (kinematic viscosity) to mass diffusivity.

What is the Schmidt Number?

400: The ratio of buoyancy to viscous forces acting on a fluid.

What is the Grashoff Number?

500:



What is Euler's number? (accept "e")

Conversions and Units

100: This is the number (to 3 significant figures) of feet in a meter.

What is 3.28?

200: This is the number (to 3 significant figures) of grams in a lb_m.

What is 454?

300: This is the number (to 3 significant figures) of hp in a kW.

What is 1.34?

400: This is the number (to 3 significant figures) of lb_f in a Newton.

What is 0.225?

500: This is the number (to 3 significant figures) of lb_m/ft-s in a cP.

What is 6.72×10^{-4}?

Elements and Periodic Table
100: This is the heaviest (in terms of atomic weight) natural element.
What is Uranium?
200: This element's Latin name is Stibium.
What is Antimony (Sb)?
300: This metal element is found in vitamin B12.
What is cobalt?
400: This has the highest tensile strength of any naturally occurring metal element but is brittle and tends to shatter on impact.
What is Tungsten?
500: The naturally occurring halogens consist of Fluorine, Chlorine, Bromine and these 2 elements.
What are Iodine and Astatine? (Astatine is the rarest naturally occurring element in the Earth's crust)

Infamous Industrial Accidents
100: This is the toxic chemical released during the 1984 Bhopal, India accident.
What is Methyl Isocyanate (MIC)?
200: This is the fuel involved in the 2008 Wentworth, Georgia explosion.
What is sugar? (Ask for more specifics if "What is dust?" is given as a response).
300: Location of the 1974 accident that resulted from the lack of a management of change (MOC) safety procedure.
What is Flixborough, England?
400: Location of the 1976 accident that resulted in 1000's of cases of chloracne, but no human deaths.
What is Seveso, Italy?
500: The two explosion types involved in the 1984 Mexico City (San Juanico) accident that killed more than 500 people.
What are VCE (vapor cloud explosion) and BLEVE (boiling liquid/expanding vapor explosion)?

Disney Princesses
100: She was the first Disney princess.
Who is Snow White?
200: This Disney princess has a raccoon as a sidekick.
Who is Pocahontas?
300: This Disney princess attempts to disguise herself as a man.
Who is Mulan?
400: This is the name used by Princess Aurora while living in the cottage in the woods.
What is Briar Rose?
500: Time that the royal ball starts in Cinderella.
What is 8:00 p.m.?

Semi-Final Round

Double Jeopardy:

Chemical Process Design

200: This happens when vapor enters the suction of a pump.

What is cavitation?

400: This parameter is equal to

$$\frac{\text{Number of days plant operates per year}}{365}.$$

What is the Stream Factor (SF)?

600: Adverse vapor conditions in a distillation column will cause weeping, foaming, flooding, and this.

What is Entrainment?

800: This is the typical temperature approach (in °F) used in the design of shell and tube heat exchangers.

What is 10°F?

1000: This transition metal is added to stainless steels to increase corrosion resistance.

What is Chromium?

Fluid Flow

200: This term represents a fluid's absolute (dynamic) viscosity divided by its density.

What is the kinematic viscosity?

400: This occurs when there is a rapid pressure change due to a rapid change in the rate of flow [of water].

What is water hammer?

600: Type of valve shown here

What is a butterfly valve?

800: This occurs when local static pressure in a fluid reaches a level below the vapor pressure liquid at the given temperature.

What is cavitation?

1000: In a pump this is a measure of how close the fluid at a given point is to boiling and thus to cavitation.

What is the Available Net Positive Suction Head ($NPSH_A$)?

Physics
200: 1 $(kg - m)/s^2$ is equivalent to this SI unit.
What is a Newton?
400: This type of collision does not conserve kinetic energy.
What is an inelastic collision?
600: This law states that the electric flux out of a closed surface is proportional to the charge held within the surface divided by the permittivity.
What is Gauss's Law?
800: This elementary particle is the most recent part of the Standard Model of Particle Physics to be discovered.
What is the Higgs Boson?
1000: "Laser" is an acronym for this.
What is light amplification by stimulated emission of radiation?

Biochemical Engineering
200: The two criteria that need to be addressed during the FDA approval process for new drugs.
What are efficacy and safety?
400: These are the four phases in a typical bacterial growth curve.
What are lag, exponential (or log), stationary and death (or decline) phases?
600: This is defined as the moles of CO_2 produced per mole of O_2 consumed.
What is the respiratory quotient (RQ)?
800: These are the two types of product production determined using the Luedeking and Piret model.
What are growth-associated and non-growth associated?
1000: This is the model organism used in designing a sterilization process for microbial growth media.
What is *Bacillus stearothermophilus*?

Differential Equations
200: Describes a first order differential equation of the form: $dy/dx + p(x)y = q(x)$.
What is linear?
400: This method is used to solve a first order differential equation of the form:
$dy/dx + p(x)y = q(x)$.
What is an integrating factor?
600: This quantity is used to test the linear independence of two or more functions.
What is a Wronskian?
800: This equation can be written in the form: $ax^2 y'' + bxy' + cy = 0$.
What is the Euler Equation?
1000: This type of equation has a right-hand side that does not explicitly depend on the independent variable: $dy/dt = f(y)$.\
What is an autonomous equation?

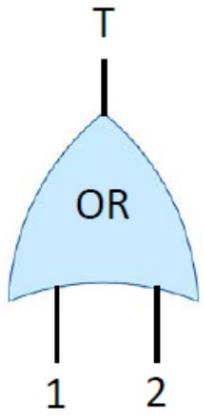
Classic Literary Characters
200: This Shakespearian character famously uttered "to be or not to be."
Who is Hamlet?
400: This character was played by Gregory Peck in the 1962 film *To Kill A Mockingbird*.

Who is Atticus Finch?
600: This *Christmas Carol* character was the father of Tiny Tim.
Who is Bob Cratchit?
800: This character was played by Henry Fonda in the 1940 film *The Grapes of Wrath*.
Who is Tom Joad?
1000: During his 20-year "nap" Rip Van Winkle missed this historical event.
What is the Revolutionary War?

Semi-Final Round

Final Jeopardy Category: Risk Assessment

This is the Probability of Failure (P) of the Top Event (T) for the Following Fault Tree in Which the Failure Probability (P) of All Input Components is 0.1.



What is 0.19?
$R = (0.9)^2 = 0.81$
$P = 1 - 0.81 = 0.19$

Final Round

Single Jeopardy:

Transport Phenomena

100: This is defined as the line drawn tangent to the velocity vector at each point in a flow field.
What is a streamline?

200: This states that a body completely or partially submerged in a gas or liquid is acted upon by an upward force equal to the weight of the displaced fluid.
What is Archimedes' Principle?

300: This equation is given by the following:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \left(\rho \vec{v} \right) = 0$$

What is the continuity equation?

400: This concept refers to the layer of fluid in the immediate vicinity of a surface where the effects of viscosity are significant.
What is the Boundary Layer (Theory)?

500: This analogy is named after the person that proposed it in 1933:

$$St Pr^{2/3} = \frac{f}{2}$$

What is the Colburn Analogy?

AIChE Ethics

100: Hold paramount the ____, ____ and ____ of the public.
What are safety, health and welfare?

200: Issue statements or present information only in an _____ and _____ manner.
What are objective and truthful?

300: Perform professional services only in areas of their _____.
What is competence?

400: Never tolerate _____.
What is harassment?

500: Conduct themselves in a ____, _____ and _____ manner.
What are fair, honorable, and respectful manner?

Catalysis

100: This is the most common equation used to describe enzyme reaction kinetics.
What is the Michaelis-Menton equation?

200: The creator of this adsorption model won the Nobel Prize in in 1932 for his work concerning surface chemistry.
What is the Langmuir (adsorption model)?

300: Although sounding like terminology from a cooking oil commercial, this behavior is characteristic of many catalytic reactions.
What is saturation kinetics?

400: This dimensionless number becomes large when diffusion cannot keep up with reaction in a catalyst pellet.
What is the Thiele modulus?
500: This seemingly common-sense ratio can exceed 100% for an exothermic reaction in a catalyst pellet.
What is the (catalyst pellet) effectiveness factor?

Equations of State
100: The compressibility factor, Z, is equal to this for a gas that behaves ideally.
What is one?
200: The Van der Waals equations of state includes a term a/V^2 which models this type of intermolecular force.
What are attractive forces?
300: The combination of Boyle's law and Charles's law eventually led to this new equation of state, first stated by Clapeyron in 1834.
What is the ideal gas law?
400: This law states that different gases behave similarly when compared to their condition relative to the critical point.
What is the law of corresponding states?
500: This equation of state is given by

$$\frac{P\hat{V}}{RT} = 1 + \frac{B}{\hat{V}} + \frac{C}{\hat{V}^2} + \ldots$$

What is the virial equation of state?

Molecular Biology
100: This is defined as the pH at which an amino acid or protein has no net charge.
What is the isoelectric point?
200: This technique, denoted by PCR, is used to amplify DNA.
What is the Polymerase Chain Reaction?
300: This enzyme is used to generate complementary DNA (cDNA) from an RNA template.
What is reverse transcriptase?
400: This device, shown here, is commonly used to count mammalian cells.

What is a hemacytometer?
500: This commonly used technique utilizes electrophoresis and antibodies to detect and analyze proteins.
What is a Western blot?

Disney Theme Parks
100: Location (city and state) of the first Disney theme park that opened in 1955.
What is Anaheim, California?
200: The first Disney theme park outside the United States opened in this country in 1983.
What is Japan?

300: These are the four theme parks at Walt Disney World.
What are Magic Kingdom, Epcot, Animal Kingdom, and Hollywood Studios (or MGM Studios)?
400: This is the fastest ride at Walt Disney World.
What is the Test Track at EPCOT?
500: He gave the opening speech when Walt Disney World opened.
Who is Roy Disney?

Final Round
Double Jeopardy:
Separations
200: The amount of condensed distillate returned to the top of a distillation column, relative to the amount removed as a product.
What is the reflux ratio?
400: Method used to separate solids from fluids by interposing a medium through which only the fluid can pass.
What is filtration?
600: The process by which a volatile solute is removed from a liquid by passing a gas through a liquid.
What is stripping?
800: A simplified version of this separation process is seen in a coffee or tea maker.
What is leaching?
1000: On a McCabe-Thiele diagram, this is the slope of the feed line if the feed is saturated with vapor.
What is zero?

Heat Transfer
200: This type of heat transfer involves higher energy molecules transferring energy to lower energy molecules.
What is conduction?
400: This law describes the power radiated from a black body in terms of its temperature.
What is the Stefan-Boltzmann Law? (Stefan's Law)
600: In most heat transfer coefficient (h) correlations for turbulent flow in pipes, h is proportional to the Reynolds number raised to this power.
What is 0.8?
800: This dimensionless number is the product of the Grashof number and Prandtl number.
What is the Rayleigh number?
1000: This parameter, used in radiative heat transfer, is defined as

$$\frac{1}{A_1}\int_{A1}\int_{A2}\frac{\cos(\theta_1)\cos(\theta_2)dA_2dA_2}{\pi r^2}$$

What is the view factor F12?

Biochemistry

200: This cellular process uses the electron transport chain to generate ATP from NADH and $FADH_2$.

What is oxidative phosphorylation?

400: This is protein-making machinery within cells reads a mRNA sequence and translates it into the amino acid sequence of a protein.

What are ribosomes?

600: These two molecules containing high reducing power are produced during the TCA cycle.

What are NADH and $FADH_2$?

800: Organisms in this class use CO_2 as their primary carbon source.

What are autotrophs?

1000: This is the equation used to describe the Central Dogma of Molecular Biology.

What is DNA → RNA → Protein?

Elements and Periodic Table

200: This is the most electronegative naturally occurring element.

What is Fluorine?

400: This is the most common element by weight in the human body.

What is Oxygen?

600: This is the color of molten Sulfur.

What is red?

800: This is the most electropositive naturally occurring and stable element.

What is Cesium? (Francium is theoretically the most electropositive element, but is unstable)

1000: The naturally occurring Nobel gases consist of Helium, Neon, Argon, and these 3 elements.

What are Krypton, Xenon, and Radon?

Pressure Relief Valves

200: This is defined as the pressure at the outlet of a relief device during the relief process resulting from pressure in the downstream discharge system.

What is backpressure?

400: This type of spring-loaded relief valve is used when a large backpressure is present.

What is a balanced bellows?

600: This type of relief device has no moving parts and is used to protect process equipment against excessive positive or negative pressures.

What is a rupture disk?

800: The relief scenario for which the following equation is used to size the relief valve.

$$T_m - T_s = \frac{Q}{G_T A C_v}\left[\ln\left(\frac{m_0 Q v_{fg}}{V G_T A \Delta H_V}\right) - 1\right] + \frac{V \Delta H_V}{m_0 C_v v_{fg}}$$

What is an external fire?

1000: The G_T in the following relief sizing equation.

$$T_m - T_s = \frac{Q}{G_T A C_v}\left[\ln\left(\frac{m_0 Q v_{fg}}{V G_T A \Delta H_V}\right) - 1\right] + \frac{V \Delta H_V}{m_0 C_v v_{fg}}$$

What is the mass flux (through the relief)?

Real Names
200: Stefani Joanne Angelina Germanotta is better known by this name.
Who is Lady Gaga?
400: Richard Starkey is better known by this name.
Who is Ringo Starr?
600: Lew Alcindor is better known by this name.
Who is Kareem Abdul-Jabbar?
800: Reginald Kenneth Dwight is better known by this name.
Who is Elton John?
1000: Barbara Millicent Roberts is better known by this name.
Who is Barbie (the doll)?

Final Round
Final Jeopardy Category: Chemical Process Design
These are the 3 main factors that determine the capital cost of a specific piece of equipment at a given time.
What are size/capacity, material of construction, and operating pressure?