2016 ChemE Jeopardy Clues/Responses

Preliminary Round

Single Jeopardy:

Biochemical Engineering

100: During exponential growth, this is defined as

$$\frac{1}{X}\frac{dX}{dt}$$

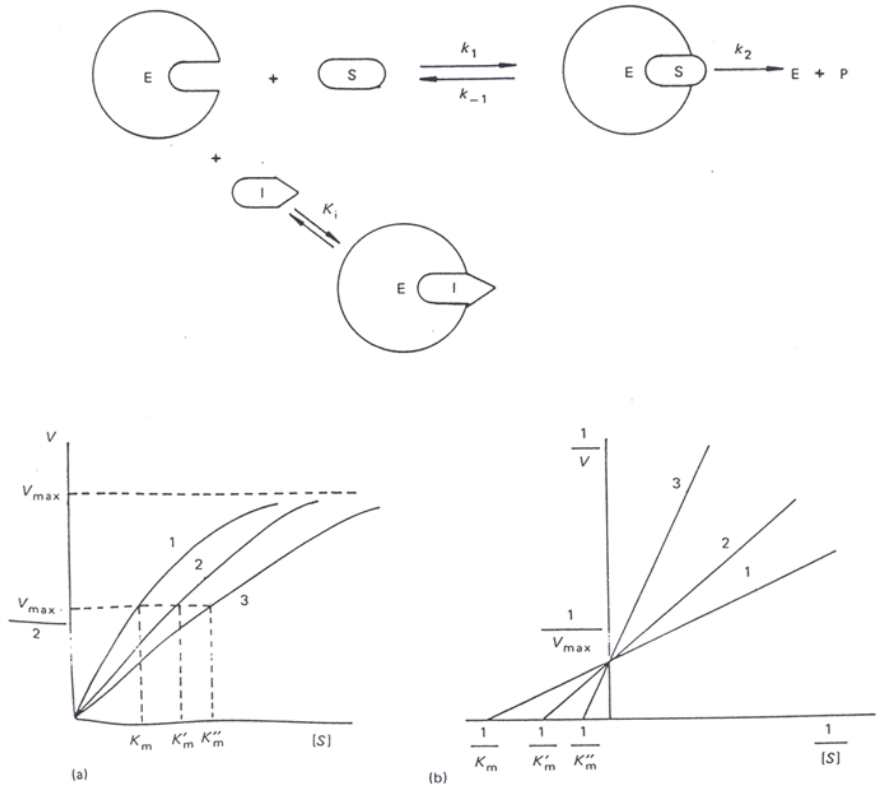
where X is the biomass concentration and t is time.

What is the specific growth rate (μ)?

200: Hybridomas produce this medically useful product.

What are (monoclonal) antibodies?

300: This type of enzyme inhibition is demonstrated by the figure given here:



What is competitive inhibition?

400: Between 20 and 80 volunteers are used to determine this characteristic of a drug during Phase I clinical trials.

What is safety?

500: This dimensionless number, represented here, is used to determine the required power in a mixing operation involving Newtonian fluids.

What is the Power Number?

Fluid Flow

100: This variable is the ratio of the fluid density to the density of water.
What is specific gravity?
200: The fanning friction factor is a function of this in fully turbulent flow.
What is the relative surface roughness (ε/D)?
300: These are the SI units for viscosity.
What are kg/(m-s)?
400: This type of fluid is represented by

$$\tau = K\left(\frac{dv}{dy}\right)^{n} \quad n<1$$

What is a pseudoplastic?
500: 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 ($NPSH_A$)?

Chemistry

100: This is a unit of pressure equal to 10^5 Pa.
What is a bar?
200: The U.S. Penny consists of these two chemical elements.
What are zinc (97.5%) and copper (2.5%)?
300: This is the best electrical conductor of the elements.
What is silver?
400: This is the energy required to remove an electron from a gaseous atom when the atom is in the ground state.
What is the ionization energy?
500: This law states that the product of the volume and pressure of a given amount of gas is constant when the temperature is constant.
What is Boyle's Law?

Thermodynamics

100: This is defined as the transfer of energy from one object to a cooler object.
What is Heat?
200: This parameter is given by:

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

What is Entropy (S)?
300: This parameter is given by U – TS.
What is the Helmholtz Free Energy (A)?

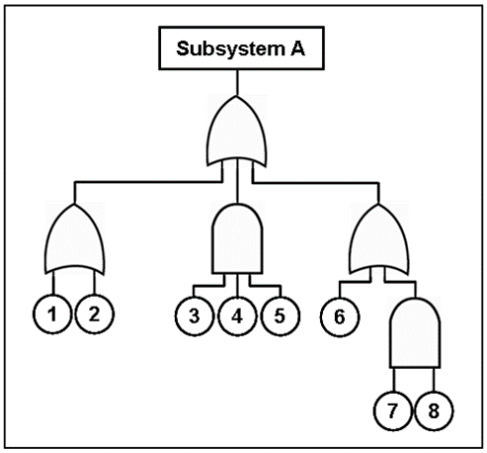
400: An enthalpy-entropy diagram is commonly called this in recognition of its creator.
What is a Mollier diagram?
500: This cycle consists of the following steps in order: adiabatic/isobaric/adiabatic/isochoric.
What is the Diesel cycle?

AIChE Trivia
100: The number of Student Chapter Regions in the United States.
What is 9?
200: The 2017 AIChE Annual Student Conference will be held in this city.
What is Minneapolis, MN?
300: The first AIChE National Meeting was held in this city.
What is Philadelphia, PA?
400: The current (2016) AIChE President.
Who is Gregory Stephanopoulos?
500: On March 25, 1985, this AIChE center, known as CCPS, was formed.
What is the Center for Chemical Process Safety?

U.S. History
100: He was the "Father of the Constitution."
Who was James Madison?
200: This was the name of the land purchase that the United States bought from France in 1803.
What was the Louisiana Purchase?
300: This policy declared that Europe should not acquire new territories in the Western Hemisphere.
What was the Monroe Doctrine?
400: This famous trial, held in Dayton, Tennessee, involved the teaching of evolution in schools.
What is the Scopes Trial?
500: These papers were written by Alexander Hamilton and others with the purpose of gaining ratification of the U.S. Constitution.
What were the Federalist Papers?

Preliminary Round
Double Jeopardy:
Chemical Process Safety
200: NFPA is the abbreviation for this organization.
What is the National Fire Protection Association?
400: This occurs when a process is unable to remove adequate heat from a reactor to control the temperature.
What is a runaway reaction?

600: The method depicted here is used to qualify and quantify the hazards and risks of a process.



What is a Fault Tree?

800: This is the lowest temperature at which a liquid gives off enough vapor to ignite in air and continue to burn.

What is the fire point?

1000: This is the flow of electricity produced by transferring electrons from one surface to another by a flowing fluid or solid.

What is a streaming current?

<u>Chemical Reaction Engineering</u>

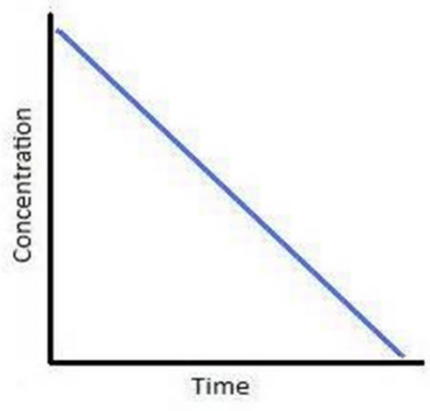
200: The temperature dependence of a chemical reaction is commonly described through the use of this equation.

What is the Arrhenius Equation?

400: A reaction follows this when the reaction orders are identical to the stoichiometric coefficients.

What is an elementary rate law?

600: This is the order of the reaction denoted by the following



What is zeroth order?

800: This type of reactor has reactants loaded in the beginning. As the reaction proceeds, more reactant is added. Once the reaction is completed, the reactor is emptied.

What is a semibatch or fed batch reactor?

1000: This dimensionless number is given by

$$\frac{\text{Rate of consumption of reactant by reaction}}{\text{Rate of transport of reactant by convection}}$$

What is the Damköhler Number?

Process Design

200: The idea that money available at the present time is worth more than the same amount in the future.
What is the time value of money?
400: This is defined as:

$$\frac{\text{Average Annual Net Profit}}{\text{Fixed Capital Investment}}.$$

What is the rate of return on investment? (or What is the Rate of Return?)
600: 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?
800: This represents the fixed capital investment of the plant, minus the value of the land, evaluated at the end of the plant life.
What is the salvage value?
1000: Nickel-copper alloys are known by this name, which is a trademark of the International Nickel Corporation.
What is Monel?

Biochemistry

200: This organelle is known as the powerhouse of the cell.
What is a mitochondrion?
400: This class of enzyme cut DNA at palindromic sequences.
What are restriction endonucleases?
600: This process, abbreviated PCR, is commonly used to amplify DNA.
What is the polymerase chain reaction?
800: These are the 3 primary types of RNA that are involved in protein synthesis.
What are messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA)?
1000: This is the primary pathway for carbon dioxide fixation in photoautotrophs and chemolithotrophs.
What is the Calvin Cycle?

Math

200: This is defined as:

$$\lim_{h \to 0} \left(\frac{f(x+h) - f(x)}{h} \right)$$

What is the derivative of f {f'(x)}?
400: This is defined as:

$$\int_0^{\infty} f(t)e^{-st}dt$$

What is the Laplace Transform of f(t)?
600: Given the lengths of 2 sides of a triangle and the corresponding angle in between, this law will provide the length of the third size.
What is the Law of Cosines?
800: This is the value of the

$$\lim_{x \to 0} \frac{1 - e^{-x}}{x}$$

What is 1? (via use of L'Hospital's Rule)
1000: These functions, first defined by the mathematician Daniel Bernoulli, are the solutions y(x) of the following differential equation:

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + \left(x^2 - \alpha^2\right) y = 0$$

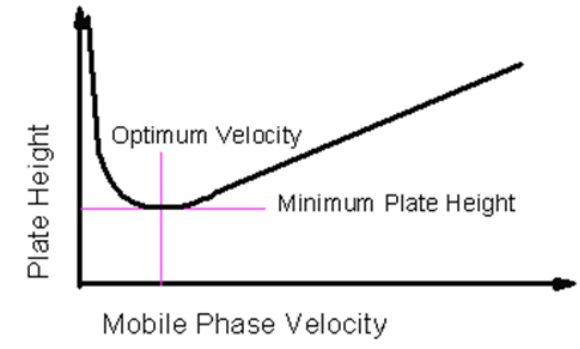
What are Bessel Functions?

Authors
200: The Grapes of Wrath.
Who was John Steinbeck?
400: The Catcher in the Rye.
Who was J.D. Salinger?
600: Pride and Prejudice.
Who was Jane Austen?
800: Moby Dick.
Who was Herman Melville?
1000: The Scarlet Letter.
Who was Nathaniel Hawthorne?

Preliminary Round

Final Jeopardy Category: Separations

This plot, used in chromatography, shows the effect of velocity on plate height.



What is the van Deemter Plot?

Final Round

Single Jeopardy:

Conversions and Units

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

What is 3.78?

200: This SI unit is the same as

$$\frac{\text{kg-m}}{\text{s}^2}$$

What is a Newton (N)?

300: This is the SI unit for sound.

What is a decibel (dB)?

400: This is the SI unit for light intensity.

What is a Candela?

500: This is the number (to 3 significant figures) of ft-lb_f in a BTU.

What is 778?

Material and Energy Balances

100: This value (to 3 significant figures) is added to the temperature in ºF to obtain ºR.

What is 460?

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: This type of material balance is the primary type used for reactive systems.

What is an elemental or atomic species balance?

500: This "law" states that the volume of a gas mixture is the sum of the pure component volumes.

What is Amagat's Law?

Process Control

100: This type of diagram provides a detailed description of the process equipment with all the valves, pumps, piping specifications and sensors located on the diagram.

What is a piping and instrumentation diagram (P & ID)?

200: This type of valve has a spherically shaped element with a hole in it that rotates to control flow.

What is a ball valve?

300: An electro-mechanical device that converts a 4-20 mA electrical signal to a 3-15 psig pneumatic signal.

What is an I/P Converter? (current to pressure converter)

400: The characteristic of a second-order process that determines the general shape of the dynamic response.

What is the damping factor?
500: A process for which the process gain is not constant.
What is a nonlinear process?

General Engineering
100: In Statics, these two parameters are zero on every part of the system.
What are forces and moments?
200: This law states that at constant temperature, the current in a conductor is directly proportional to the potential differences between its ends.
This law states that at constant temperature, the current in a conductor is directly proportional to the potential differences between its ends.
300: This is the branch of mechanics concerned with the motion of bodies under the action of forces.
What is dynamics?
400: The fundamental principles of this law, which is used in circuit analysis, are (i) the summation of potential differences around a closed loop must be zero and (ii) the summation of the currents at a junction must be zero.
What is Kirchhoff's Law?
500: This is an annuity that is established in order to produce an amount of money at some future time.
What is a sinking fund?

Physics
100: This vector quantity is the product of a mass and an acceleration.
What is a force?
200: This law states that the force needed to extend or compress a spring by some distance is proportional to that distance.
What is Hooke's Law?
300: Laser is an acronym for this.
What is light amplification by stimulated emission of radiation?
400: Tried by the Inquisition, found "vehemently suspect of heresy," and forced to recant, he spent the rest of his life under house arrest where he wrote *Two New Sciences*, summarizing his work on kinematics and strength of materials.
Who is Galileo Galilei?
500: This winner of the 1932 Nobel Prize in Physics "for the creation of quantum mechanics" introduced the uncertainty of a particle's position and momentum simultaneously.
Who is Werner Heisenberg?

U.S. Presidential Trivia
100: He was the only U.S. President to serve more than 2 terms.
Who was Franklin D. Roosevelt?
200: This U.S. President became famous for getting stuck in the White House bathtub the first time that he used it.
Who was William Taft?
300: He was the only U.S. President with a Ph.D.
Who was Woodrow Wilson?

400: He was the youngest U.S. President.
Who was Theodore Roosevelt? (42 years old when he succeeded to the presidency following the assassination of William McKinley)
500: This U.S. President signed the treaty to purchase Alaska from Russia.
Who was Andrew Johnson?

Final Round
Double Jeopardy:
Heat Transfer
200: This type of heat transfer occurs without any contact between the surfaces.
What is radiation?
400: This is equal to

$$\frac{q}{A*\Delta T_{lm}}$$

What is U (Overall Heat Transfer Coefficient)?
600: This dimensionless number is given by

$$\frac{g\beta\left(T_w - T_\infty\right)D^3}{\upsilon^2}$$

What is the Grashof Number?
800: The type of heat transfer and the geometry for which the following equation applies

$$q = -\frac{4\pi}{\frac{r_2 - r_1}{k_A r_1 r_2} + \frac{r_3 - r_2}{k_B r_2 r_3}}\left(T_3 - T_1\right)$$

What is conduction and concentric spheres?
1000: This radiation heat transfer parameter is given by

$$\frac{1}{A_1}\iint_{A_1,A_2}\frac{\mathrm{Cos}\left(\theta_1\right)\mathrm{Cos}\left(\theta_2\right)dA_2 dA_1}{\pi r^2}$$

What is the view factor F_{12}?

Mass Transfer

200: This law states that

$$J_A = -D_{AB} \nabla C_A$$

What is Fick's First Law of Diffusion?

400: Many one-dimensional mass transfer problems can be solved with the following equation that is commonly called this

$$\frac{\partial C_A}{\partial t} = D_{AB} \frac{\partial^2 C_A}{\partial t^2}$$

What is Fick's Second Law of Diffusion?

600: The following dimensionless number is commonly used in convective mass-transfer coefficient correlations and is sometimes referred to as the "mass transfer Nusselt Number."

$$\frac{k_c L}{D_{AB}}$$

What is the Sherwood Number?

800: The ratio of thermal diffusivity and mass diffusivity is designated by this dimensionless number.

What is the Lewis Number?

1000: 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?

Chemical Process Safety Acronyms

200: VCE

What is a Vapor Cloud Explosion?

400: AIT

What is the AutoIgntion Temperature?

600: NFPA

What is the National Fire Protection Association?

800: BLEVE

What is a Boiling Liquid Expanding Vapor Explosion?

1000: DIERS

What is the Design Institute for Emergency Relief Systems?

Microbiology
200: A noncellular entity that consists minimally of protein and nucleic acid and that can replicate only after entry into living cells.
What is a virus?
400: This species of bacteria is used in the commercial production of insulin.
What is *Escherichia coli*?
600: This is the common name for lyophilization.
What is freeze-drying?
800: Varivax vaccine produced by Merck is used to prevent this childhood disease.
What is Chicken Pox?
1000: Malaria is caused by infection with parasites from this genus.
What is *Plasmodium*?

Metals and Alloys
200: Modern bronze contains copper and this metal.
What is Tin?
400: Stainless Steels are iron alloys containing a minimum of 10.5% of this metal.
What is Chromium?
600: This is the metallic element with the highest melting point.
What is Tungsten (3422°C)?
800: More than 90% of the present day U.S. quarter is this metal.
What is Copper?
1000: The beneficial effects of these 3 metals are combined in Hastelloy C to give an expensive, but highly corrosion-resistance material. Hastelloy C also contains iron, tungsten and manganese, as well as non-metal components.
What are Nickel, Molybdenum and Chromium?

Geography
200: This continent is located at Latitude 90° S Longitude 0.0° E.
What is Antarctica?
400: This razor-thin country accounts for more than half of the western coastline of South America.
What is Chile?
600: This river runs through Baghdad.
What is the Tigris River?
800: Angel Falls, the Earth's highest waterfall, is located in this country.
What is Venezuela?
1000: This is the highest (above sea level) mountain in Europe.
What is Mount Elbrus?

Final Round
Final Jeopardy Category: Equations
This equation is given by:

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

What is the Continuity Equation?