BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations January 2020

Sub: **PHY 113** (Structure of Matter, Electricity & Magnetism and Modern Physics)

Full Marks: 180   Time: 2 Hours

The figures in the margin indicate full marks. Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION-A

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

1. (a) Distinguish between crystalline and non-crystalline solids. You are given niobium and aluminum crystals. Discuss all possible differences of these crystals from crystallographic point of view.   **(15)**

    (b) What are the differences between monoclinic and tetragonal crystal systems? Draw the unit cells of their various space lattices and find out the number of atoms per unit cell in each space lattice of these crystal system.   **(15)**

2. (a) Draw a typical unit cell for *NaCl* Crystal. Describe its crystal structure. Write down the expression for lattice constant of *NaCl* in terms of ionic radii of *Na* and *Cl*. How many *NaCl* molecules are there in a unit cell of *NaCl* crystal.   **(15)**

    (b) Ionic radii of *Na* and *Cl* are 0.097 *nm* and 0.187 *nm*, respectively. How many molecules of *NaCl* are in a crystal of length 2.54 *cm*, width 1.27 *cm* and thickness 0.127 *µm*. Find out the packing factor of *NaCl* crystal. Is there any deviation from ideal FCC crystal structure? **(15)**

3. (a) Describe the term X-ray diffraction related to Crystallography? What information do you get from X-ray diffraction of a crystal? From this information how will you obtain lattice parameters of a cubic crystal?   **(20)**

    (b) Suppose you are given a solid whose crystal structure is face centered cubic. Discuss about it's coordination number. Why the study of coordination number is important?   **(10)**

4   (a) What is the importance of Lorentz transformations? If a frame is fixed and another one is moving with a constant velocity with respect to the previous one, then establish a connection of time coordinates between these two frames.   (22)

(b) Two observers, A on earth and B in a spacecraft whose speed is 2×10^8 m/s, both set their watches to the same time when the ship is abreast of the earth. How much time must elapse by A's reckoning before the watches differ by 1 s?   (8)

SECTION-B

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

5.   (a) Write down the three important results of photoelectric effect. Discuss in detail why the wave theory of light cannot explain these results. How quantum theory of light was applied to explain the results of photoelectric effect?   (22)

(b) The distance between adjacent atomic planes in calcite is 0.3 nm. What is the smallest angle between these planes and an incident beam of 30-pm X-rays at which scattered X-rays can be detected?   (8)

6.   (a) Give a qualitative figure of how binding energy of nuclei depends on the mass number. Explain the dependence of binding energy per nucleon on mass number.   (22)

(b) The binding energy of $^{20}_{10}Ne$ is 160.64 MeV. Find its atomic mass.   (8)

7. (a) What is meant by electric flux? Find the Gauss's law for dielectrics, and an expression for electric polarization.   (15)

(b) A spherical cavity of radius 4.0 cm is placed in a piece of metal. A point charge of $2 \times 10^-$ ^{6} °C is there at the center of the cavity. Use the Gauss's law to find the electric field at a point half way from the center to the surface of the cavity. What will be the electric field at a point inside the metal?   (15)

8. (a) A point charge q is moving with a velocity $\vec{v}$ in an external magnetic field. What is the side way magnetic force? If $\vec{v}$ and $\vec{B}$ make an angle 60°, what will be the work done by the force? Show that the magnetic force on a conducting wire of length l carrying a current i is

$$\vec{F} = i\vec{l} \times \vec{B}.$$

(15)

(b) What is dielectric constant? A parallel plate capacitor is filled with three different dielectrics each of thickness $d/3$, where d is the distance between two plates. Find the capacitance of the capacitor when dielectric constants of them are κ_1, κ_2, and κ_3. (15)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1 B.Sc Engineering Examinations January 2020
Subject: **Chem 117** (Chemistry I)
Full Marks: 180   Time: 2 hours
Figures in the margin indicate full marks.
USE SEPARATE SCRIPTS FOR EACH SECTION and upload in the LMS system
separately
Symbols used here bear usual meaning. Assume reasonable values for any missing data.

SECTION - A
.(There are **FOUR** questions in the section. Answer any **THREE**)

1. (a) Suggest an experiment to differentiate a solution from suspension.   5+15
   Propose a mechanism for the dissolution of a strong electrolyte in water.   = **20**
   (b) What is meant by inverted solubility? Illustrate with example.   5+5
   Based on a solubility curve, suggest a technique to obtain pure KNO_3 from a   = **10**
   mixture of KNO_3 and NaCl solution.

2. (a) Consider the following equilibrium system: HA (aq) + H_2O (l) $\leftrightarrows$ H_3O^+ (aq)   5+15
   + A^- (aq) and explain how the equilibrium position governs the power of acidity   = **20**
   of the system.
   Calculate the pH of a 1.0 M HF (K_a = 7.2 x 10^{-4}), a weak acid.
   (b) State the equilibrium expression for the auto-ionization of H_2O system at 25   5+5
   °C and calculate stepwise the values of pH, pOH and K_w of the system.   = **10**
   If at 60 °C, the value of K_w is 1×10^{-13}, find the value of pOH and comment on
   your result (pH, pOH and K_w have the usual meanings).

3. (a) State and explain the phase rule for a condensed system. What shall be the   8+12
   number of phases when water exists at its triple point?   = **20**
   Sketch and discuss the cooling curves for a pure liquid and a mixture of solids
   solution.
   (b) What is the driving force behind osmosis?   3+7
   Design and describe an artificial kidney machine to purify blood based on   = **10**
   osmosis phenomenon.

4. (a) Compare the boiling point (bp)s of solvent and solution using vapour pressure   5+15
   vs temperature curve and predict the elevation of bp.   = **20**
   Establish a relation between molal elevation constant and elevation of bp and
   thus suggest how the molecular weight of a solute can be obtained.
   (b) The half-reaction at an electrode is: Mg^{2+} (molten) + $2e^-$ → Mg (s). Calculate   10
   the number of grams of Mg that can be produced by supplying 1.00 F to the
   electrode.

Section - B

(There are **FOUR** questions in the section. Answer any **THREE**)

5. a) Boiling point of *cis*-dichloroethylene is higher than that of *trans*-dicholoethylene. why?   6

   b) Why is O_2 paramagnetic? Explain with the help of Molecular Orbital Theory (MOT).   10

   c) In molecular orbitals diagram, the energy of $\pi 2p$ orbital is lower than that of $\sigma 2p$ for B_2, C_2, and N_2. For O_2, F_2, and Ne_2, the energy of $\sigma 2p$ orbital is lower than the $\pi 2p$. Why does this happen?   14

6. a) What is a radial distribution function? Draw this function for the 1s, 2s, 2p, 3s, 3p and 3d orbitals in a hydrogen atom.   9

   b) Calculate the wavelength (in nanometers) of a photon emitted by a hydrogen atom when its electron drops from the n = 5 state to the n = 3 state.   12

   c) Why does transition elements form colored compounds?   9

7. a) Calculate Z_{eff} for: i) a 4d electron of Ag (Z = 47), ii) 5p electron of Xe (Z=54), iii) 5d electron of Tungsten (Z = 74).   9

   b) Arrange the following atoms in order of decreasing radius: 5

   i) Cl, N, Ne   ii)   Na, Al, P, Cl, Mg

   c) In the periodic table, the element hydrogen is sometimes grouped with the alkali metals and sometimes with the halogens. Explain why hydrogen can resemble the Group 1A and the Group 7A elements.   6

   d) General trend in any period of the main group elements is an increase in electron affinities from left to right, except group IIA and VA elements, which have smaller electron affinities than the preceding element. Explain.   10

8. a) For the isolation of inert gas mixture from dry air: Nitrogen, oxygen, moisture and carbon dioxide of the air are removed by some reactions. Write down the reactions.   8

   b) Write a short note on the formation of non-stoichiometric compounds by transition elements.   10

   c) Group the following electron configurations in pairs that would represent similar chemical properties of their atoms: 12

   i) $1s^2 2s^2 2p^6 3s^2$, $1s^2 2s^2 2p^3$, $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$, $1s^2 2s^2$, $1s^2 2s^2 2p^6$, $1s^2 2s^2 2p^6 3s^2 3p3$

   ii) $1s^2 2s^2 2p^5$, $1s^2 2s^1$, $1s^2 2s^2 2p^6$, $1s^2 2s^2 2p^6 3s^2 3p^5$, $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$, $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1   B. Sc. Engineering Examinations 2019-2020
Sub: **MATH 181** (Differential Calculus and Integral Calculus)
Full Marks: 180   Time: 2 Hours
USE SEPARATE SCRIPTS FOR EACH SECTION
The figures in the margin indicate full marks.
Symbols used have their usual meaning.

SECTION-A

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

1.   (a)   Discuss the continuity and differentiability of $f(x)$ at $x = 0$ and $x = 1$,   (20)

where $f(x) = \begin{cases} x^2 + 1 & \text{when } x < 0 \\ x & \text{when } 0 \le x \le 1 \\ \dfrac{1}{x} & \text{when } 1 < x \end{cases}$

(b)   Evaluate: $\lim\limits_{x \to \infty} \left\{ x - \sqrt{(x-a)(x-b)} \right\}$ (10)

2.   (a)   If $y = \cos(m \sin^{-1} x)$ find the value of the following: (18)

$(1 - x^2) y_{n+2} - (2n+1) x y_{n+1} + m^2 y_n.$

(b)   Using Maclaurin's series find the first three terms of $y = \tan(m \tan^{-1} x)$.   (12)

3.   (a)   The three sides of a trapezium are equal, each being 6 cm long find the area of   (15)
trapezium when it is maximum.

(b)   If $u = \sin^{-1}\left\{ \dfrac{(x+y)}{(\sqrt{x} + \sqrt{y})} \right\}$ find the value of $x\dfrac{\partial u}{\partial x} + y\dfrac{\partial u}{\partial y}$.   (15)

4.   (a)   If $lx + my = 1$ is normal to the parabola $y^2 = 4ax$ then find the value of   (15)

$al^3 + 2alm^2.$

(b)   Find the radius of curvature at any point of the ellipse $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$ (15)

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

5.   Workout the following:

(a) $\int \dfrac{dx}{[1 + k(k+2)x^2]\sqrt{1-x^2}}$ (15)

where k = last digit in your student ID number and k = 10 when last digit is equal to zero in your student ID number.

(b) $\int e^x \left(\dfrac{1-x}{1+x^2} \right)^2 dx$ (15)

6.   (a) Prove that $\Gamma(m)\,\Gamma\left(m + \dfrac{1}{2}\right) = \dfrac{\sqrt{\pi}}{2^{2m-1}}\,\Gamma(2m)$ (15)

(b) Evaluate the improper integral $\displaystyle\int_{2}^{\infty} \dfrac{dx}{x^2 - 1}$ (15)

7.   Evaluate the following:

(a) $\displaystyle\int_{0}^{\pi} \ln(\sin x)\,dx$ (15)

(b) $\displaystyle\int_{0}^{1} \cot^{-1}\left(\sqrt{x}\right) dx$ (15)

8.   (a) Find the area of a loop of the curve $b^2(x^2 - y^2) = x^4$ (15)

(b) Find the volume of the solid formed by revolving the curve   (15)
$\dfrac{r}{2k} = \cos^2\left(\dfrac{\theta}{2}\right)$ about the initial line, where k = last digit in your student ID number and k = 10 when last digit is equal zero in your student ID number.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B.Sc. Engineering Examinations- January 2020

Sub: HUM 111 (English)

Full Marks: 120   Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 3 page(s) in this question paper.

SECTION – A

There are FOUR questions in this section. Answer Q.No.1 and any TWO from the rest.

1. Answer any one of the following: (20)

   (a) What does the author portray in the story 'The Garden Party'? Elucidate critically.

   (b) What is the reason of arguments between the banker and the young lawyer that led them to set the bet? Whom do you support and why?

2. (a) Explain with reference to the context any one of the following: (10)

   i) "You have lost your reason and taken the wrong path. You have taken lies for truth, and hideousness for beauty."

   ii) They were the greatest possible eyesore, and they had no right to be in that neighbourhood at all.

   (b) Answer any two of the following: (10)

   i) What is your notion about Mr. Loisel?

   ii) Why didn't the Sheridan family call off the garden party?

   iii) Does the banker have any self-awakening eventually? If so, how?

3. Write a dialogue between two students of your department regarding their experience of education online during covid-19 pandemic.   (20)

4. Write a precis of the following passage with a suitable title: (20)

An intellectual is one who is an enlightened person. He has to give light to others who are in need of it. In every society we find intellectuals such as philosophers, scientists, scholars, writers and critics; they, as enlightened men, have a great responsibility towards society. In a society all cannot be intellectuals. If a time comes when all are intellectuals, it would be a blessed time indeed. But at present, at any rate, all are not intellectuals and those who are intellectuals have the great responsibility of guiding others on to the right path. If today we have our civilization and culture, if we have order and security in life and if our life is better than that of our primitive ancestors it is because the intellectuals, from time to time have been guiding humanity on the path of felicity and amity. An intellectual should come out of his ivory tower and try to elevate others to his level. This is the theme of Tennyson's famous poem "The Palace of Art". An intellectual has the duty of seeing the truth and teaching it to others. An intellectual contemplates on the eternal laws of the universe to explore the truth. The perception of the truth is almost the same as the perception of beauty and the duty of an intellectual is to see this truth on beauty, and to reveal it to others.

SECTION – B

There are FOUR questions in this section. Answer Q.No.5 and any TWO from the rest.

5. Read the following passage carefully and answer all the questions that follow: (20)

Great books do not spring from something accidental in the great men who wrote them. They are the affluence of their very core, the expression of the life itself of the authors. And literature cannot be said to have served its true purpose, until it has been translated into the actual life of him who reads it. It does not succeed until it becomes the vehicles of the vitals. Progress is the

gradual result of the unending battle between human reason and human instinct; in which it forms slowly but surely wins. The most powerful engine in this battle is literature. It is the vast reservoir of true ideas and high emotions, and life is constituted of ideas and emotions. In a world deprived of literature, the intellectual and emotional activity of all but a few exceptionally gifted men would quickly sink and retract to a narrow circle. The broad, the noble, the generous, would tend to disappear for want of accessible storage. And life would be correspondingly degraded, because of the fallacious ideas and the pretty emotion would never feel the upward pull of the ideas and emotions of genius. Only by conceiving a society without literature can it be clearly realized that the function of literature is to raise the plain towards the top level of the peaks. Literature exists so that where one man has lived finely, ten thousand may afterwards live finely. It is a means of life, it concerns the living essence.

Questions:
  a) What, according to the writer, is the source of a great book?
  b) When does literature serve its true purpose?
  c) What happens in a world deprived of literature?
  d) 'Literature is a means of life'-Explain this idea.

6. Suppose you have recently placed an order for some equipment for your   (20)
organization. But after the delivery, the equipment are found to be defective.
Now write a letter of complaint to the supplier for the replacement of those
products. (Provide necessary details of your own.)

7. Write an essay on any one of the following: (20)
a) A Winter Morning: A Moment of Scenic Beauty
b) Youth of Today, Leader of Tomorrow.

8. Describe in brief the functions of different components of a formal report.   (20)