L-1/T-1/WRE **Date: 21/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) Define the term "System of Forces". In a Tree Diagram, show the classification of force system, which are generally considered in Solid Mechanics. **(5)**

   (b) Determine the forces induced in the bars ***AC*** and ***BC*** as shown if **Figure 1** due to the action of the horizontal force ***P*** applied at ***C***. The bars are hinged together at ***C*** and to the foundation at ***A*** and ***B***. Neglect the self-weight of these bars. State whether the forces are tensile and/or compressive. **(15)**

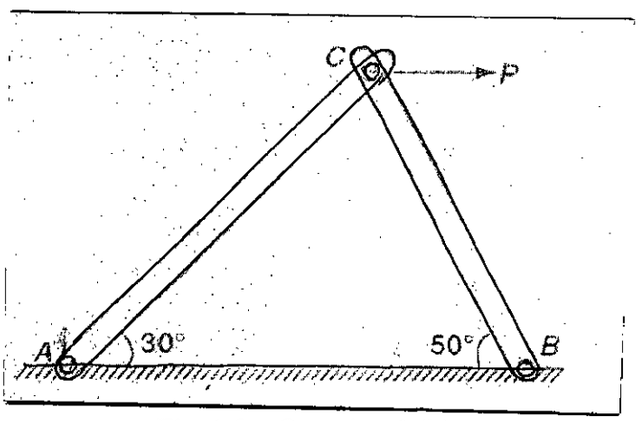

Fig. 1 for Question 1 (b)

   (c) A beam ***ABC*** is hinged at ***A*** and resting on a roller at ***B***, which is loaded as shown in **Figure 2**. Determine the reactions at the supports. Neglect the width of the beam. **(15)**

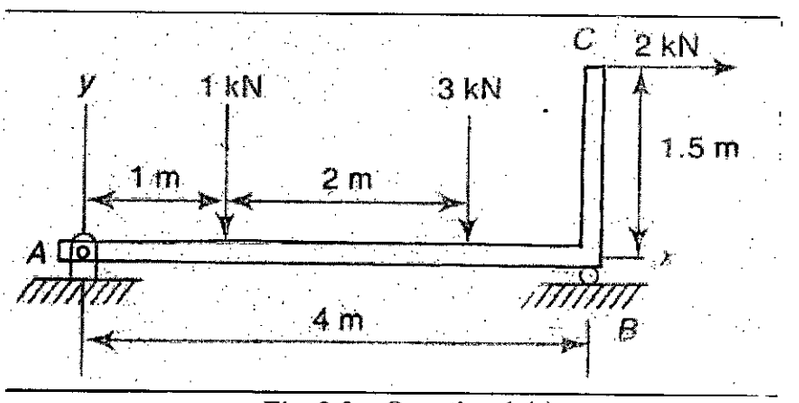

Fig. 2 for Question 1 (c)

2. (a) State the assumptions considered by Structural Engineers for solving a Truss. **(5)**

   (b) A roof truss is loaded as shown in Figure 3. Determine the forces in member ***AC***, ***BC***, ***CE***, ***GH***, ***FH***, and ***GI***. **(20)**

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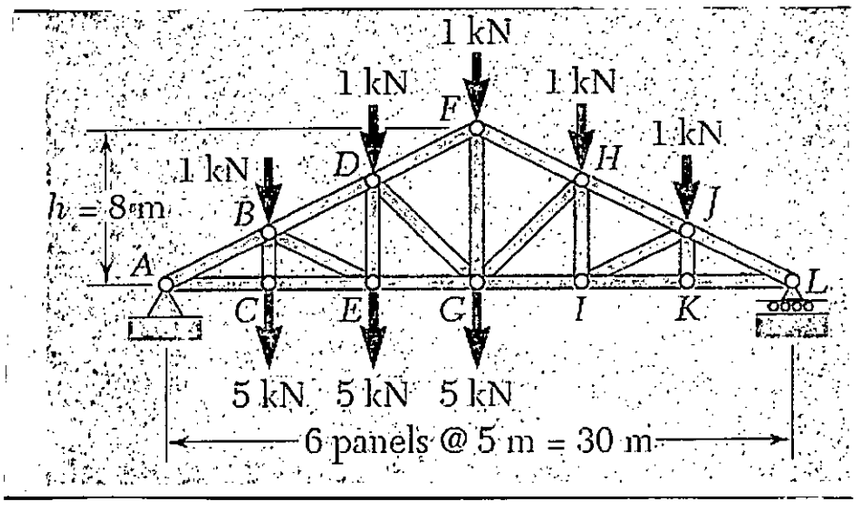

Fig. 3 for Question 2 (b)

(c) A Wheel with a diameter of 6-m is acted upon by a force ***F*** (see **Figure 4**), which tends to pull the wheel over the obstruction at ***A***. At the instant the wheel is about to move, calculate the magnitude of the force ***F*** if $\alpha = 30^0$.Assume self-weight of the wheel is ***2500N***. **(10)**

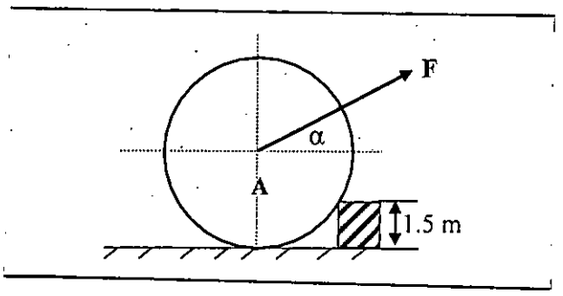

Fig. 4 for Question 2 (c)

3. (a) A symmetrical wedge ***B*** is being inserted between a movable block ***A***, shich weighs ***4500 N*** and a fixed surface ***C***. for all the slipping surfaces, let the angle of friction is $\varphi = 18.5^0$. If there is a horizontal resistance acting on ***A*** of ***P = 7500 N*** towards right, what force ***Q*** will impose impending motion of ***A***? Also calculate all the frictional forces on each slipping surface. See **Figure 5** for details. **(20)**

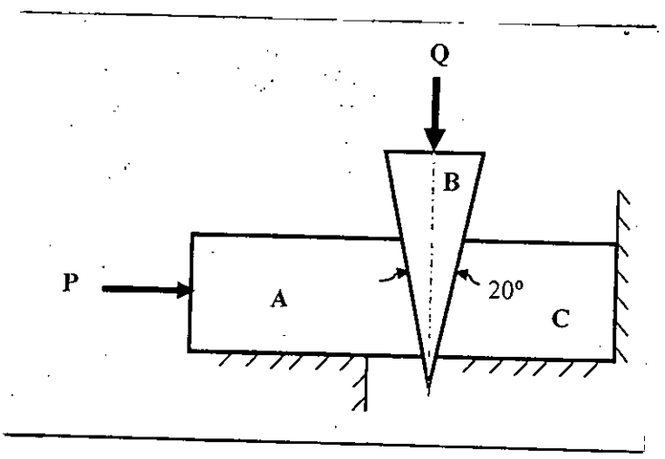

Fig. 5 for Question 3 (a)

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(b) A light cable is attached to a support at ***A***, passes over a small frictionless pulley at ***B***, and supports a load ***P*** (see **Figure 6**). The sag of the cable is **0.5 m** and the mass per unit length of the cable is ***0.75 kg/m***. Determine (a) the magnitude of the load ***P***, (b) the slope of the cable at ***B***, (c) the total length of the cable from ***A*** to ***B***. Neglect the weight of the portion of cable from ***B*** to ***D***. **(15)**

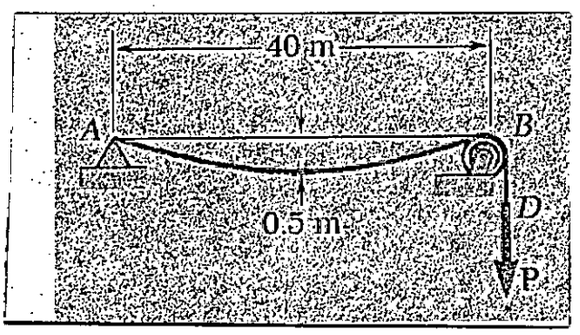

Fig. 6 for Question 3 (b)

4. (a) The cable ***DE*** is holding the timbers in a horizontal plane and supporting the vertical load of ***W= 1 K/N***. The horizontal line ***AC*** is the intersection of the plane of the boom with the vertical wall. The construction is such that the boom members can turn about the axes at ***A*** and ***C*** (see **Figure 7**). What are the forces on the timber and the cable if ***AB*** = ***BC*** = ***BE*** = 10 m and ***BD*** = 8 m. **(10)**

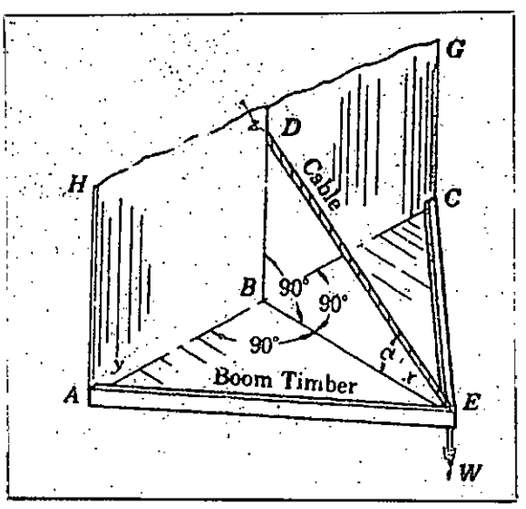

Fig. 7 for Question 4 (a)

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(b) For the loads $F_1 = 1000\ N$ and $F_2 = 5000\ N$ (see Figure 8), calculate the x and y components of the reactions at A and B. Also calculate the force on member CE, and the pin reactions of C and D on member CD. **(15)**

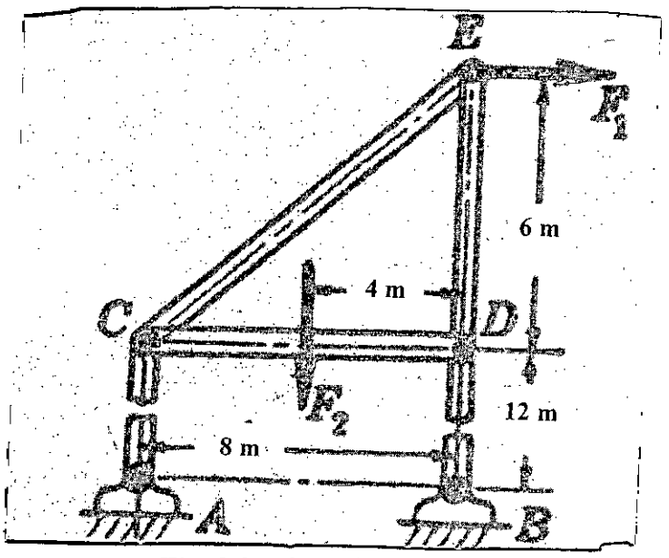

Fig. 8 for Question 4 (b)

(c) Two bodies A and B are connected with a cable over two fixed cylinders as shown in **Figure 9**. Given that $W_B = 200\ N$, $\theta = 30^0$ and the frictional coefficients for cylinders and inclined surface are $1/\pi$ and 0.2, respectively. If the body B is impending down the inclined plane, calculate weight of A. **(10)**

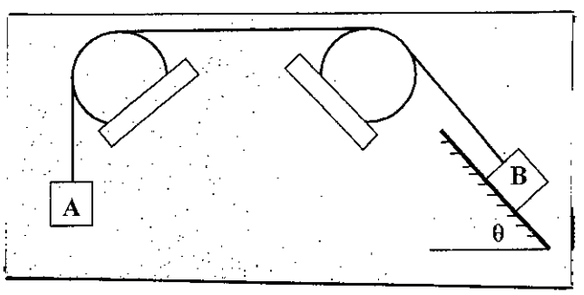

Fig. 9 for Question 4 (c)

SECTION – B

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

5. (a) Calculate the centroids of the area between two curves $y = \frac{h}{b}x$ and the bottom curve $y = \frac{h}{b}x^2$ between the origin and the point (b, h). See Fig. 10. **(12)**

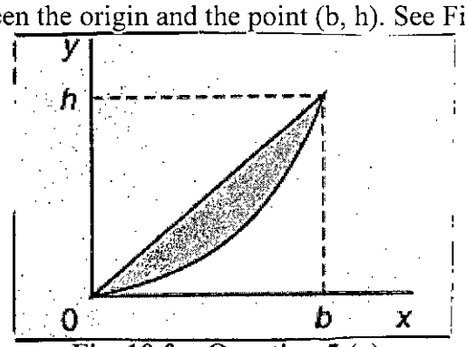

Fig. 10 for Question 5 (a)

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(b) Find the centroid of a sector of a circle of radius *r* who's central angle is β. **(12)**

(c) The object shown in Figure 11 is half a cone composed of homogeneous material. Use integration to determine the coordinates (y, z) of its centroid. Use the centroid of a semi-circular area of radius r is located a distance $4r/(3\pi)$ above the base diameter. **(11)**

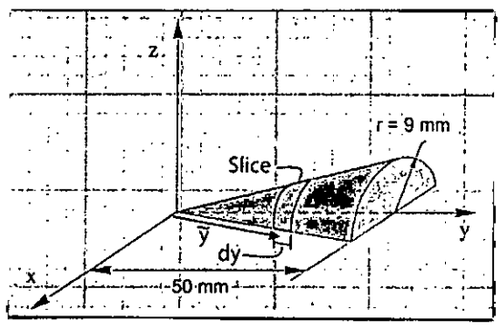

Fig. 11 for Question 5 (c)

6. (a) Determine the coordinates of the centroid of the shaded area. See Fig. 12. **(12)**

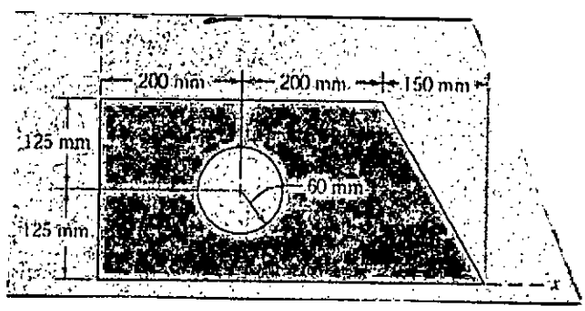

Fig. 12 for Question 6 (a)

(b) If the coordinates of P in fig 13 are (5mm, 25 mm), find the moment of inertia with respect to y axis of (a) A1 and (b) A2. **(11)**

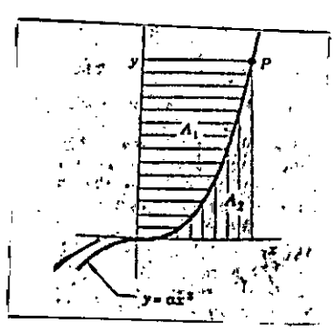

Fig. 13 for Question 6 (b)

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(c) Determine the minimum radius of gyration of the area as shown in Fig. 14 if the product of inertia is 70 in^4. **(12)**

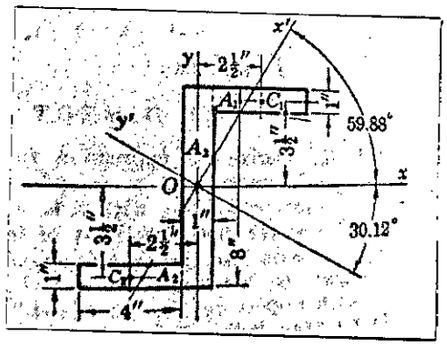

Fig. 14 for Question 6 (c)

7. (a) Determine the moment of inertia of the section about the base BC. See Fig. 15. **(12)**

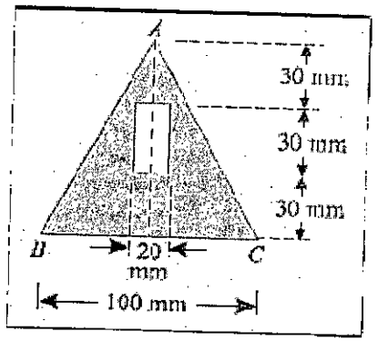

Fig. 15 for Question 7 (a)

(b) Find the moment of inertia about the geometric axis of the cast iron frustum of a cone as shown in fig 16. Which has a short 4X2 ft cylindrical hole in the base. **(12)**

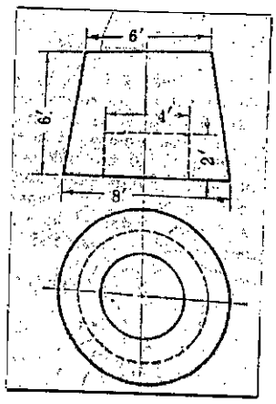

Fig. 16 for Question 7 (b)

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WRE 101
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(c) Determine the forces on the cables if A moves 60 m from rest up the incline in 12 sec. Also calculate the weight of B. What is the change of potential energy of A and B? Assuming the pulleys to be smooth and weightless as shown in Fig. 17. **(11)**

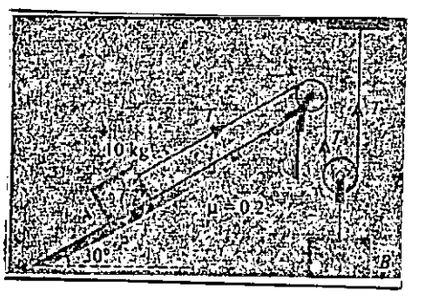

Fig. 17 for Question 7 (c)

8. (a) Small steel balls fall from rest through the opening at A at the steady rate of 2 per second. Find the vertical separation h of two consecutive balls when the lower one has dropped 3 meters. Neglect air resistance. See fig 18. **(12)**

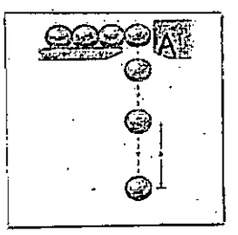

Fig. 18 for Question 8 (a)

(b) In figure 19 the bodies A and B weigh WA = 500 lb and WB = 150 lb. and D = 9 ft. the rotating part C weighs 600 lb and has a radius of gyration of 3 ft with respect to its axis. (a) After B has moved 10ft from rest, what is the speed of A and B? (b) What is the acceleration of A and B and the angular acceleration of C? **(12)**

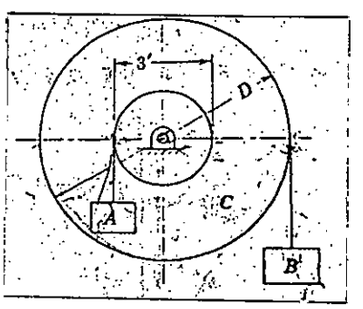

Fig. 19 for Question 8 (b)

(c) A ball of mass 1 kg moving with a velocity of 2 m/s impinges directly on a ball of mass 2 kg at rest. The first ball, after impinging, comes to rest. Find the velocity of the second ball after the impact and the coefficient of restitution. **(11)**

L-1/T-1/WRE **Date: 27/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) What are free, damped and forced vibrations? **(7)**

   (b) If the mass of a spring m is not negligible but small compared to the mass M of an object suspended from it, then show that the period of the simple harmonically oscillating spring is $T = 2\pi\sqrt{\frac{M+\frac{m}{3}}{k}}$, where the symbols have their usual meanings. From the above equation, discuss the effect of spring mass in the oscillation. **(20)**

   (c) An automobile can be considered to be mounted on a spring as far as vertical oscillations are concerned. The springs of a certain car are adjusted so that the vibrations have a frequency of 2.5 Hz. What is the spring's force constant if the car weight is 1500 kg? What will the vibration frequency be if five passengers, averaging 75 kg each, ride in the car? **(8)**

2. (a) What is phase velocity? Find the relation between group velocity and phase velocity. When does the group velocity become equal to the phase velocity? **(7)**

   (b) What is a stationary wave? Explain analytically the formation of stationary waves. Derive expression for the distance between two consecutive nodes and antinodes. **(20)**

   (c) A string vibrates according to the equation

   $$y = 6Cos\left(\frac{\pi x}{4}\right)Sin(40\pi t)$$

   where x and y are in centimeters and t is in seconds. What are the amplitude and velocity of the component waves whose superposition can give rise this vibration? **(8)**

3. (a) What are reverberation and reverberation time? On what factors do they depend? **(7)**

   (b) What are assumptions of Sabine? Deduce an expressions for the growth and decay of intensities of sound in a room. **(20)**

   (c) Find the reverberation time of a room of 6 m wide, 10 m long and 4 m high and contains 50 wooden seats. There are 50 students in the room. Absorption co-efficient of room (wall, floor and ceiling) is 0.02. Absorbing power per student = 0.2 Sabines and per wooden seat = 0.15 Sabines. **(8)**

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PHY 107

4. (a) Explain the term "diffraction of light" **(5)**

   (b) Derive an expression for the intensity distribution due to the Fraunhofer diffraction of light at a single slit. What is diffraction grating? Define the dispersive power of a grating. **(22)**

   (c) Calculate the minimum number of lines in a grating which will just resolve the sodium lines in the first order spectrum. The wavelengths are 5890 Å and 5896 Å. **(8)**

SECTION – B

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

5. (a) What is meant by interference of light? Write down the differences between constructive and destructive interference of light. **(10)**

   (b) Show that the distance between two consecutive bright or dark fringes is given by $\beta = \frac{\lambda D}{d}$, where d is the distance between two coherent sources, D is the distance of the screen from the coherent sources and λ is the wave length of light. **(15)**

   (c) What are Newton's rings? In a Newton's rings experiment the diameter of the 10th ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid. **(10)**

6. (a) Distinguish between unpolarized and polarized light. Explain Malus' law. **(10)**

   (b) Give Huygen's explanation of double refraction. What is meant by 'retardation plates'? Explain half-wave plate. **(15)**

   (c) Define specific rotation. A 200 mm long and containing 48 cm^3 of sugar solution produces an optical rotation of 11° when placed in a saccharimeter. If the specific rotation of sugar solution is 66°, calculate the quantity of sugar contained in the form of a solution. **(10)**

7. (a) Name the three physical properties which are used for the measurement of temperature. **(7)**

   (b) Describe a platinum resistance thermometer. Explain how it works with the help of Callendar and Griffith's bridge. How is the true temperature deduced from the measured platinum temperature? Discuss its advantages and disadvantages. **(20)**

   (c) If the platinum temperature is 50.25°C when the temperature on the gas scale is 50°C, what will be the temperature on the platinum scale corresponding to 150°C on the gas scale? **(8)**

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PHY 107

8. (a) Distinguish between a perfect gas and a real gas. Explain the volume and pressure corrections in Van der Waal's equation for a real gas. **(15)**

(b) What are critical constants of a gas? Obtain expressions for the critical constants in terms of the constants of Van der Waal's equation. **(15)**

(c) For carbon dioxide it is found that if unit pressure be taken as the standard barometric pressure and unit volume as the volume at N.T.P., then a = 0.00874 and b = 0.0023. Calculate critical temperature for carbon dioxide gas. **(5)**

L-1/T-1/WRE **Date : 04/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) How can you identify a colloidal solution? Explain how micelles form association colloids. **(9)**

   (b) Briefly describe the solution process at the molecular level. **(10)**

   (c) State the Raoult's law of lowering of vapor pressure. How is the lowering in vapor pressure related to a rise in the boiling point of a solution? **(8)**

   (d) How many grams of urea $[(NH_2)_2CO]$ must be added to 450 g of water to give a solution of a vapor pressure 2.50 mmHg which is less than that of pure water at 30°C? (The vapor pressure of water at 30°C is 31.8 mmHg.) **(8)**

2. (a) What is the main cause of eutrophication? What happens to a freshwater ecosystem that undergoes eutrophication? **(9)**

   (b) Discuss the steps for cleaning water in wastewater treatment plant. **(6)**

   (c) Write a short note on setting and hardening of cement. **(7)**

   (d) (i) How to test soundness of cement? **(5)**

   (ii) Write down the manufacturing process of Portland cement. **(8)**

3. (a) (i) Why are the metals good conductors of electricity and heat? **(7)**

   (ii) Discuss the biological importance of sodium and potassium. **(6)**

   (b) Why do halogens exist in different states at room temperature? **(6)**

   (c) What is bioaccumulation? How does mercury consumption affect human health? **(8)**

   (d) Briefly discuss the mechanism of toxicity of chromium (Cr) and lead (Pb). **(8)**

4. (a) How does the strength of an oxoacid depend on the electronegativity and oxidation number of the central atom? **(8)**

   (b) Predict and explain the pH (>7, <7, or ≈7) of the aqueous solutions containing the following salts: **(8)**

   (i) $AlCl_3$ (ii) NaCN (iii) KCl (iv) $(NH_4)_2SO_4$

   (c) What are some real life applications of buffer solution? How a buffer solution with specific pH is prepared? **(11)**

   (d) Calculate the pH of a 0.036 M nitrus acid (HNO_2) solution, whose K_a is 4.5×10^{-4}. **(8)**

Contd P/2

CHEM 115

SECTION - B

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

5. (a) Draw the shapes of *p* and *d* orbitals on the basis of quantum mechanical concept. **(5)**

(b) Write a note on Heisenberg's uncertainty principle. How does this principle go against Bohr's theory? **(10)**

(c) What is the significance of the wave function, 'ψ'? What are four quantum numbers used to describe an orbital? Specify the rule that governs the values of each quantum number. **(10)**

(d) Describe various series in hydrogen spectrum and derive the expression of energy levels of hydrogen atom. **(10)**

6. (a) Write about electromagnetic radiations and Compton effect. Calculate the kinetic energy of an electron emitted from a surface of potassium metal (work function = 3.62×10^{-12} erg) by light of wavelength 5.5×10^{-8} cm. **(10)**

(b) Explain qualitatively the valence bond theory with reference to hydrogen molecule. Indicate the type of bonding that exists in the following solids: (i) Ice (ii) Naphthalene (iii) Diamond (iv) Potassium chloride. **(10)**

(c) What do you understand by hydrogen bonds? Classify them with examples. Explain why water has abnormally high boiling point. **(10)**

(d) A covalent bond is stronger than a metallic bond. Why? **(5)**

7. (a) What is hybridization? Write down the rules for hybridization of atomic orbitals. **(5)**

(b) Draw the molecular orbital structure of oxygen molecule and answer the following: (i) Calculate bond order of oxygen molecule (ii) How many bonding and anti-bonding orbitals are in the molecule? (iii) Is oxygen a paramagnetic or diamagnetic molecule? Why? **(10)**

(c) Draw figures for *p-p* axial and *p-p* lateral overlap of *p* orbital. Compare and explain the polarity character of the following pairs: (i) NH_3 and NF_3 (ii) CO_2 and SO_2 **(10)**

(d) What do you understand by LCAO in molecular orbital theory? Differentiate bonding, anti-bonding and non-bonding molecular orbitals. **(10)**

8. (a) Discuss the variation of heat of reaction with temperature at constant pressure and constant volume. How are they related? **(10)**

(b) Define bond energy and internal energy. Graphite and diamond are two forms of carbon. The enthalpy of combustion of graphite at 25°C is -393.51 kJ mol^{-1} and that of diamond is -395.41 kJ mol^{-1}. What is the enthalpy change in the process of graphite to diamond at the same temperature? **(10)**

(c) Write the name of electrodes to determine the pH of a solution. Describe the construction and working principle of calomel electrode. **(10)**

(d) Write some important applications of emf measurements. **(5)**

L-1/T-1/WRE **Date : 11/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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**.

1. (a) Discuss the continuity and differentiability at x = -1 of the function

$$f(x)=\begin{cases}-2x-1 & for\ x<-1\\ x^2+3 & for\ x\geq -1\end{cases}$$ **(20)**

Also sketch the graph of the function.

(b) Evaluate (i) $\lim_{x\to 0}\frac{3\tan x-3x-x^3}{x^5}$ **(7)**

(ii) $\lim_{x\to 0}(\cos x)^{\cot^2 x}$ **(8)**

2. (a) If $y=\frac{1}{2}\left(\tan^{-1}x\right)^2$, then prove that

$$y_{n+2}(0)+2n^2y_n(0)+n(n-1)^2(n-2)y_{n-2}(0)=0.$$ **(12)**

(b) In the Mean value theorem $f(a+1) = f(a) + f'(a+\theta)$, $0<\theta<1$, if $f(x)=\frac{1}{3}x^3-\frac{2}{3}x^2$,

find the value of θ in the interval (0, 3). **(12)**

(c) Use Maclaurin's theorem to expand $f(x)=\frac{1}{(1-2x)^2}$ in powers of x in infinite series. **(11)**

3. (a) Show that $\frac{\partial^2V}{\partial x^2}+\frac{\partial^2V}{\partial y^2}=\frac{\partial^2V}{\partial r^2}+\frac{1}{r}\frac{\partial V}{\partial r}+\frac{1}{r^2}\frac{\partial^2V}{\partial\theta^2}$, where V is a function of x and y and

x = rcosθ, y = rsinθ. **(15)**

(b) If $u=x\sin^{-1}\left(\frac{y}{x}\right)+y\sin^{-1}\left(\frac{x}{y}\right)$, find the value of $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}$ at (1, 1). **(10)**

(c) Find the point on $y = x^2$ closest to the point (3, 0). **(10)**

4. (a) If xcosα + ysinα = p touches the curve $\frac{x^m}{a^m}+\frac{y^m}{b^m}=1$, show that

$$(a\cos\alpha)^{\frac{m}{m-1}}+(b\sin\alpha)^{\frac{m}{m-1}}=(p)^{\frac{m}{m-1}}.$$ **(11)**

(b) Find the pedal equation of the parabola $r^m = a^m\sin m\theta$. **(12)**

(c) Find the radius of curvature at the point (x, y) on the curve $ay^2 = x^3$. **(12)**

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MATH 131

SECTION – B

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

5. Work out the following integral :

(a) $\int \frac{dx}{\cos(2x-a)\cos(2x+a)}$ **(11)**

(b) $\int \frac{(x-3)dx}{\sqrt{4x^2-4x-3}}$ **(12)**

(c) $\int \frac{\sin x+\cos x}{5-\sin 2x}dx$ **(12)**

6. (a) Find a reduction formula for $I_n = \int e^{ax}\cos^n x\,dx$ and hence find $\int e^{-x}\cos^3 x\,dx$ **(12)**

(b) Evaluate: $\lim_{n\to\infty}\left[\left(1+\frac{1}{n^2}\right)^{2/n^2}\left(1+\frac{2^2}{n^2}\right)^{4/n^2}\left(1+\frac{3^2}{n^2}\right)^{6/n^2}\cdots\left(1+\frac{n^2}{n^2}\right)^{2n/n^2}\right]$ **(12)**

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

7. (a) Evaluate $\int_0^1 \cot^{-1}\left(1-x+x^2\right)dx$ **(12)**

(b) Show that $\int_0^\infty \frac{x^2dx}{\left(x^2+a^2\right)\left(x^2+b^2\right)} = \frac{\pi}{2(a+b)}$, $a,b>0$ **(11)**

(c) Prove that (i) $\beta(m,n) = \frac{\Gamma m\Gamma n}{\Gamma(m+n)}$ (ii) $\int_0^\infty x^4e^{-4x}dx = \frac{3}{4}\sqrt{\pi}$ **(6+6)**

8. (a) Find the area included between the curves $y^2 = 4ax$ and $x^2 = 4ay$. **(12)**

(b) Find the volume of the solid formed by revolving the curve r = a(2+cosθ) about the initial line. **(12)**

(c) Evaluate $\int_0^1 \int_x^{x^2} \int_{xy}^{x^2y^2} xy\,dzdydx$ **(11)**
