BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2016-2017

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

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) Derive Lorentz transformation equations. Show that the Galilean transformation is a special case of Lorentz transformation. **(17)**

   (b) Find the acceleration of a particle of mass m and velocity v when it is acted upon by the constant force F, where F is parallel to v and hence show that the particle can never reach the speed of light. **(10)**

   (c) A spaceship moving away from the earth at a speed of 0.80c fires a missile parallel to its direction of motion. The missile moves at a speed of 0.60c relative to the ship. What is the speed of the missile as measured by an observer on the earth?

2. (a) Find the relation between energy and momentum of a particle with rest mass m_0. **(8)**

   (b) An energetic photon strikes an electron at rest in the laboratory coordinate system. Obtain the expression for the Compton wave-length shift. When the Compton wave-length shift becomes maximum and minimum? **(19)**

   (c) A photon of wavelength 0.40 nm strikes an electron at rest and rebounds at an angle of 150° to its original direction. Find the speed and wavelength of the photon after the collision. **(8)**

3. (a) Describe the nature of the nuclear force. **(8)**

   (b) Show that the density of nuclear matter is independent of mass number. **(8)**

   (c) What is mean life of a radioactive element? Obtain an expression for the mean life of a radioactive substance. **(11)**

   (d) The radius of $^{238}_{92}U$ is 7.4 Fermi. Deduce the radius of $^{16}_{8}O$. **(8)**

4. (a) Define current density and establish the relation between drift velocity of an electron and current density. **(6)**

   (b) State and explain the Biot-Savart law. Under what condition the Biot-Savart law becomes more applicable than Ampere's law? **(6)**

   (c) Applying the Biot-Savart law find out $\bar{B}$ due to a current 'i' in a long straight wire at a point outside the wire. **(17)**

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Contd ... Q. No. 4

(d) A wire of length 0.800 m carrying a current of 2.75A, placed perpendicularly to a uniform magnetic field, experiences a force of 2.85 N, what is the magnitude of the magnetic field where the wire is located? **(6)**

SECTION – B

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

5. (a) What do you mean by the flux of an electric field? **(4)**

(b) State and explain Gauss's law in electrostatics. What is a Gaussian surface? Give its importance. **(8)**

(c) Derive an expression for the electric field intensity due to an infinitely long straight wire of linear charge density, λ. **(15)**

(d) A conducting sphere of radius 0.10 m has an unknown charge. If the electric field 0.20 m from the centre of the sphere is 1.5×10^3 NC^{-1} and points radially inward, calculate (i) the net amount of charge on the sphere and (ii) the electric flux. **(8)**

6. (a) What are dielectrics? Distinguish between polar and non-polar dielectrics. Give examples. **(6)**

(b) Define capacitance of a capacitor. Show that the capacitance C of a parallel plate capacitor with a compound dielectric is **(20)**

$$C = \frac{K\varepsilon_0 A}{t + K(d - t)}$$

where K is the dielectric constant of the slab, ε_0 is the permittivity of air, t is the thickness of the slab, d is the separation between the plates, and A is the area of each plate.

(c) A parallel-plate capacitor has a capacitance of 100 pF, a plate area of 100 cm^2, and a mica dielectric, K = 5.4. At 50 V potential difference, calculate (i) the free charge on the plates (ii) E in the mica, and (iii) the induced surface charge. **(9)**

7. (a) Derive the Bragg's law for X-ray diffraction. **(15)**

(b) Discuss briefly the powder X-ray diffraction technique for a crystal structure analysis. Write down the advantages of X-ray diffraction technique for crystallographic measurements. **(14)**

(c) Find out the wavelengths of the diffracted beam, when a beam of X-rays having wavelengths in the range 0.23 Å to 1.00 Å are incident at an angle of 10° with the face of a cubic crystal. Consider the interplanar spacing d = 2.82 Å. **(6)**

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8. (a) Describe Sodium Chloride (NaCl) structure with necessary diagram. How does it differ from a standard face centered cubic structure? Calculate the packing factor of NaCl structure considering the ionic radii of Na^+ and Cl^- ions as 0.097 nm and 0.181 nm, respectively. **(15)**

(b) Distinguish between metal semiconductor and insulator in the light of band theory of solid. Why resistivity of metal increases with the increase of temperature? **(12)**

(c) Discuss Van Der Waals' bond in solid. Show that Van Der Waals' force of attraction between a polar and non-polar molecule is proportional to r^{-7}, where r is the intermolecular distance. **(8)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1   B. Sc. Engineering Examinations 2016-2017
Sub : **HUM 111** (English)

Full Marks : 140   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 Q. No. 1 and any other **TWO** from the rest.

1. Read the following passage carefully and answer the questions that follow: **(30)**

Of all the amusements which can possibly be imagined for a hard working man, after his daily tails, there is nothing like reading an entertaining book. It calls for not bodily exertion of which he had enough. It relives his home of its dullness. It transports to a lovelier and more interesting scene; and while he enjoys himself there, he may forget the evils of the present moment. May it accompanies him to his day's work and if the book he has been reading be anything above the very idlest and lightest gives him something to think of, besides the drudgery of his everyday occupation. If I were to pray for a taste which should stand me instead under every variety of circumstances and be a source of happiness and cheerfulness through life, it would be taste for reading. Give me a man this taste and the means of gratifying it, and you can hardly fail of making a happy man, unless indeed, you put into his hands most perverse selection of books. You place him in contact with the best society in every period of history, with the wisest, With the wittiest, the tenderest, the bravest and the purest characters which have adorned humanity. You make him a citizen of all nations, contemporary of all ages.

Questions:

(i) Why is the taste for reading a great source of amusement?

(ii) How is the reading of light literature a light recreation?

(iii) What benefits can be derived by studying good books?

(iv) What is the writer's belief about reading books?

(v) How do you feel about the writer's opinion?

(vi) Write down the meanings of the following words as used in the passage:

Exertion, drudgery, adorn, perverse, contemporary.

2. (a) Suppose you are the Assistant Engineer of a company. Draft a suitable complaint letter about having received defective goods from your suppliers. (Provide other details from your own).   **(10)**

(b) Give phonetic transcriptions of the following words: (Any five)   **(10)**

Basic, abstract, cottage, think, finger, pleasure.

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3. (a) Write a dialogue between two friends about the future prospect of Marine Engineers in our country.   **(10)**

   (b) Write a short essay on any <u>ONE</u> of the following topics: **(10)**

       (i) Dilemma of a Modern Man

       (ii) Global Peace: A Need of the Time

       (iii) Internet : A Gateway to knowledge

4. (a) Transform the following sentences as directed: (Any five).   **(10)**

       (i) The child went to her mother dancing. (Make it compound)

       (ii) Be just and fear not. (Complex)

       (iii) Sujana kept her promises, (Compound)

       (iv) Sumona was ill, so I went to the market without her. (Simple)

       (v) He may have received the letter but forgotten to reply. (Simple)

       (vi) To source a good grade he studied throughout the year (Complex)

   (b) Write short notes on any <u>TWO</u> of the following: **(10)**

       (i) Barriers to communication

       (ii) The Diphthongs

       (iii) Parts of a formal report

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** questions including Q. No. 5 as compulsory.

5. (a) Explain with reference to the context any one of the following: **(8)**

       (i) "True, the were far too near. They were the greatest possible eyesore, and they had no right to be in that neighborhood at all".

       (ii) "By the terms of the agreement the only relations he could have with the outer world were by a little window mare purposely for that object."

   (b) Answer any one of the following: **(10)**

       (i) The ten years of hard work changed Matilda's spoiled nature and made her a better person. Do you agree? Why?

       (ii) Describe an important experienced of Laura and show how it affected her character.

   (c) Answer any three of the following: **(12)**

       (i) Do the characters in "The Garden Party" really learn anything from their encounters with others?

       (ii) What kind of life does Matilda want?

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Contd ... Q. No. 5(c)

    (ii) Is the lawyer right in thinking that "the death sentence and the life sentence are equally immoral"? Give reasons for your answer.

    (iv) Why was Matilda so happy at the party?

6. Recast and correct any ten of the following sentence: **(20)**

    (i) We discussed about the matter.

    (ii) Please convey my best wishes back to your parents.

    (iii) The nine children were conversing excitedly with each other.

    (iv) We had two thirds of a cake.

    (v) He feels badly about his son's injury.

    (vi) The juice tastes sourish.

    (vii) There is no place in the bench.

    (viii) Keep off of the glass.

    (ix) One should do his duty to succeed in life.

    (x) I was disinterested in the story.

    (xi) The car's hood is protected.

    (xii) He is here now, and I will not speak to him.

7. (a) Give meanings of any ten of the following words: **(10)**

adroit, arch, chasm, depict, equitably, flicker, grudge, identical, munch, shrug, obstinate, palatable.

(b) Make sentences with any ten of the following words: **(10)**

assuage, bewilder, concurrence, discern, eulogy, feeble, moron, pauper, posterity, relapse, retort, vanity.

8. Write a précis of the following passage: **(20)**

A great location, honest government and lot of foreign trade helped transform the tiny state of Singapore into a regional powerhouse. When it started life as an independent, separate country in 1965, Singapore's prospects did not look good. Tiny and underdeveloped, it had no natural resources and a population of relatively recent immigrants with little shared history. The country's first prime minister, the late Lee Kuan Yew, Is credited with transforming it. He called one volume of his memoirs, "From third World to First". First, its strategic location and natural harbor helped. It is at the mouth of the Malacca Strait, through which perhaps 40% of world maritime trade passes. It was an important trading post in the 14th century, and again from the 19th, when British diplomat Sir Stamford Raffles founded the modern city. Now it is at the heart of one of the world's most dynamic regions.

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Contd ... Q. No. 8

Under Mr Lee, Singapore made the most of these advantages. Second, under Mr Lee Singapore welcomed foreign trade and investment. Multinationals found Singapore a natural hub and were encouraged to expand and prosper. Third, the government was kept small, efficient and honest-qualities absent in most of Singapore's neighbors. It regularly tops surveys for the ease of doing business. But the island city is not ideal. Although clean and orderly, it has harsh judicial punishments, a tame press and illiberal social policies. Mr. Lee saw his authoritarian style of government as an essential ingredient in Singapore's success, emphasizing the island's vulnerability in a potentially hostile neighborhood. But younger people now question whether Singapore really is that fragile, and dislike the restrictions on their freedom.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1   B. Sc. Engineering Examinations 2016-2017
Sub : **MATH 181** (Differential Calculus and Integral Calculus)
Full Marks : 210   Time : 3 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) Let, $f(x) = \begin{cases} 1+x, & x \leq 0 \\ x, & 0 < x < 1 \\ 2-x, & 1 \leq x \leq 2 \\ 2x - x^2, & x > 2 \end{cases}$,

Show that $f(x)$ is continuous at $x = 1$ and $x = 2$ but $f'(x)$ does not exist at these points.   **(15)**

(b) Evaluate: $\lim\limits_{x \to 0}(\coth x)^{\sinh x}$ **(10)**

(c) If $y = \dfrac{x^2}{(x-1)^2(x+2)}$, then find y_n.   **(10)**

2. (a) If v be a function of x and y, prove that $\dfrac{\partial^2 v}{\partial x^2} + \dfrac{\partial^2 v}{\partial y^2} = \dfrac{\partial^2 v}{\partial r^2} + \dfrac{1}{r}\dfrac{\partial v}{\partial r} + \dfrac{1}{r^2}\dfrac{\partial^2 v}{\partial \theta^2}$

where $x = r\cos\theta, y = r\sin\theta$.   **(15)**

(b) If $y = \dfrac{1}{2}\left(\tan^{-1}x\right)^2$, then prove that $y_{n+2}(0) + 2n^2 y_n(0) + n(n-1)^2(n-2)y_{n-2}(0) = 0$ **(10)**

(c) Prove that the curve $\dfrac{x^2}{a} + \dfrac{y^2}{b} = 1$ and $\dfrac{x^2}{a'} + \dfrac{y^2}{b'} = 1$ cuts orthogonally if $a - b = a' - b'$.   **(10)**

3. (a) An open box is to be made from a 16-inch by 30-inch piece of card board by cutting out squares of equal size from the four corners and bending up the sides. What size should the square be to obtain a box with the largest volume?   **(15)**

(b) Verify Mean-value theorem for the function $f(x) = 3 + 2x - x^2$ in the interval (0, 1).   **(10)**

(c) Find the area of the triangle formed by the axes and the tangents to the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$.   **(10)**

4. (a) Find all the asymptotes of the curve $x^3 + 2x^2 y - xy^2 - 2y^3 + 4y^2 + 2xy + y - 1 = 0$ **(15)**

(b) Find the radius of curvature at (r, θ) on the curve $r^n = a^n \cos n\theta$.   **(10)**

(c) If $u = \sin^{-1}\left[\dfrac{x+y+z}{x^2+y^2+z^2}\right]$, then prove that $x\dfrac{\partial u}{\partial x} + y\dfrac{\partial u}{\partial y} + z\dfrac{\partial u}{\partial z} = -\tan u$.   **(10)**

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SECTION – B

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

5. Compute the following: **(12+11+12)**

   (a) $\int \dfrac{dx}{x^4(2+3x)^3}$

   (b) $\int \dfrac{dx}{(1+x)\sqrt{1+x+x^2}}$

   (c) $\int e^{4x} \cos(3x+5)dx$

6. (a) Obtain a reduction formula for $In = \int\left(\sin^{-1}x\right)^n dx$ and hence find $\int\left(\sin^{-1}x\right)^3 dx$ **(12)**

   (b) Evaluate: $\displaystyle\int_0^{\frac{\pi}{2}} \dfrac{\sin x \cos x}{a^2 \sin^2 x + b^2 \cos^2 x} dx$ **(11)**

   (c) Evaluate: $\displaystyle\lim_{n\to\infty}\left[\dfrac{n^{\frac{1}{2}}}{n^{\frac{3}{2}}} + \dfrac{n^{\frac{1}{2}}}{(n+4)^{\frac{3}{2}}} + \dfrac{n^{\frac{1}{2}}}{(n+8)^{\frac{3}{2}}} + \cdots + \dfrac{n^{\frac{1}{2}}}{\{n+4(n-1)\}^{\frac{3}{2}}}\right]$ **(12)**

7. (a) Evaluate: $\displaystyle\int_0^{\pi} \dfrac{x\tan x}{\sec x + \tan x} dx$ **(12)**

   (b) Prove that

   (i) $\displaystyle\int_0^{\frac{\pi}{2}} \log \sin x\, dx = -\dfrac{\pi}{2}\log 2$. **(12)**

   (ii) $\Gamma\left(\dfrac{1}{2}\right) = \sqrt{\pi}$ **(11)**

8. (a) Find the common area between the circles $x^2 + y^2 = 4$ and $x^2 + y^2 = 4x$. **(12)**

   (b) Determine the perimeter of the loop of the curve $3ay^2 = x^2(x-a)$. **(11)**

   (c) Find the volume of the solid of revolution of the lemniscate $r^2 = a^2 \cos 2\theta$ about the initial line. **(12)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B. Sc. Engineering Examinations 2016-2017

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 value for missing data, if any.

1. (a) A ship of 9,900 tonnes displacement has KM = 7.3 m, and KG = 6.4 m. She has yet to load two 50 tonnes lifts with her own gear and the first lift is to be placed on deck on the inshore side (KG 9 m and center of gravity 6 m out from the center line). When the derrick plumbs the quay its head is 15 m above the keel and 12 m out form the center line. Calculate the maximum list during the operation. **(25)**

   (b) A ship of 5,000 tonnes displacement has a rectangular tank 6 m long and 10 m wide. Calculate the virtual reduction in metacentric height if this tank is partly full of oil with relative density 0.8. **(10)**

2. (a) What is the difference between heel and list? **(5)**

   (b) A vessel of constant triangular cross-section has a depth of 12 m and a breadth at the deck of 15 m. Calculate the draught at which the vessel will become unstable if the center of gravity is 6.675 m above the keel. **(15)**

   (c) A vessel has displacement 22,600 tonnes, KG 8.2 m discharges 3000 tonnes of ballast from a mean KG of 2.0 m. She loads 400 tonnes of cargo at a mean KG of 7.8 m. A further parcel of 1200 tonnes of cargo remains to be loaded. Determine the mean KG at which to load this cargo so that the final GM is at least 0.5 m. **(15)**

3. (a) Write short notes on Bonjean curves. **(7)**

   (b) What is Lunching curves? List the important features of the lunching curves. **(13)**

   (c) With figure describe sideway lunching. **(6)**

   (d) Define lightweight, deadweight and displacement of a ship. **(9)**

4. (a) A ship of 6000 tonnes displacement is composed of masses of 300, 1200 and 2000 tonnes at distances 60, 35 and 11m aft of midships, and masses of 1000, 1000 and 500 tonnes at distances 15, 30 and 50 m forward of midships. Calculate the distance of the center of gravity of the ship from midships. **(15)**

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Contd ... Q. No. 4

(b) A containership has the following C_W values commencing at the base: 0.427, 0.504, 0.577, 0.647 and 0.715 aft the Summer Load Line (SLWL). These C_W values are spaced equidistant apart up to the draft moulded. Calculate the block-coefficient C_B when this containership is loaded up to her SLWL. **(20)**

SECTION – B

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

5. (a) Explain what you understand by downflooding angle. Describe the IMO intact stability criteria for a ship. **(12)**

(b) A mass of 6 tonne is moved transversely through a distance of 14 m on a ship of 4300 tonne displacement, when the deflection of an 11 m pendulum is found to be 120 mm. The transverse distance is 7.25 m above the keel. Determine the height of the center of gravity above the keel. **(10)**

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

6. (a) A ship of length 520 ft has a loaded displacement of 18230 tonnes and LCB 9.2 ft abaft amidships. At a waterline tangential to the margin line the areas of immersed sections are given below: **(25)**

Station	Area (ft^2)
A. P.	380
$\frac{1}{2}$	855
1	1240
$1\frac{1}{2}$	1615
2	1930
3	2290
4	2350
5	2320
6	2260
7	2240
8	1430
$8\frac{1}{2}$	1015
9	600
$9\frac{1}{2}$	245
F.P.	-

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

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Contd ... Q. No. 6

(b) A vessel of constant rectangular cross-section is 60 m long and 10 m wide. It floats at a level keel draft of 3 m and has a centre of gravity 2.5 m above the keel. Determine the fore and aft drafts if an empty, full-width, fore end compartment 8 m long is opened to the sea. **(10)**

7. (a) Why sub-division of a ship is necessary? Describe the effects of flooding of a ship. **(10)**

(b) A ship 150 m long has a displacement mass of 14000 tonne and its centre of buoyancy is 1 m forward of midships. When a forward compartment is flooded it sinks to a waterline which is tangential to the margin line. The areas of the immersed sections, up to the flooded waterline, at equally spaced intervals, are: **(15)**

Station	A.P.	1	2	3	4	5	6	7	8	9
Area of immersed section (m²)	0	42	96	138	157	178	192	205	188	117

Find the volume of lost buoyancy due to flooding and the distance of its centroid from the original centre of buoyancy. Also obtain a first approximation to the floodable length, assuming a permeability of 80%. **(20)**

8. (a) A box-shaped vessel 45 m × 10 m × 6 m is floating in salt water at a draft of 4 m forward and aft. GM = 0.6 m. Calculate the dynamic stability to 20 degrees heel. **(17)**

(b) A box-shaped vessel 40 m long, 8 m wide and 6 m deep, floats in salt water on an even keel at 3 m draft. GM = 1 m. Find the new GM if an empty compartment 4 m long and situated amidships is bilged. **(18)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1 B. Sc. Engineering Examinations 2016-2017
Sub : **CHEM 117** (Chemistry -I)
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) What is Fuel? Describe three fuel-oxidizer systems used in rockets. **(8)**

   (b) In writing thermochemical equation, why is it important to indicate the physical state of each substance? Explain with a suitable example. **(8)**

   (c) Justify that Internal energy is a state function but work is not. **(9)**

   (d) A quantity of 1.274 g of Naphthalene ($C_{10}H_8$) was burned in a constant –volume bomb colorimeter. Consequently, the temperature of the water rose from 21.49 °C to 26.52°C. If the heat capacity of the bomb plus water was 10.17 kJ/°C, calculate the molar heat of combustion of naphthalene. **(10)**

2. (a) The rate law for the decomposition of $N_2O_5(l)$ is: rate = $k[N_2O_5]$ where $k = 6.22 \times 10^{-4}$ sec^{-1}. Calculate half life of $N_2O_5(l)$ and the number of seconds it will take for an initial concentration of $N_2O_5(l)$ of 0.100 M to drop to 0.0100 M. **(10)**

   (b) Why high molecularity reactions are rare? **(6)**

   (c) Show that half life for a second order reaction is inversely proportional to rate constant. **(9)**

   (d) Derive the integrated Arrhenius equation of activation energy. How is the energy of activation determined from the plot? **(10)**

3. (a) Describe the distinguishing characteristics of a crystalline solid and amorphous solid. **(8)**

   (b) What properties of nematic liquid crystals are employed in LCD displays? **(8)**

   (c) Define coordination number. What is the coordination number of Cs^+ in CsCl, of Na^+ in NaCl, and Zn^{2+} in ZnS? **(9)**

   (d) Gold (atomic mass = 196.97 amu) 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. Calculate the number of gold atoms in a unit cell, assuming al atoms are at lattice points. What type of cubic lattice does gold have? **(10)**

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4. (a) Explain Triple point and Eutectic point with examples. **(8)**

   (b) Explain why the fusion curve of ice has a negative slope wheres the sublimation curve has position slope in the phase diagram. **(8)**

   (c) How do the phase diagrams of KI –H_2O and Pb –Ag systems differ from each other? **(12)**

   (d) For one component system, the triple point is invariant. Discuss. **(7)**

SECTION – B

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

5. (a) What new idea about light did Einstein use to explain the photoelectric effect? Why does the photoelectric effect exhibit a threshold frequency but not a time lag? **(8)**

   (b) Derive the equation $\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$ where the symbols represent their usual meaning. **(10)**

   (c) A radio wave has a frequency of 3.8×10^{10} Hz. What is the energy (in J) of one photon of this radiation? **(5)**

   (d) Why couldn't the Bohr model predict spectra for atoms other than hydrogen? **(7)**

   (e) Use the Rydberg equation to find the wavelength (in nm) of the photon emitted when an electron in a H atom undergoes a transition from n = 5 to n = 2. **(5)**

6. (a) What is penetration? How is it related to shielding? Use the penetration effect to explain the difference in relative orbital energies of 3 p and 3d electron in the same atom. **(12)**

   (b) State the exclusion principle. What does it imply about number and spin of electons in an atomic orbital? **(7)**

   (c) Write down the full electronic configuration with the following successive ionization energies (IE) (in kJ/mol) $IE_1 = 801$, $IE_2 = 2427$, $IE_3 = 3659$, $IE_4 = 25022$ and $IE_5 = 32822$ **(8)**

   (d) Explain the relationship between (i) IE and reducing strength in Group IA(1) and

   (ii) the relationship between IE and oxidizing strength in Group 7A(17) **(4)**

   (e) What is pseudo-noble gas configuration? Give examples. **(4)**

7. (a) Use a Born-Haber cycle for KF and calculate a value for the electron affinity of fluorine by using the following values. **(10)**

$K(s) \rightarrow K(g)$	$\Delta H° = 90$ kJ
$K(g) \rightarrow K^+(g) + e^-$	$\Delta H° = 419$ kJ
$F_2(g) \rightarrow 2F(g)$	$\Delta H° = 159$ kJ
$K(s) + \frac{1}{2} F_2(g) \rightarrow KF(s)$	$\Delta H° = -569$ kJ
$K^+(g) + F^-(g) \rightarrow KF(s)$	$\Delta H° = -821$ kJ

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(b) Draw a Lewis structure for each, and state the type of octet rule exception for the following (i) PF_6^- (ii) ClO_3^- and (iii) H_3PO_3(one P-H bond) **(9)**

(c) From the following resonance structures, calculate and select the lowest formal charge **(5)**
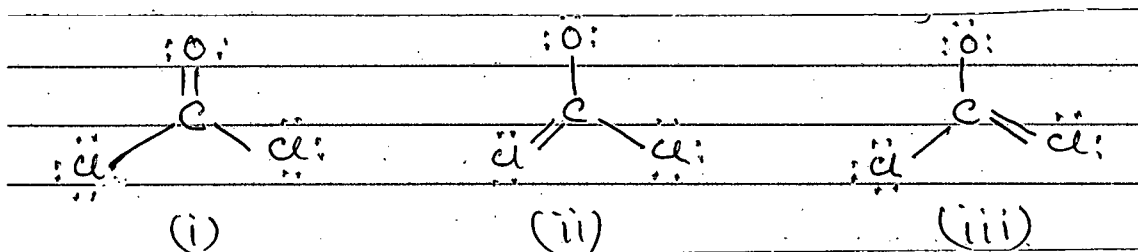
(d) Determine the shape around each central atom in each molecule, and explain any derivation from ideal bond angles: **(6)**

(i) H_3PO_4 (no H-P bond) and (ii) CH_3-O-Ch_2-CH_3

(e) A molecule of formula AX_3 is found experimentally to be polar. Which molecular shapes are possible and which are impossible for AX_3? **(5)**

8. (a) What is wave-particle duality of matter and energy? Explain. **(7)**

(b) Give the name, magnetic quantum numbers, and number of orbitals for each sub-level with following quantum numbers: **(8)**

(i) n = 3, l = 2, (ii) n = 2, l = 0, (iii) n = 5, l = 1 and (iv) n = 4, l = 3

(c) What factors are affecting the atomic orbital energies? Explain. **(10)**

(d) What type of central-atom orbital hybridization corresponds to each electron group arrangement: **(10)**

(i) Trigonal planar, (ii) Octahedral, (iii) Linear, (iv) Tetrahedral and (v) Trigonal bipyramidal.