L-1/T-1/NAME **Date: 18/04/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **NAME 117** (Hydrostatics and Stability)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for any missing data.

1. (a) Calculate the area, position of the center of flotation and the second moments of area about the two principal axes of the waterplane defined by the following ordinates numbered from forward. It is 220.00 m long. **(20)**

Ordinate No.	1	2	3	4	5	6	7	8	9	10	11
½ ordinate(m)	0.20	2.40	4.60	6.70	8.10	9.00	9.40	9.20	8.60	6.30	0.00

(b) A ship 135.00 m long, 18.00 m beam and 7.60 m draught has a displacement of 14,000 tonne. The area of the load waterplane is 1925 m^2 and the area of the immersed midship section 130 m^2. Calculate C_w, C_m, C_b and C_p. **(15)**

2. (a) The underwater portion of a vessel is divided by transverse sections 10 m apart of the areas commencing from forward as 0.2, 22.7, 48.8, 73.2, 88.4, 82.8, 58.7, 26.2 and 3.9 square meter respectively. Find the position of the center of buoyancy relative to the middle section. **(17)**

(b) A ship of displacement mass 5000 tonne, 98 m long floats at draughts of 5.50 m forward and 6.20 m aft. The longitudinal metacentric height is 104 m and the center of flotation is 2.1 m aft of midship. Determine the moment to change trim 1 centimeter. Also find the new end draughts when a mass of 85 tonnes which is already on board is moved 30 m forward. **(18)**

3. (a) A ship of 8000 tonnes displacement has KM 7.50 m and KG 7.00 m. A double bottom tank is 12.00 m long, 15.00 m wide and 1.00 m deep. The tank is divided longitudinally at the center line and both sides are full of salt water. Calculate the list if one side is pumped out until it is half empty. **(25)**

(b) What is free surface? Describe the practical considerations of the free surface effects on ship. **(10)**

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4. (a) Illustrate the launching curves and also lists the information that can be extracted from the launching curves. **(12)**

(b) With figure describe the sideway launching. **(6)**

(c) Define Gross Tonnage (GT) and Net Tonnage (NT). **(4)**

(d) Why Inclining experiment is carried out for a ship? Briefly describe the procedure of conducting the Inclining Experiment. **(13)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols have their usual meaning. Assume reasonable values for any missing data.

5. (a) A box-shaped vessel 65m × 12m × 8m has KG 4m, and is floating in salt water upright on an even keel at 4m draft F and A. Calculate the moments of statical stability at (i) 5 degrees and (ii) 25 degrees heel. **(15)**

(b) A ship of 12000 tonne displacement has a second moment of area about the centerline of 72×10^3 m^4. If the metacentric height is –0.05m, calculate the angle of loll. **(10)**

(c) The righting levers of a ship of 15000 tonne displacement at angles of heel of 15°, 30°, 45° and 60° are 0.29, 0.70, 0.93 and 0.90 m respectively. Calculate the dynamical stability of ship at 60° heel. **(10)**

6. (a) What is meant by the term floodable length? Illustrate your reply by drawing a typical curve of floodable length for a ship. **(12)**

(b) A ship of length 520 ft has a load displacement of 18230 tons and L.C.B 9.2 ft abaft amidships. At a waterline tangential to the margin line the areas of immersed sections are as given in the second column of table. **(23)**

Determine the length and position of the flooded compartment for this condition assuming a permeability of 70 percent.

Station	A.P	½	1	1½	2	3	4	5	6	7	8	8½	9	9½	F.P
Area, (ft^2)	380	855	1240	1615	1930	2290	2350	2320	2260	2040	1430	1015	600	245	—

7. A vessel of constant rectangular cross-section is 150 m long, 35 m beam and flats on an even-keel draught of 6m. A compartment of 50 m long amidships is bilged. Find the effect of this on the initial stability, using the lost-buoyancy and added-weight methods of calculation. The value of KG before bilging is 6 m. **(35)**

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8. (a) A box-shaped vessel 45m × 10m × 6m is floating in salt water at a draft of 4m F and A. GM = 0.6 m. Calculate the dynamic stability to 20 degree heel. **(15)**

(b) The angles of inclination and corresponding righting lever for a ship at an assumed KG of 6.5 m are: **(20)**

Inclination (degree)	0	15	30	45	60	75	90
Righting lever (m)	0	0.11	0.36	0.58	0.38	–0.05	–0.60

In a particular loaded condition the displacement mass is made up as follows:

Item	Mass (tonne)	VCG (m)
Lightship	4,200	6.0
Cargo	9,100	7.0
Fuel	1,500	1.1
Stores	200	7.5

Plot the curve of statical stability for this loaded condition and determine the range of stability.

L-1/T-1/NAME Date: ~~23/04/2024~~ 25/5/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **CHEM 117** (Chemistry-I)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The corresponding Course Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the Course are mentioned at the end of the question paper.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer to **Question No. 1 is compulsory**.

Answer any **TWO** Questions from Question No. 2-4.

1. (a) What are colligative properties? Write the equations relating each of these properties to the concentration of the solution. **(5)** (CO1)

(b) Show that half-life for a second order reaction is inversely proportional to the rate constant. Obtain the unit of the second order rate constant from the rate expression. **(10)** (CO2)

(c) What is Henry's Law? Explain the law in terms of the kinetic molecular theory of gases. Give an exception to Henry's law. **(10)** (CO3)

(d) A 7.85-g sample of a compound with the empirical formula C_5H_4 is dissolved in 301 g of benzene. The freezing point of the solution is 1.05°C below that of pure benzene. What are the molar mass and molecular formula of this compound? (The value of the constant $K_f = 5.12$°C/m). **(10)** (CO4)

2. (a) Gold has cubic crystals whose unit cell has an edge length of 407.9 pm. The density of the metal is 19.3 g/cm^3 and atomic weight of gold is 196.97 g/mol. Calculate the number of gold atoms in a unit cell, assuming all atoms are at lattice points. What type of cubic lattice does gold have? **(15)**

(b) The gas-phase reaction between methane (CH_4) and diatomic sulphur (S_2) is given by the equation **(10)**

$$CH_4\,(g) + 2S_2\,(g) \rightarrow CS_2\,(g) + 2H_2S\,(g)$$

At 550°C the rate constant for this reaction is 1.1 Lmol^{-1}sec and at 625°C the rate constant is 6.4 Lmol^{-1}sec. Calculate activation energy for this reaction.

(c) Show that pH + pOH = 14. Calculate the H^+ and OH^- ion concentrations of the rain water having pH of 4.82. **(10)**

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3. (a) Draw a well-labelled phase diagram of sulphur system and discuss its salient features. **(15)**

(b) For one component system, the triple point is an invariant point. Discuss. **(10)**

(c) Define Congruent Melting Point. Why is it nonvariant for two component system? **(10)**

4. (a) Justify that Enthalpy is a state function. **(15)**

When 23.6 g of calcium chloride, $CaCl_2$, was dissolved in water in a calorimeter, the temperature rose from 25.0°C to 38.7°C. If the heat capacity of the solution and the calorimeter is 1258 J/°C, what is the enthalpy change when 1.20 mol of calcium chloride dissolves in water? The solution process is $CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^-(aq)$

(b) What is meant by the reference form of an element? What is the standard enthalpy of formation of an element in its reference form? **(10)**

(c) Calculate the standard enthalpy of formation of acetylene (C_2H_2) from its elements:

$2C(\text{graphite}) + H_2(g) \rightarrow C_2H_2(g)$ **(10)**

The equations for each step and the corresponding enthalpy changes are

(i) $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H^\circ_{rxn} = -393.5$ kJ/mol

(ii) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\quad \Delta H^\circ_{rxn} = -285.8$ kJ/mol

(iii) $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l)$ $\quad \Delta H^\circ_{rxn} = -2598.8$ kJ/mol

SECTION – B

There are **FOUR** questions in this section. Answer to **Question No. 5 is compulsory.**

Answer any TWO questions from Questions 6-8.

5. (a) Which defects of Bohr's atomic model led to the development of quantum theory? **(5)**

(b) Briefly describe Einstein's explanation of photoelectric effect. **(10)**

(c) For B^{4+} ion calculate (i) the binding energy of an electron to the ground state and the second excited state (ii) the energy difference between these two states, and (iii) the wavelength of the light emitted during the transition of an electron from the second excited state to the ground state. **(10)**

$$\left[E_n = -Z^2 R_H / n^2 ; R_H = 2.1799 \times 10^{-18} J ; h = 6.626 \times 10^{-34} Js \right]$$

(d) Molecular O_2 is not formed through double bonding, rather it's a biradical. Justify this according to molecular orbital theory. **(10)**

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6. (a) What are the assumptions to derive Schrödinger's quantum wave equation? Proof that the wave equation of a vibrating string ($\Psi = A\sin\frac{2\pi x}{\lambda}$) could be a solution of time independent Schrödinger's equation. **(15)**

(b) Define Shielding effect and Effective Nuclear charge. Draw the radial probability distribution for a 2s orbital and a 2p orbital (label the axes and indicate any nodes with an arrow). Would a 2s electron feel more or less shielding than a 2p electron? Briefly explain your answer. **(10)**

(c) What would be the extent of ionization energy, electron affinity and electronegativity of the second rightmost element of the second period ($1s^2 2s^2 2p^5$) of the Periodic table? Explain your answer. **(10)**

7. (a) Write down the Lewis structure (draw resonance forms if applicable) and predict the molecular geometry according to VSEPR model of the followings: **(15)**

N_2O, SCN^-, NO, ClF_3, HPO_4^{2-}

(b) Show and explain the bond formation of CO using molecular orbital theory **(10)**

(c) During the molecular orbitals diagram, the pi-bonds come before sigma for B_2, C_2, and N_2. For O_2, F_2 and Ne_2, the sigma bond comes first, then the pi-bonds. Why does this happen? **(10)**

8. (a) The relationship between reaction quotient and equilibrium constant governs the direction of the equilibrium of a reversible reaction, explain this in terms of Gibb's free energy. **(10)**

(b) Write the equilibrium-constant expression for K_c for each of the following reactions: **(8)**

i. $CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(l)$
ii. $SnO_2(s) + 2CO(g) \rightleftharpoons Sn(s) + 2CO_2(g)$
iii. $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$
iv. $CO_2(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$

(c) Each of the following mixtures was placed in a closed container and allowed to stand. (i) $CaCO_3$, (ii) CaO and CO_2 at a pressure greater than the value of K_p, (iii) $CaCO_3$ and CO_2 at a pressure greater than the value of K_p, (iv) $CaCO_3$ and CaO; Which is capable of attaining the equilibrium $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ **(10)**

(d) H_2 and I_2 react according to the equation **(7)**

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Suppose 1.00 mol of H_2 and 2.00 mol of I_2 are placed in a 1.00 litre vessel. How many moles of substances are in the gaseous mixture when it comes to equilibrium at 458°C? The equilibrium constant K_c at this temperature is 49.7.

Course outcomes of Chem 117

	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**
CO-1	Identify fundamental concepts of atomic structure, chemical bonding, and periodic properties according to quantum theory	1	C1
CO-2	Illustrate the basic principles associated with properties of atom/molecule, solution, chemical equilibria, chemical kinetics, phase diagram and electrochemistry	1	C2
CO-3	Solve problems associated with physical and chemical changes	2	C3
CO-4	Analyze the behavior of materials and chemical systems with the principles of chemistry	3	C4

L-1/T-1/NAME Date: ~~04/05/2024~~ 19/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **MATH 181** (Differential Calculus and Integral Calculus)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Let $f(x)=\begin{cases} x\sin\left(\frac{1}{x}\right), & x\neq 0 \\ 0\ , & x=0 \end{cases}$ **(11)**

(i) Show that f is continuous but not differentiable at $x = 0$.

(ii) Find $f'(x)$ for $x \neq 0$ and sketch $f(x)$ near $x = 0$.

(b) Suppose that the speed v (in *ft/s*) of a skydiver t seconds after leaping from a plane is given by $v = (1 - e^{-0.168t})$. **(11)**

(i) Sketch the graph of v versus t.

(ii) By evaluating an appropriate limit, show that the graph of v versus t has a horizontal asymptote $v = c$ for an appropriate constant c and also mention the physical significance of the constant c.

(c) State Leibnitz's theorem. If $y = (\sinh^{-1}x)^2$, show that **(13)**

$(1+x^2)y_{n+2}+(2n+1)xy_{n+1}+n^2y_n=0$. Also find $y_n(0)$.

2. (a) Evaluate: $\lim_{x\to 0}\left[\frac{1}{x}-\frac{1}{\tan^{-1}x}\right]$ **(11)**

(b) Write down the Taylor's finite series with Lagrange's form of remainder. Expand $\frac{1}{1-x}$ in powers of x in a finite series with the form of Lagrange's remainder. **(12)**

(c) State Mean value theorem with its geometrical interpretation. Show that if $(0 < u < v)$, then $\frac{v-u}{1+v^2}<\tan^{-1}v-\tan^{-1}u<\frac{v-u}{1+u^2}$. Also show that $\frac{\pi}{4}+\frac{3}{25}<\tan^{-1}\left(\frac{4}{3}\right)<\frac{\pi}{4}+\frac{1}{6}$. **(12)**

3. (a) An offshore oil well located at a point W that is 5 km from the closest point A on a straight shoreline. Oil is to be piped from W to a shore point B that is 8 km from A by piping it on a straight line under water from W to some shore point P between A and B and then on to B via pipe along the shoreline. If the cost of laying pipe is \$1,000,000/*km* under water and \$500,000/*km* over land, where should the point P be located to minimize the cost of laying the pipe? **(12)**

(b) State Euler's theorem on homogeneous functions. Using Euler's theorem, if $u=\sin^{-1}\left[\frac{x+2y+3z}{\sqrt{x^8+y^8+z^8}}\right]$ then show that $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}+z\frac{\partial u}{\partial z}+3\tan u=0$. **(12)**

(c) Find the pedal equation of the curve $r^n = a^n \cos n\theta$. **(11)**

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MATH 181

4. (a) If the tangent at (x_1, y_1) to the curve $x^3 + y^3 = a^3$ meets the curve again at (x_2, y_2), then show that $\frac{x_2}{x_1} + \frac{y_2}{y_1} = -1$. **(11)**

(b) Find the curvature of $x = 4\cos t$, $y = 3\sin t$. At what point on this ellipse does the curvature have the greatest & the least values? What are the magnitudes? **(12)**

(c) Explain different types of asymptotes of a curve. Find the asymptotes of the curve $y^3 + x^2y + 2xy^2 - y + 1 = 0$. **(12)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define an antiderivative and evaluate the following integral: **(3+9)**

$$\int e^x \frac{2+\sin 2x}{1+\cos 2x}\,dx$$

(b) Use appropriate substitute to evaluate the integral: $\int \tan^4 2x \sec^3 2x\,dx$ **(11)**

(c) Sketch the graph and find the area of the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ by using antiderivative. **(12)**

6. (a) Derive a reduction formula for $I_{m,n} = \int \sin^m x \cos^n x \;\; dx$, and hence evaluate **(12)**

$\int \sin^3 x \cos^4 x\,dx$

(b) Suppose x* is the midpoint of each subinterval to find the area under the parabola $y = f(x) = 9 - x^2$ and over the interval [0, 3] with n = 10. **(11)**

(c) Evaluate: $\int_0^{\frac{\pi}{2}} \frac{\sin^2 x}{1+\cos x \sin x}\,dx$ **(12)**

7. (a) Define beta and gamma function. Prove that $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x\,dx = \frac{\Gamma\left(\frac{m+1}{2}\right)\Gamma\left(\frac{n+1}{2}\right)}{2\Gamma\left(\frac{m+n+2}{2}\right)}$ **(3+8)**

(b) Show that $\int_0^{\infty} \frac{x\,dx}{(1+x)(1+x^2)} = \frac{\pi}{4}$ **(12)**

(c) Verify: $\int_0^{\frac{\pi}{2}} \frac{dx}{\sqrt{1-\frac{1}{2}\sin^2 x}} = \frac{(\Gamma(1/4))^2}{4\sqrt{\pi}}$ by applying the hypothesis of beta and gamma function. **(12)**

8. (a) Define are length of a smooth curve and find the are length of the curve: **(3+8)**

$$x = e^t(\sin t + \cos t),\; y = e^t(\cos t - \sin t);\; (1 \le t \le 4)\ .$$

(b) Find the volume of the solid generated by revolution of the area $y = 2x - x^2$ about x-axis by disk method. **(12)**

(c) Find the area of the surface that is generated by revolving the portion of the curve $y = x^2$ between $x = 1$ and $x = 2$ about the y-axis. **(12)**