L-1/T-1/WRE Date : 06/12/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **WRE 101** (Analytical Mechanics)

Full Marks : 280 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) In figure-1, CD is a rigid, weightless body and F = 150 N., the pegs are smooth, and the cable is also weightless and flexible. Determine the weight of A and B if the bodies are in equilibrium and CD remains horizontal. **(15)**

   (b) The derrick shown in figure-2 which supports a load of W = 2000 N. Find the tension in the boom cable and the compression in the boom when the angle θ is 30°. **(16⅔)**

   (c) A frame structure is shown in the figure-3, if Q = 100 N, θ = 30° and F = 200 N, find the forces in the members BC, CD and BD. **(15)**

2. (a) A truss is shown in the figure-4, if the load at C is 2000 N, find the reactions at A and F and also the forces in all the members of the truss. **(23⅔)**

   (b) A wedge **B** is inserted between a fixed surface **A** and a movable block **C** which weighs W_c = 5000 N as shown in the figure-5. For all slipping surfaces, let f = 1/3. If there is a horizontal resistance acting on C of R = 8000 N, what force Q will impose impending motion of C towards right? **(23)**

3. (a) What do you understand by Catenary? Derive the equation for maximum tension which the engineer needs to know in design. **(16⅔)**

   (b) At the point of support of a cable (catenary), the tension is 25% greater than the tension at the low point. The cable weighs 1 N per meter and the sag is 20 m. If the points of supports are on the same level, find the span. What is the length of the cable? **(15)**

   (c) Two fixed cylinder as shown in the figure-6, have radii r_A = 1 m and r_B = 2 m, and θ = 30°. The load W is increased until W = 130 N, when it is on the verge of moving downward. Find frictional coefficient, f. Assume both cylinder are of same material. **(15)**

4. (a) The figure-7 represents a boom that supports a load W = 1000 N. If AB = BC = BD = 6 m and BE = 8 m, find the tension in the cable and the forces in each timber. **(23)**

   (b) Two cables A and B terminates on a pole as shown in the figure-8 and exert forces in the horizontal plane at C. The guy cable CD makes an angle with the pole of 45° and the anchor at D is to be so located that the pole will have only a compressive load (that is, $\Sigma F_x = 0$ and $\Sigma F_y = 0$). Let θ = 30°, A = 5000 N, B = 8000 N and CE = 25 m. Find the value of angle α and the tension in the cable CD. **(23⅔)**

Contd P/2

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SECTION – B

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

5. (a) The equation of an ellipse is $x^2/25 + y^2/16 = 1$. Locate by integration the centroid of that part of the area of this ellipse which falls in the first quadrant. The linear unit is meter. **(18)**

(b) A stone is thrown downward from a 30 m high tower with an initial velocity of 6 m/s. **(16)**

(i) With what speed did it hit the ground?

(ii) What was the velocity when t = 2 sec?

(iii) What was the time of flight?

(iv) What initial speed would reduce the time of flight to 50% of that found in part (iii)?

(c) The acceleration of a particle moving with rectilinear motion is $a = 5t^{1/2}$. If the initial velocity is 2 m/s, what space is traversed in 16 sec? What is the space traversed during the last 4 sec of this 16 sec? **(12⅔)**

6. (a) In Figure 9, $W_A = 135$ N and $f_A = 1/3$. The speed of A changes from $V_{A_1} = 18$ m/s to $V_{A_2} = 3$ m/s during 25 sec. Determine (i) the weight W, (ii) the distance moved by W during 25 sec and (iii) the tension in the cable. **(16)**

(b) What is the least radius of gyration of the shaded area of Figure 10, for axes passing through point A? **(20)**

(c) Derive the expression for tangential and normal acceleration of a point moving in a curved path. **(10⅔)**

7. (a) A jet of water issues from a nozzle with a velocity of $V_{W_1} = 60$ m/s and at the absolute rate of 1 N/sec. It enters a fixed blade shaped as shown in Figure 11 where $\theta = 60°$ and it passes through the blade with a negligible frictional loss. **(18⅔)**

(i) What are the horizontal and vertical components of the force exerted upon the fixed blade?

(ii) When the blade starts to move with a speed $V_B = 25$ m/s toward the right, find the horizontal and vertical components of the force on the blade.

(b) For the composite body as shown in Figure 12, find the radius of gyration with respect to the geometric axis. Unit weight of the material of the composite body is 1500 kg/m^3. **(10)**

(c) In Figure 13, $W_A = 140$ N, $f_A = 0.15$, $f_B = 0.6$ and the guide C for the weightless cable is smooth. The bodies A and B are moving leftward with an initial speed of 6 m/s. After these bodies have moved 50 m, neither one changing its direction, their speed is 3 m/s. **(18)**

(i) What is the weight of the body B?

(ii) What are the tension in the cables AC and BC?

Contd P/3

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8. (a) Locate by integration the center of gravity of a slender wire bent into a parabolic curve whose equation is $y^2 = 4x$ and whose ends are defined by points (0, 0) and (4, 4). **(12⅔)**

(b) In Figure 14, the body A is a 20 N cylinder which is 0.5 m in diameter. It is being rolled up the incline where $\theta = 30°$ by a constant force Q = 15 N acting parallel to the incline. **(18)**

(i) What is the speed of its center of gravity after a displacement of 5 m from rest?

(ii) What is its angular acceleration?

(iii) What is the frictional force between the plane and the cylinder?

(iv) What coefficient of friction is necessary for rolling?

(c) For the composite area shown in Figure 15, find the moments of inertia I_x and I_y. The centroid of the semi-ellipse is at (1.7 cm, 0). **(16)**

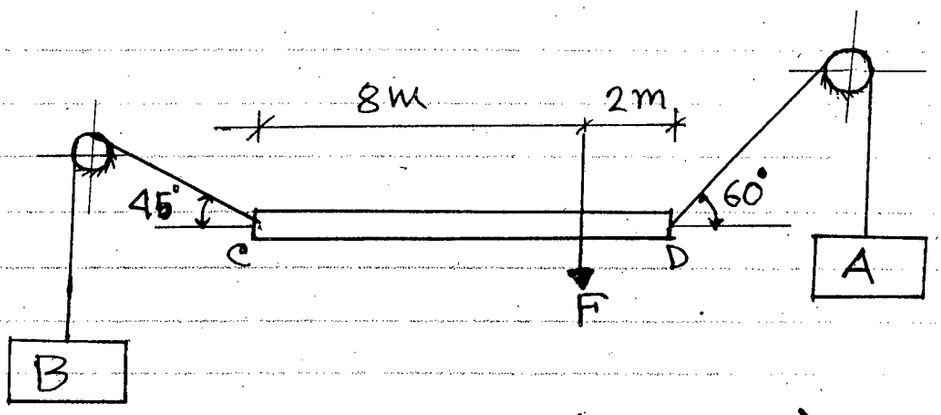

Figure-1 ~~(Prob 1(a))~~ for Q.1(a)

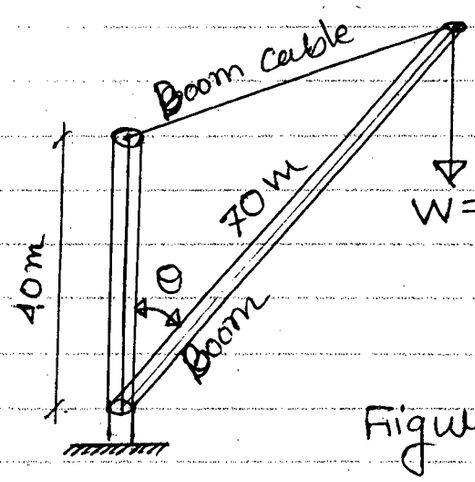

Figure-2 ~~(1(b))~~ for Q.1(b).

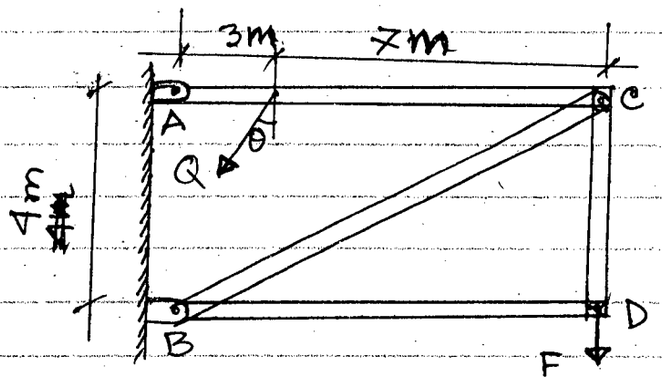

Figure-3 ~~(1(c))~~ for Q.1(c)

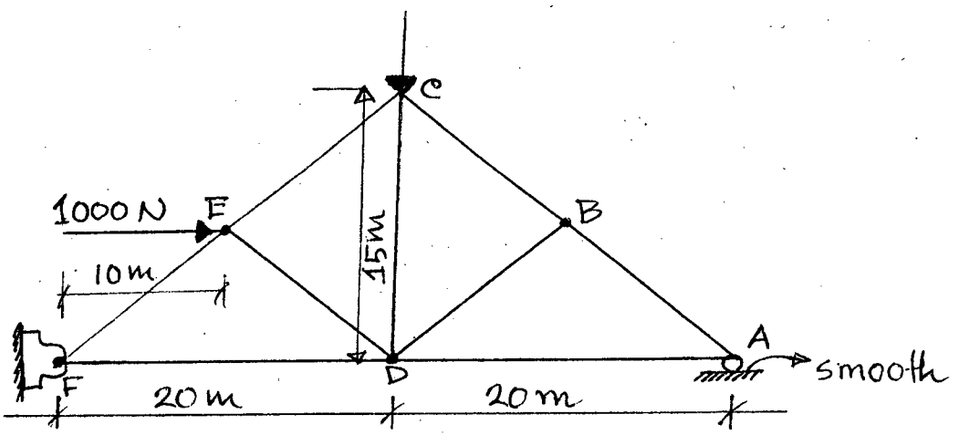

Figure-4 ~~(2(a))~~ for Q. 2(a)

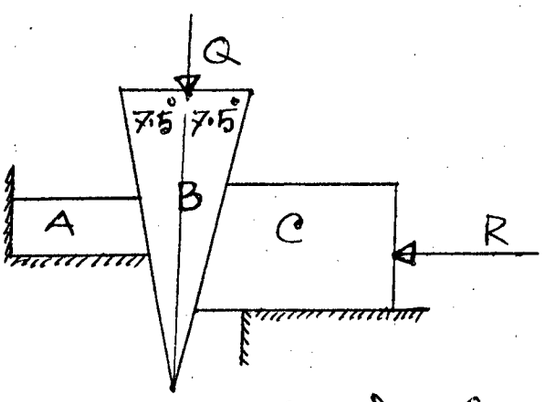

Figure-5 ~~(2(b))~~ for Q. 2(b)

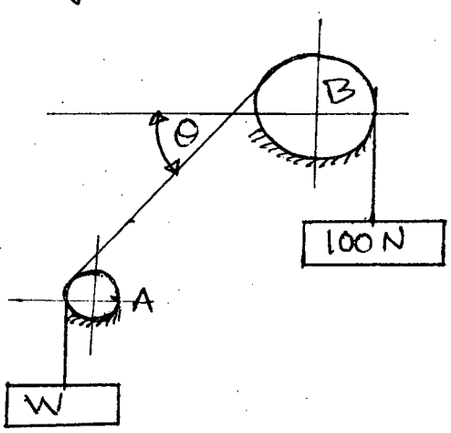

Figure-6 ~~(3(c))~~ for Q. 3(c)

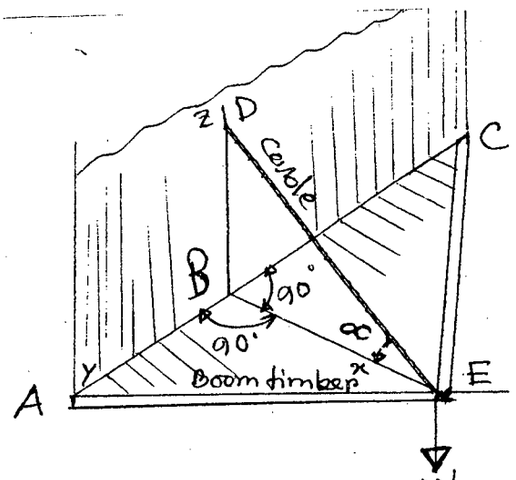

Figure-7 ~~(4(a))~~ for Q. 4(a)

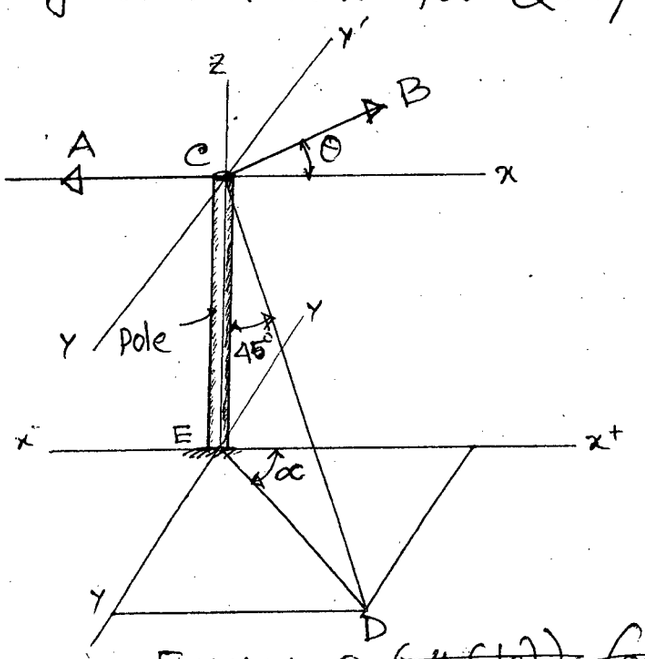

Figure-8 ~~(4(b))~~ for Q. 4(b)

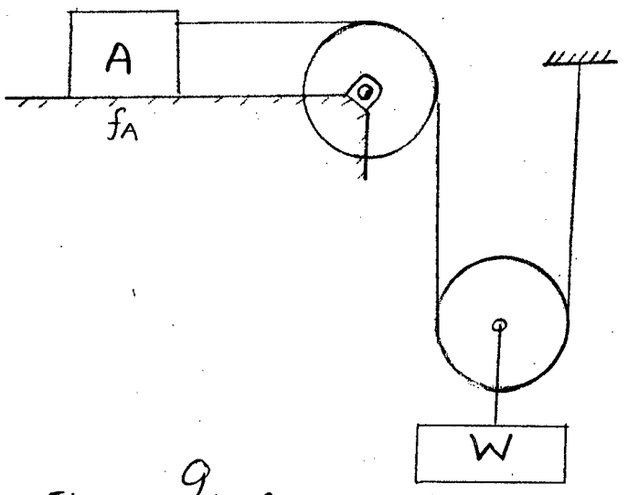

Figure ~~10~~ 9 for Q 6(a)

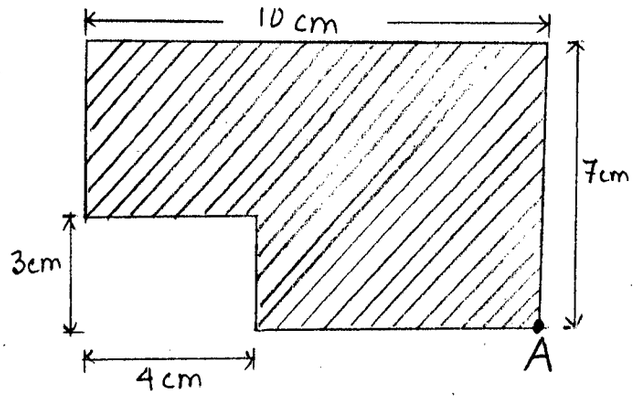

Figure 10 for Q 6(b)

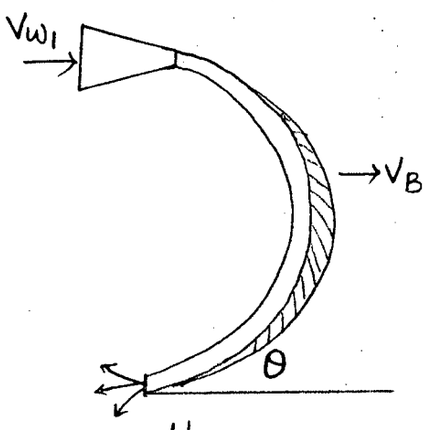

figure ~~12~~ 11 for Q 7(a)

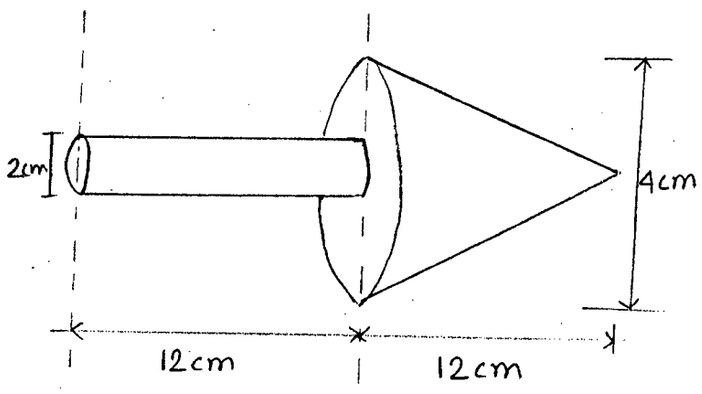

Figure ~~13~~ 12 for Q 7(b)

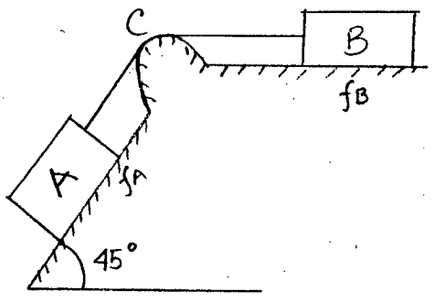

Figure ~~14~~ 13 for Q 7(c)

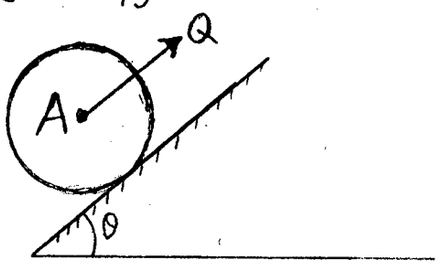

Figure ~~15~~ 14 for Q 8(b)

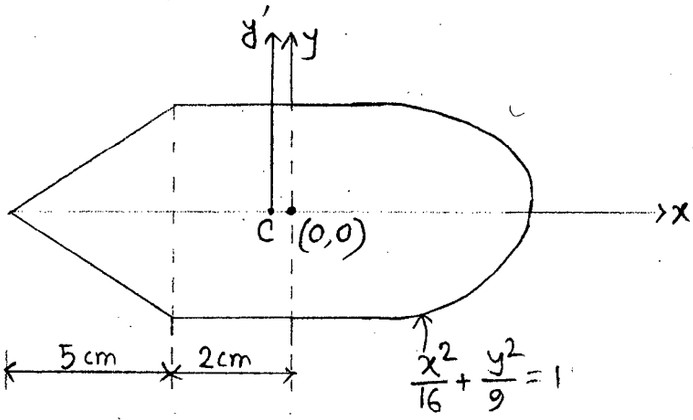

Figure ~~16~~ 15 for Q 8(c)

L-1/T-1/WRE Date : 11/12/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **MATH 131** (Differential 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**.

Symbols have their usual meaning.

1. (a) Sketch the graph of the function $f(x)=\begin{cases}(x+1)^2, & \text{if } x\le -1\\ \sqrt{1-x^2}, & \text{if } -1<x<1\\ x, & \text{if } x\ge 1\end{cases}$ **(25)**

and discuss continuity and differentiability of f(x) at x = –1 and x = 1.

(b) Test whether the limit $\lim_{x\to\frac{\pi}{2}}\frac{e^{\tan x}-1}{e^{\tan x}+1}$ exists. If possible find the value of the limit. **(10)**

2. (a) If $y = \sin(m \sin^{-1} x)$ then shown that $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2-m^2)y_n = 0$ and find the value of y_n at x = 0. **(20)**

(b) If a normal to the curve $x^{2/3} + y^{2/3} = a^{2/3}$ makes an angle ϕ with the axis of x, show that its equation is $y\cos\phi - x\sin\phi = a\cos 2\phi$. **(15)**

3. (a) State and prove Mean Theorem and verify it for the function $f(x) = 2x - x^2$ in the interval (0, 1). **(17)**

(b) If $u = \tan^{-1}\frac{x^3-y^3}{x+y}$; then show that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \sin 2u$ and evaluate $x^2u_{xx} + 2xyu_{xy} + y^2u_{yy}$. **(18)**

4. (a) Find the maximum and minimum values of $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 5$. Sketch the graph of f(x). **(13)**

(b) Find the radius of curvature at the point (r, θ) on the cardiode $r = a(1 - \cos\theta)$, and show that it varies as $\sqrt{r}$. **(10)**

(c) Find the asymptotes of the curve $x^3 + 3x^2y - 4y^3 - x + y + 3 = 0$. **(12)**

Contd P/2

MATH 131 (WRE)

SECTION – B

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

5. Work out the following integrals: **(10+12+13)**

(a) $\int \frac{dx}{x^{3/2}(a+bx)^{5/2}}$, (b) $\int \frac{dx}{2+3\cos x}$

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

6. (a) Find a reduction formula for $I_n = \int (\sin^{-1} x)^n \, dx$. **(10)**

(b) Evaluate: $\lim_{x \to \infty} \left[\left(1+\frac{1}{n^2}\right)\left(1+\frac{2^2}{n^2}\right)\left(1+\frac{3^2}{n^2}\right) \ldots\ldots\ldots\ldots \left(1+\frac{n^2}{n^2}\right)\right]^{1/n}$. **(12)**

(c) Evaluate: $\int_0^{\pi/4} \log(1+\tan\theta)\,d\theta$. **(13)**

7. Evaluate the following:

(a) (i) $\int_0^{\pi} x \sin^6 x \cos^4 x \, dx$ **(11)**

(ii) $\int_{-\infty}^{\infty} \frac{x^2\,dx}{x^4+x^2+1}$ **(12)**

(b) Establish a relation between gamma function and beta function. **(12)**

8. (a) Find the whole area of the curve $a^2y^2 = a^2x^2 - x^4$. **(12)**

(b) Find the volume of the solid formed by the revolution of the loop of the curve **(10)**

$$y^2 = x^2(a-x)$$

about x-axis.

(c) Evaluate the following: **(13)**

$$\int_{x=0}^{a} \int_{y=0}^{x} \int_{z=0}^{y} x^3 y^2 z \, dz\, dy\, dx$$

L-1/T-1/WRE **Date : 08/01/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **PHY 107** (Physical Optics, Waves and Oscillations and Thermodynamics)

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 do you understand by Coherent and incoherent sources? **(4)**

   (b) Explain analytically the interference of light on the basis of wave theory. **(16)**

   (c) Discuss Lloyd's single mirror experiment and conclude the phase change of light. **(10)**

   (d) Calculate the separation between coherent sources formed by a biprism whose inclined forces make an angle of 2° with base. The slit source is 10 cm away from the biprism and the refractive index of the material of biprism is 1.5. **(5)**

2. (a) Distinguish between Fresnel and Fraunhofer diffraction. **(6)**

   (b) Give an analytical treatment to obtain the intensity expression for Fraunhofer diffraction from a single slit and hence obtain the condition of secondary maxima. **(24)**

   (c) A parallel beam of light of wavelength 5×10^{-5} cm is incident normally on a narrow slit of width 0.2 mm. The Fraunhofer diffraction pattern is observed on a screen, which is placed at the focal plane of a convex lens of focal length 50 cm. Calculate the distance between first two minima. Assume that the lens is placed very close to the slit. **(5)**

3. (a) What do you mean by polarized and unpolarized light? **(5)**

   (b) Discuss with mechanisms how unpolarized light can be plane polarized by reflection and refraction. **(15)**

   (c) Write down and prove Brewster's law. **(10)**

   (d) A ray of light is incident at the polarizing angle on the surface of a glass plate of refractive index 1.55. Calculate the angle of refraction. **(5)**

4. (a) What are damped oscillations? Write down the differential equation of a damped oscillator. Solve it to obtain an expression for the displacement in the case of damped oscillatory motion. Discuss the effect of damping on the natural frequency of an oscillator. **(3+20+2=25)**

   (b) The initial displacement of a damped harmonic oscillator of mass 2 kg and damping constant 2.8 kg/s is 0.2 m. Find the time taken for the amplitude to be reduced to 5% of its initial value. Find the mean life time of the oscillation. **(10)**

Contd P/2

PHY 107 (WRE)

SECTION – B

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

5. (a) Define simple harmonic motion. Write down its differential equation. **(3+2=5)**

(b) Show that the total energy of a particle executing simple harmonic motion is $2\pi^2 ma^2n^2$, where the symbols have their usual meanings. **(20)**

(c) A simple harmonic oscillator can be described by the equation **(10)**

$$y = 5 \sin(\omega t + \pi/4) \text{ meter}$$

It has mass of 0.2 kg and a force constant 450 N/meter. (i) Find the total mechanical energy of the oscillator. (ii) Calculate the potential and kinetic energy when the displacement is 0.30 meter.

6. (a) What is reverberation and reverberation time? On what factors it depend? **(5)**

(b) What are nodes and antinodes? Analytically discuss the formation of stationary waves and hence show that two nodes or antinodes are separated from each other by a distance $\lambda/2$. **(22)**

(c) A string vibrates according to the equation **(8)**

$$y = 6 \cos\left(\frac{\pi}{4}\right) x \sin(20\pi) t,$$

where x and y are in centimeters and t is in second. (i) What is the amplitude and velocity of the component waves whose superposition can give rise this vibrations? (ii) What is the distance between consecutive nodes?

7. (a) What do you mean by degrees of freedom? State the law of equipartition of energy. Prove that $\frac{c_p}{c_v} = 1 + \frac{2}{n}$ for a perfect gas whose molecules have n degrees of freedom. Where the symbols have their usual meanings. **(13)**

(b) Obtain an expression for mean free path of a molecule in terms of its mass and diameter and density of the gas. Show that mean free path of a molecule is inversely proportional to pressure. **(12)**

(c) At 30°C find for oxygen (i) KE of translation per molecule (ii) total KE per molecule (iii) total KE per mole. Given that $N = 6.02 \times 10^{23}$ and $K = 1.37 \times 10^{-23}$ Jk^{-1}. **(10)**

8. (a) Describe Carnot cycle and calculate the work down in each operation of the cycle when the working substance is a perfect gas. **(17)**

(b) Prove that the efficiency of all reversible engines working between the same two temperatures must be the same. **(8)**

(c) The efficiency of a Carnot engines is 40% when the temperatures of the sink is 15°C. It is desired to inverse the efficiency to 60%. By how many degrees should the source temperature be increased or sink temperature be decreased? **(10)**

L-1/T-1/WRE Date : 13/01/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

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 any **THREE**, including **Q. No. 1** as compulsory.

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

(i) "oh! my poor Matilda! How your have changed __".

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

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

(i) What is your opinion about capital punishment? Discuss in light of the story 'The Bet'.

(ii) How does the story of 'Circe's Garden' deal with the concept of struggle between the good and the evil?

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

(i) Who is Eurylochus? What is his role in the story?

(ii) What realization has Mrs. Matilda Loisel had at the end of the story?

(iii) "I am indebted to you for the happiness of my life, let me help you! No, it is too much!" — who said this and why?

(iv) What is the moral of the story "Circe's Garden"?

(v) Why does Matilda want to attend the party?

2. Recast and correct any ten of the following sentences: **(20)**

(i) Haman will leave, providing that the weather is good.

(ii) Playing the drum and singing simultaneously are difficult.

(iii) Either Jamil nor Jaman is not going.

(iv) Irfan scored 90s in the last cricket match.

(v) Alvi does not like the idea in any way, shape, or form.

(vi) Children planned on outing, eating, and play.

(vii) Rima looked differently after her return from Canada.

(viii) Nafis is not as responsible as Hafiz.

(ix) If Alif was here now, he would show you how to play the piano.

(x) There is a few points to be added in this report.

(xi) The fish fry tasted badly.

(xii) The PS of the minister gave a fulsome account of the minutes.

Contd P/2

HUM 111 (WRE)

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

Abject, Bump, Cogent, Dent, Enervate, equivocal, Facile, Grouchy, Malign, Pact, Prior, Retard.

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

Accessory, Cataclysm, Commend, Culpable, Deride, Entice, Falter, Grievance, Outrageous, Precept, Sever, Taciturn.

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

Trees give shade for the benefit of others and while they themselves stand in the sun and endure scorching heat, they produce the fruit by which others profit. The character of good men is like that of trees. What is the use of this perishable body, if no use of it is made for the benefit of mankind? Sandal wood – the more it is rubbed, the more scent does it yield. Sugarcane – the more it is peeled and cut into pieces, the more juice does it produce. Gold – the more it is burnt, the more brightly does it shine? The men who are noble at heart do not lose these qualities even in losing their lives. What does it matter whether men praise them or not? What difference does it make whether riches abide with them or not? What does it signify whether they die at this moment or whether their lives are prolonged? Happen what may, those who tread in the right path will not set foot in any other. Life itself is unprofitable to a man who does not live for others. To live for the mere sake of living ones life is to live the life of dogs and cows. Those who lay down their lives for the sake of a friend, or even for the sake of a stranger, will assuredly dwell forever in a world of bliss.

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 given below: **(30)**

Few of us realize how much we need encouragement. Yet we must bask in the warmth of approval now and then or lose ourself – confidence.

All of us need to feel needed and admired. But unless we hear words of praise from someone else, how can we know that we are valued friends or co-workers? Anyone who wants to improve his relationship with others need only to show a sympathetic understanding. The way to express this understanding and to give others the feeling of importance and worthiness boils down to this : always look for something in the other person you can admire and praise – and tell him about it.

We each have a mental picture of ourselves, a self-image. To find life reasonably satisfying, that selfimage must be one we can live with, one we can like. When we are proud of our self-image, we feel confident and free to be ourselves. We function at our best. When we are ashamed of our self-image, we attempt to hide it rather than express it. We become hostile and hard to get along with.

Contd P/3

HUM 111 (WRE)

Contd ... Q. No. 5

A miracle happens to the person whose self-esteem has been raised. He suddenly likes other people better. He is kinder and more co-operative with those around him. Praise is the polish that helps keep his self-image bright and sparkling.

What has this to do with your giving praise? A lot. You have the ability to perform that kind of miracle in another person. When you add to his self-esteem, you make him want to like you and to co-operate with you.

In a classic bit of advice, Lord Chesterfield suggested to his son that he follow the example of the Duke de Nivernois : "You will perceive that he makes people pleased with him by making them first pleased with themselves".

The effects of praise can be great indeed. A new clergyman called to a church jokingly referred to as "the refrigerator" decided against criticizing his congregation for its coolness towards strangers. Instead, he began welcoming visitors from the pulpit and telling his flock how friendly they were. Time after time he held up a picture of the church as he wanted it to be, giving his people a reputation to live up to. The congregation thawed. "Praise transformed the ice – cube members, into warm hearted human beings", he said.

Praise helps rub off the sharp edges of daily contact. Nowhere is this truer than in marriage. Yet it is perhaps in the home that the value of praise is appreciated than elsewhere. The spouse who is alert to say the heartening thing at the right moment has learned one of the most important requirements for a happy family life. Encouragement through praise is the most effective methods of getting people to do their best.

As artists find joy in giving beauty to others, so anyone who masters the art of praising will find that it blesses the giver as much as the receiver. There is truth in the saying, "Flowers leave part of their fragrance in the hand that bestows them.

Questions:

(i) Why do people need to get encouraged?

(ii) How does praise polish our mental picture?

(iii) How does the writer of the passage illustrate the methods of praising by the example of "refrigerator"?

(iv) How does the writer of the passage establish the relationship of praise with our daily contact?

(v) What is meant by "Flowers leave part of their fragrance in the hand that bestows them"?

(vi) Give the meaning of the following words as used in the passage:

worthiness, hostile, miracle, congregation, pulpit, thaw

Contd P/4

HUM 111 (WRE)

6. (a) Draft a suitable reply to a claim made by one of your business clients seeking appropriate steps to be taken in his favour regarding the problems that were identified with the electrical products supplied by you. **(10)**

   (b) Write the phonetic spellings of the following words: (any five) **(10)**

   said, burn, adjust, sports, spoonful, think

7. (a) Write a dialogue between two students of WRE department about early marriage of girls in our country. **(10)**

   (b) Write a short composition on any one of the following topics: **(10)**

   (i) The cricket of Bangladesh

   (ii) Freedom of the Press

   (iii) Dish antenna : Blessing or Curse?

8. (a) Transform the following sentences as directed: (any five) **(10)**

   (i) He was unlucky and therefore met with a bad accident on the eve of his examination. (Simple)

   (ii) He succeeded unexpectedly. (Complex)

   (iii) Having finished his exercise, he put away his books. (Compound)

   (iv) Everything comes if a man will only work and wait. (Simple)

   (v) Little Jack Horner sat in a corner, eating his Christmas pie. (Compound)

   (vi) Every body knows the author of Gulliver's Travels. (Complex)

   (b) Write short notes on any TWO of the following: **(10)**

   (i) Monophthongs;

   (ii) Topic sentence;

   (iii) Format of a business letter.

L-1/T-1/WRE Date : 03/01/2015

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **CHEM 115** (Chemistry I)

Full Marks : 210 Time : 3 Hours

03.01.2015

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) A cell consists of a zinc electrode and a hydrogen electrode and another cell consists of a copper electrode and a hydrogen electrode. Both cells are operating under standard-state conditions. Sketch the cell, labeling the anode and cathode and indicating the corresponding electrode reactions. Show the direction of electron flow in the external circuit and the direction of cation movement in the half-cells. Given that $E^{\circ}_{Zn^{2+}/Zn} = -0.76$ V and $E^{\circ}_{Cu^{2+}/Cu} = 0.34$ V. **(7+7=14)**

(b) What is Nernst equation? One breaker contains a solution of 0.0200M $KMnO_4$, 0.0050M $MnSO_4$, and 0.5000M H_2SO_4; and a second breaker contains 0.1500M $FeSO_4$ and 0.015M $Fe_2(SO_4)_3$. The two breakers are connected by a salt bridge, and platinum electrodes are placed in each. The electrodes are connected with a voltmeter in between. What would be the potential of each half-cell (i) before reaction and (ii) after reaction? What would be the measured cell voltage at the start of the reaction? Assume H_2SO_4 to be completely ionized and in equal volumes in each breaker. **(2+4+4+2=12)**

(c) Construct and describe the working principle of Lithium-Ion Battery. **(9)**

2. (a) Consider the following equilibrium process between dinitrogen tetrafluride (N_2F_4) and nitrogen difluride (NF_2): **(4×3=12)**

$$N_2F_4\,(g) \rightleftharpoons 2\,NF_2\,(g); \qquad \Delta H^0 = +538.5\ kJ/mol$$

Predict the changes in the equilibrium if (i) the reaction mixture is heated at constant volume; (ii) some N_2F_4 gas is removed from the reacting mixture at constant temperature and volume, (iii) the pressure of the reacting mixture is decreased at constant temperature; and (iv) a catalyst is added to the reacting mixture.

(b) Derive the integral form of Van't Hoff equation. **(10)**

(c) Define solubility product and molar solubility. Calculate the solubility of silver chloride (in g/L) in a 8.3×10^{-3} M silver nitrate solution. The solubility product of AgCl is 1.6×10^{-10} and molar mass of is 143.4. **(2+6=8)**

(d) Give an example of complex ion equilibrium and define formation constant. **(5)**

Contd P/2

CHEM 115 (WRE)

3. (a) Explain the following, giving appropriate reasons: **(3×5=15)**

(i) PbO_2 is an oxidizing agent while $SnCl_2$ is not.

(ii) BF_6^{3-} ion does not exist but AlF_6^{3-} ion exists.

(iii) LiCl is soluble in organic solvents while the chlorides of other alkali metals are not.

(b) Define electron affinity. Explain how electron affinity of elements varies in a period and a group of the periodic table. **(3+12=15)**

(c) On the basis of HSAB principle, explain why HgS is insoluble and $Hg(OH)_2$ is soluble in dil. HCl. **(5)**

4. (a) Define hardness of water. Discuss the various softening techniques for the removal of hardness. **(2+8=10)**

(b) What is heavy water? Write three exchange reaction of heavy water. **(2+3=5)**

(c) What is molecular orbital theory? On the basis of this theory, why the ionization energy of N_2 molecule is higher than that of N-atom, but the ionization energy of O_2 molecule is lower than that of O-atom? **(3+7=10)**

(d) Calculate the pH of a buffer containing 1.0 M CH_3COOH and 1.0M CH_3COONa. What is the pH of the buffer system after the addition of 0.10 mole of gaseous HCl to 1.0 L on the solution? Assume that the volume of the solution does not change when the HCl is added. $[pKa = 1.8 \times 10^{-5}]$ **(10)**

SECTION – B

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

5. (a) Define the term (i) dialysis and (ii) electrodialysis. **(8)**

(b) Small amount of electrolyte is essential for the stability of lyophobic sols – Explain. **(8)**

(c) What is meant by electrophoresis? How does this phenomenon provide information about the charge of colloidal particles? **(12)**

(d) Calculate the total surface area, when a cube of 1 cm edge is disintegrated into cubes of approximate colloidal dimension of 10^{-6} cm edge. **(7)**

6. (a) Why does vapor pressure of a liquid solvent decreases due to the addition of a nonvolatile solute to it? **(6)**

(b) Define osmotic pressure. Establish a relation between the lowering of vapor pressure and osmotic pressure. **(8)**

(c) Describer how you can determine the molar mass of a solute by measuring the boiling point elevation of the solution. **(15)**

(d) A solution of 12.5 g of urea in 170 g of water gave boiling point elevation of 0.63 K. Calculate the molar mass of urea. $[K_b = 0.52\ K\ kg\ mole^{-1}]$ **(6)**

Contd P/3

CHEM 115 (WRE)

7. (a) Give the chemical formula and abbreviations of the major constituents of Portland cement. **(6)**

   (b) Draw the flow chart and describe the process of manufacturing of Portland cement. **(12)**

   (c) What is screening constant? How does it affect the ionization potential of an element? **(8)**

   (d) Discuss the types of hybridization and shapes of SF_4 and XeF_4. **(9)**

8. (a) Write the Schrodinger wave equation and explain the terms involved in it. The acceptable solutions to the Schrodinger wave equation must have four special properties. What are these? **(12)**

   (b) What do you understand by quantization of angular momentum? Derive an expression for it using wave nature of electron. **(13)**

   (c) Apply de Broglie's equation to calculate the wavelength associated with motion of the earth, a stone and electron. The masses and the velocities of these objects are given below: **(6)**

Mass	Velocity
Earth = 6×10^{24} kg	3×10^{4} ms^{-1}
Stone = 0.1 kg	1.0 ms^{-1}
Electron = 10^{-30} kg	6×10^{5} ms^{-1}
Planak's constant = 6.6×10^{-3} Js	6.6×10^{-34} Js

   Which of these objects will have reasonable wavelength?

   (d) Differentiate between orbit and orbital. **(4)**
