Syllabus for FIXED TERM PROJECT ASSISTANT -- Written Test (Microbiology / Biotechnology)

Section 1: Microbiology and Biotechnology

Microbial Identification, Microbial Nutrition, Microbial growth, Microbial Metabolites, Microbial enzymes,

Section 2: Molecular Biology, Genetics, Biostatistics

Microbial Genetics, Bioinformatics, Microbial Genomics and Proteomics, Recombinant DNA Technology

Section 3: Environmental Microbiology /Biotechnology

Biodegradation, Bioremediation, Role of Microbiology in effluent treatment, Applications of biosensors in environmental monitoring

Section 4: Bioprocess technology

Bioreactors, Types of fermentations, Scale-up, Lignocellulosic Biofuels production, Biomass pretreatment, Enzymatic hydrolysis

Section 5: Analytical Instrumentation and methods

Analytical instrumentation in microbiology / biotechnology research. HPLC, GC, Spectrophotometry, Biomass analysis, Biofuels analysis, Analytical method development.

Model Objective Type Questions

(Microbiology and Biotechnology):

1) The primary stain to determine the gram character of a microbe is

A. Safranin
B. Phenolphthalein
C. **Crystal violet**
D. Methyl red

2) An organism which obtains energy from chemicals is designated as a

A. Prototroph
B. **Chemotroph**
C. Organotroph
D. Autotroph

3) Which of the following organisms typically get their carbon for biosynthesis from organic compounds?

A. Aerobic, glucose-respiring bacteria (aerobic respiration)
B. Ammonia-oxidizing bacteria (chemolithotrophic bacteria)
C. Photosynthetic cyanobacteria (phototrophic metabolism)
D. None of the above

4) The word, used for the small solid supports onto which are spotted hundreds of thousands of tiny drops of DNA that can be used to screen gene expression, is

A. southern blot
B. replica plate technique
C. **DNA microarrays**
D. northern blot

5) Which type of plasmid can exist with or without being integrated into the host's chromosome?

A. Medisome
B. Lisosome
C. Lysogen
D. **Episome**

6) The correct term for the transfer of genetic material between bacteria in direct physical contact is

A. Conjugation
B. Transformation
C. Replication
D. Transduction

7) What is an anaerobic digester?

A. A process to generate Helium
B. the anaerobic production of butanol
C. **method to convert agricultural waste into a biogas**
D. All of the above

8) The BOD value of wastewater is related to

A. the live bacterial count
B. **amount of organic material**
C. amount of inorganic material
D. amount of glycosides

9) Which of the following is responsible for the corrosion problem?

A. Iron bacteria
B. **Sulfur bacteria**
C. Slime forming bacteria
D. Nitrogen fixing bacteria

10) The production of acetic acid from ethanol is an

A. anaerobic process
B. **aerobic process**
C. a combination of both
D. none of the above

Answer Keys for Model Questions

1	2	3	4	5	6	7	8	9	10
C	B	A	C	D	A	C	B	B	B

Syllabus for FIXED TERM PROJECT ASSISTANT -- Written Test (CHEMISTRY)

Syllabus:

General Chemistry, Organic, Inorganic, Physical Chemistry covering
Catalysis, Chemical kinetics, thermodynamics, electrochemistry, organic reactions, surface chemistry, spectroscopy, analytical chemistry, co-ordination and inorganic complexes, organometallics and so forth.

Model Questions:

1) **The E˚ values of the following reduction reactions are given**
   Fe^{3+} (aq) + e^- → Fe^{2+} (aq), E˚ = 0.771 V
   Fe^{2+} (aq) + $2e^-$ → Fe^{2+} (s), E˚ = -0.447 V
   What will be the free energy change for the following reaction?
   Fe^{3+} (aq) + $3e^-$ → Fe (s), E˚ = 0.771 V (1F=96485 C mol^{-1})
   (A) 18.51 kJ mol^{-1} (B) 11.87 kJ mol^{-1} (C) -8.1 kJ mol^{-1} (D) -10.41 kJ mol^{-1}

2) What is Bragg's equation ?
   a) $2d \sin(\theta) = n\lambda$ b) $2 \sin(\theta) = n\lambda$ c) $2n = d \sin(\theta)$ d) $\sin(\theta) = n\lambda$

3) Which spectroscopic technique uses the molecular motions such as vibrations, rotations for characterizing the substances?
   a) Infrared spectroscopy b) NMR c) EPR d) XPS

4) What is the basic assumption of Langmuir theory?
   a) Monolayer adsorption b) Multilayer adsorption c) no adsorption d) a and b.

5) What is isothermal condition ?
   a) Constant Temperature b) Constant Pressure c) Constant volume d) none of the above.

6) What are the metals present in the Wilkinson catalyst ?
   a) P & Re b) Re and Rh c) P and Rh d) P and Ir.

7) Which is of the following is a non-destructive technique ?
   a) TGA b) Elemental Analysis c) NMR d) X-ray diffraction

8) Which among the following are the paramagnetic ?
   a) Ni & Al b) Si and Fe c) Fe and Co d) Ni and Si

9) What is the oxidation state of Cr in $K_2Cr_2O_4$?
   a) 2 b) 4 c) 6 d) 8

10) What are the pH of 0.01 M HCl and 0.01M NaOH solutions, respectively ?
   A) 2 & 2 b) 2 & 14 c) 2 & 12 d) none of the above

Syllabus for FIXED TERM PROJECT ASSISTANT -- Written Test (CHEMICAL ENGINEERING)

Section 1: Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems.

Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

First and Second laws of thermodynamics.

Applications of first law to close and open systems.

Second law and Entropy.

Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Section 2: Fluid Mechanics and Mechanical Operations

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance,

Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds,

Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Section 3: Heat Transfer

Steady and unsteady heat conduction, convection and radiation

Thermal boundary layer and heat transfer coefficients

Boiling, condensation and evaporation

Types of heat exchangers and evaporators and their process calculations, cooling towers, furnace calculations.

Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Section 4: Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies;

Stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts

Design and operation of equipment for distillation (flash, multi-component distillation etc), absorption and stripping, leaching, liquid-liquid extraction, drying, membrane separation, humidification, dehumidification and adsorption.

Section 5: Chemical Reaction Engineering

Theories of reaction rates

Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors

Development of rate laws, Residence time distribution, single parameter model

Non-isothermal reactors

Catalysis and catalytic reactions, catalyst deactivation and regeneration, Kinetics of heterogeneous catalytic reactions

Diffusion effects in catalysis.

Different type of industrial reactors - Fixed bed, fluidized bed, trickle bed, slurry bed

Section 6: Instrumentation and Process Control

Measurement of process variables

Sensors, transducers and their dynamics

Process modeling and linearization

Transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID)

Control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Section 7: Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, Interest and investment costs, taxes and insurance, material selection and equipment fabrication

Computer aided design, Optimization in process design and sizing of chemical engineering equipments such as compressors, heat exchangers, multistage contactors, reactors etc.

Section 8: Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry)

Fertilizers (Ammonia, Urea, SSP and TSP)

Natural products industries (Pulp and Paper, Sugar, Oil, and Fats)

Petroleum refining and petrochemicals

Polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

Section 9: Transport Phenomena

Transport of momentum, heat and mass by molecular motion – Newton's law of viscosity, Fourier's law of heat conduction and Fick's law

Transport properties – Viscosity, Thermal conductivity and Mass diffusivity.

One-dimensional mathematical models for transfer processes using shell balance of momentum, heat and mass.

Development of general differential equations for transfer of momentum, heat and mass and their applications in solving one-dimensional steady and unsteady problems. Boundary layer theories.

Turbulent transport and Interphase transport.

Model Objective Type Questions (Chemical Engineering):

1. Space velocity is the proper performance measure of flow reactors. The space velocity has the units of
   (A) Time
   (B) $(time)^{-1}$
   (C) Velocity
   (D) $(velocity)^{-1}$

2. In petroleum refining Operations, the process used to convert paraffins and naphthenes to aromatics is

   (A) Hydrotreating
   (B) Hydrocracking
   (C) Catalytic reforming
   (D)Isomerization

3. For obtaining a given separation in distillation column the minimum number of theoretical stages is obtained with

   (A) minimum reflux ratio
   (B) optimum reflux ratio
   (C) Total reflux
   (D) Zero reflux ratio

4. The total number of molecule in 8.5 gm of an ideal NH_3 gas is .....X 10^{23}

   (A) 6.023

   (B) 3.0115

   (C) 12.046

   (D) 9.0345

5. When the temperature of an ideal gas is increased from 27°C to 927°C, the kinetic energy will be

   (A) same

   (B) twice

   (C) eight times

   (D) four times

6. Reynolds number for flow of water at room temperature through 2 cm dia pipe at average velocity of 5 cm/sec is around

(A) 10000
(B) 100
(C) 10
(D) 1000

7 . A gaseous mixture contains methane and inert gas. 20 ml of this mixture requires 16 ml of O_2 for complete combustion. What is the percentage of methane in the mixture ?

(A) 20
(B) 40
(C) 60
(D) 80

8. In liquid liquid extraction the solvent B is used to separate solute C from a given solution of A and C. If A and B are completely insoluble in one another, the selectivity of B will be

(A) 0
(B) 1
(C) ∞
(D) >1

9. Methane is being cracked on a catalyst

$$CH_4 \rightarrow C + 2H_2$$

Under circumstances such that CH_4 (A) diffuses to the cracking surface and H_2 (B) diffuses back. At steady state the ratio $N_A/(N_A+N_B)$ is

(A) 1/3
(B) -1
(C) 2/3
(D) -2

10. Gases A and B are fed continuously to a tank with a volume of 30 ft^3. The normal tank conditions are 40 psia and 80°F and the normal flow rates of A and B are 40 and 10 cfm, respectively, measured at tank conditions. What is the time-constant of the system?

(A) 0.75 min

(B) 3 min

(C) 0.60 min

(D) 1.67 min

Answer Keys for Model Questions

1	2	3	4	5	6	7	8	9	10
B	C	C	B	D	D	B	C	B	C