L-1/T-1/ChE **Date : 10/07/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **PHY 111** (Physical Optics, Waves and Oscillation and Heat 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) Deduce the relation between the ratio of two specific heats and the degrees of freedom. **(7)**

   (b) Evaluate the average energy of a gas molecule according to Maxwell's law of distribution of velocities. **(18)**

   (c) Calculate the average kinetic energy of a molecule of a gas at a temperature of 300 K. (Given $k = 1.38 \times 10^{-16}$ erg/molecule – deg). **(10)**

2. (a) State Second law and third law of thermodynamics. **(7)**

   (b) State and prove Carnot's theorem. **(18)**

   (c) An engine whose temperature of the source is 400 K takes 200 calories of heat at this temperature and rejects 150 caloires of heat in the sink of temperature 200 K. Calculate the efficiency of the engine. **(10)**

3. (a) Explain the working procedure of a platinum resistance thermometer. **(20)**

   (b) Deduce the Maxwell's thermodynamic relation by using the thermodynamic functions. **(15)**

4. (a) Establish the differential equation of simple harmonic motion and solve it to obtain an expression for the displacement. **(15)**

   (b) A particle is executing simple harmonic motion. Show that the maximum potential energy and the maximum kinetic energy are equal. **(10)**

   (c) A body is vibrating with simple harmonic motion of amplitude 15 cm and frequency 4 Hz. Calculate the velocity when the displacement is 9 cm. **(10)**

SECTION – B

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

5. (a) Explain power dissipation in damped harmonic oscillation. Derive an expression for the average power dissipation in damped harmonic oscillation. **(5+12)**

   (b) What is quality factor? Obtain an expression for the quality factor in damped harmonic oscillation. **(3+7)**

Contd P/2

PHY 111(ChE)

Contd ... Q. No. 5

(c) A harmonic oscillator consisting of a 50 gm mass, attached to a massless spring, has a quality factor 200. If it oscillates with an amplitude of 2 cm in resonance with a periodic force of frequency 20 Hz, calculate (i) the average energy stored in it and (ii) the rate of dissipation of energy. **(8)**

6. (a) Define the energy flux of a plane progressive wave. Obtain an expression for energy flux of a plane progressive wave. **(3+12)**

   (b) Derive the differential equation of one dimensional wave motion. **(10)**

   (c) Which of the following is the solution of one dimensional wave equation? (i) $y = 2 \sin x \cos \nu t$ and (ii) $y = \sin 2x \cos \nu t$. **(10)**

7. (a) What is the difference between interference and diffraction? What does the interference of light tell us about the nature of light? **(7)**

   (b) Describe fresnel's biprism. Discuss in detail how the wavelength of monochromatic source of light can be determined with its help. **(20)**

   (c) A biprism is placed 10 cm from a slit illuminated by sodium light ($\lambda = 5890 \times 10^{-8}$cm). The width for the fringes obtained on a screen 75 cm from the biprism is 9.0×10^{-2}cm. What is the distance between the two coherent sources? **(8)**

8. (a) Explain clearly what is meant by resolving power of an optical instrument. **(7)**

   (b) Explain the phenomenon of Fraunhofer diffraction at a single slit. **(18)**

   (c) State and explain Malus' law of polarization. **(10)**

L-1/T-1/CHE Date : 01/10/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **ME 141** (Engineering Mechanics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols indicate their usual meaning. Assume any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Under normal operating conditions, tape is transferred between the reels as shown in the Fig. for Q. 1(a) at a constant speed of 600 mm/s. At time, t = 0, portion A of the tape is moving to the right at a speed of 480 mm/s and has a constant acceleration. Knowing that portion B of the tape has a speed of 600 mm/s and that the speed of portion A reaches 600 mm/s at time, t = 5 s, determine: **(18)**

   (i) The acceleration and velocity of the compensator C at time, t = 3 s.

   (ii) The distance through which C will have moved at time, t = 5 s.

   (b) Sand is discharged at A from a horizontal conveyor belt with an initial velocity v_0 as shown in the Fig. for Q. 1(b). Determine the range of values of v_0 for which the sand will enter the vertical chute as shown in the Fig. for Q. 1(b). (Neglect the thickness of the chute). **(17)**

2. (a) 20 kg block B is suspended from a 2 m cord attached to a 30 kg cart A as shown in the Fig. for Q. 2(a), Neglecting friction, determine: **(17)**

   (i) The acceleration of the cart

   (ii) The tension in the cord, immediately after the system is released from rest in the position shown.

   (b) Two wires BC and AC are tied at C to a sphere which revolves at the constant speed v in the horizontal circle as shown in the Fig. for Q. 2(b). Determine the allowable values of v, if the tension in either of the wires is not to exceed 35 N. **(18)**

3. (a) The total mass of loading car A and its load is 3500 kg as shown in the Fig. for Q. 3(a). The car is connected to a 1000-kg counterweight and is at rest when a constant 22-kN force is applied as shown. (i) If the force is applied through the entire motion what is the speed of the car after it has traveled 30 m. (ii) If after the car has moved through a distance x, the 22-kN force is removed, the car will coast to rest. After what distance x, should the force be removed if the car is to come to rest after a total movement of 30 m? **(18)**

Contd P/2

ME 141

Contd ... Q. No. 3

(b) An 8-kg plunger is released from rest in the position as shown in the Fig. for Q. 3(b) and is stopped by two nested springs. The spring constant of the outer spring is $k_1 = 4$ kN/m and the spring constant of the inner spring is $k_2 = 12$ kN/m. If the plunger is released from the height h = 600 mm, determine the maximum deflection of the outer spring. **(17)**

4. (a) A 1.5 kg ball is falling vertically with a velocity of magnitude $V_A = 8$ m/s, when it is hit as shown in the Fig. for Q. 4(a) by a 1.25 kg ball B, which has a velocity of magnitude 5 m/s. Knowing that the coefficient of restitution between the two balls is e = 0.75, and assuming no friction, determine the velocity of each ball immediately after impact. **(20)**

   (b) Crank AB as shown in the Fig. for Q. 4(b) has a constant angular velocity of 200 rpm counterclockwise. Determine the angular velocity of rod BD and the velocity of collar D when $\theta = 90°$. **(15)**

SECTION – B

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

5. (a) Two structural members A and B are bolted to a bracket as shown in Fig. for Q. 5(a). Knowing that both the members are in compression and that the force is 20 kN in member A and 30 kN in member B, determine the magnitude and direction of the resultant of the forces applied to the bracket by members A and B. **(15)**

   (b) It is known that connecting rod AB exerts on the crank BC (as presented in Fig. for Q. 5(b)) a 2.5 kN force directed down along the centerline of AB. Determine the moment of that force about C. **(20)**

6. (a) A uniform slender rod 25.4 cm long and weighing 4.6 gm is balanced on a glass of inner diameter 7 cm as presented in the Fig. for Q. 6(a). Neglecting friction, determine the angle θ corresponding to equilibrium. **(17)**

   (b) Locate the centroid of the plane area presented in Fig. for Q. 6(b). **(18)**

7. (a) Determine the force in each member of the truss presented in Fig. for Q. 7(a) state whether each member is in tension or compression. **(25)**

   (b) A 4.80 beam is subjected to the force shown in the Fig. for . 7(b). Reduce the given system of force to an equivalent force couple system at A. **(10)**

8. (a) Determine whether the 10-kg block presented in Fig. for Q. 8(a), is in equilibrium, and find the magnitude and direction of the friction force when P = 62.5 N and $\theta = 15°$. **(15)**

   (b) Determine the volume and total surface area of the body as shown in Fig. for Q. 8(b). **(20)**

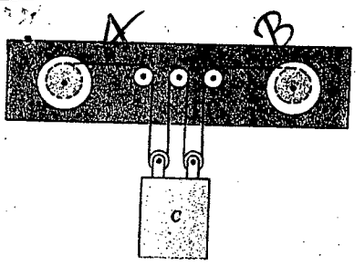

Fig for Q. 1. (a)

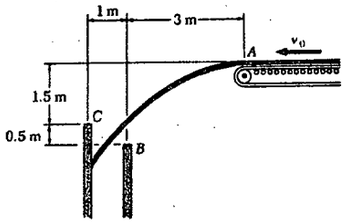

Fig. for Q. 1 (b)

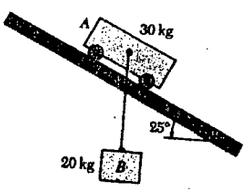

Fig for Q. 2(a)

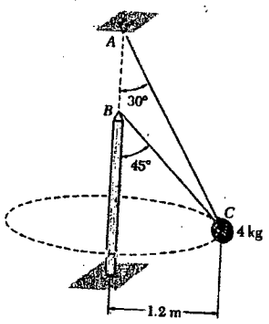

Fig. for Q. 2 (b)

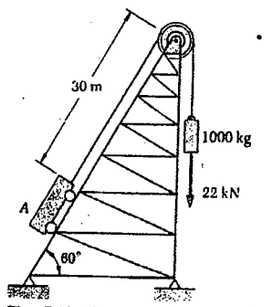

Fig. P13.16

Fig. for. Q. 3(a)

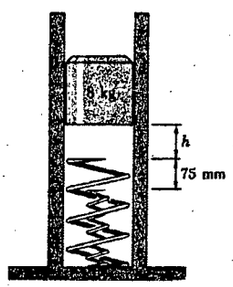

Fig. for. Q. 3(b)

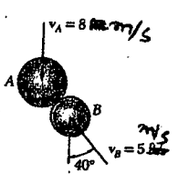

Fig. for Q. 4 (a)

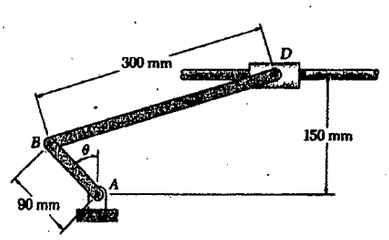

Fig. for. Q. 4 (b)

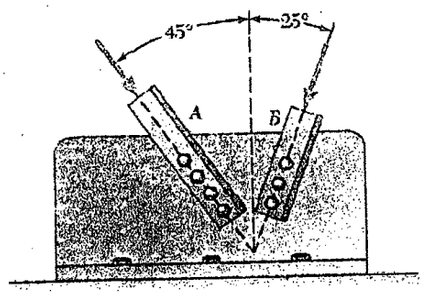

Fig. for Q 5.(a)

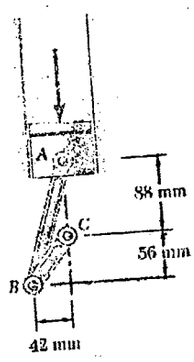

Fig. for Q 5.(b)

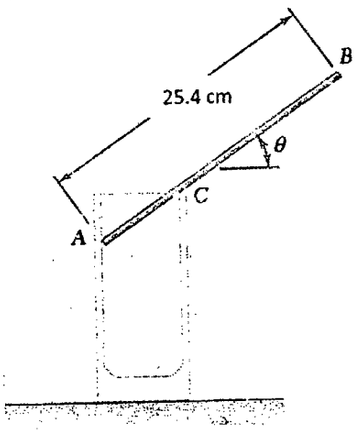

Fig. for Q 6.(a)

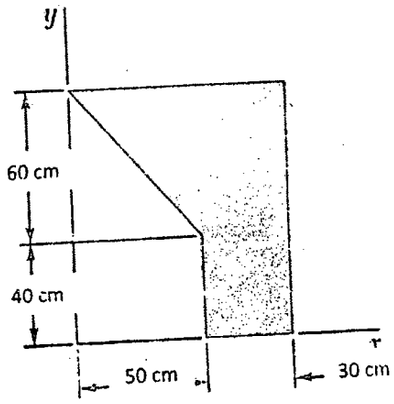

Fig. for Q 6.(b)

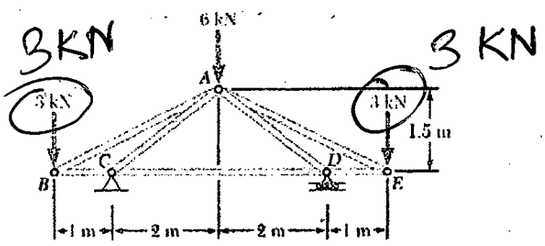

Fig. for Q 7.(a)

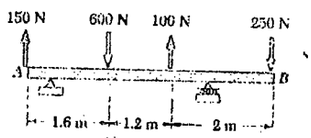

Fig. for Q 7.(b)

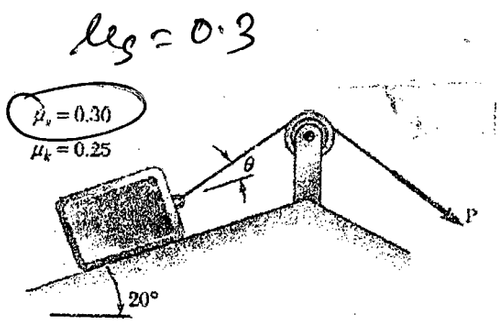

Fig. for Q 8.(a)

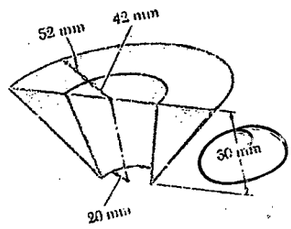

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Fig. for Q 8.(b)

L-1/T-1/CHE Date : 25/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **MATH 121** (Differential Calculus and Coordinate Geometry)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Check the continuity and differentiability of the function $f(x) = |x| + |x-1| + |x-2|$ at $x = 1$. Also sketch the function. **(15)**

   (b) Prove that every finitely derivable function is continuous. **(5)**

   (c) Find the n-th derivative of $y = \dfrac{1}{x^2 + b^2}$. Also find y_7. **(15)**

2. (a) State and prove Leibnitz's Theorem. If $x = \sin\left(\dfrac{1}{m}\ln y\right)$ then prove that **(17)**

   $$\left(1-x^2\right)y_{n+2} - (2n+1)\,y_{n+1} - \left(n^2 + m^2\right)y_n = 0.$$

   Also find $(y_n)_0$ where n is odd.

   (b) State and prove Lagrange's Mean Value Theorem. **(8)**

   (c) Expand $2x^3 + 7x^2 + x - 1$ in powers of $(x-2)$. **(10)**

3. (a) If $u = f(r)$ and $r^2 = x^2 + y^2$ then prove that $\dfrac{\partial^2 u}{\partial x^2} + \dfrac{\partial^2 u}{\partial y^2} = \dfrac{\partial^2 u}{\partial r^2} + \dfrac{1}{r}\dfrac{\partial u}{\partial r}$. **(13)**

   (b) Define homogeneous function with example. Write the statement of Euler's Theorem on homogeneous function and prove it. **(10)**

   (c) Find the vectorial angle of the point at which the tangent to the cardioide $r = a(1 + \cos\theta)$ is parallel to the initial line. **(12)**

4. (a) Show that in the curve $y = c\ln(x^2 - c^2)$, sum of the lengths of the tangent and the subtangent varies as the product of the co-ordinates of the point of contact. **(10)**

   (b) A farmer can afford for buying 8800 ft of wire fencing. He wishes to enclose a rectangular field of largest possible area. What should be the dimensions of the field? **(15)**

   (c) Find the values of p and q so that $\lim\limits_{x\to 0} \dfrac{x + px\cos x - q\sin x}{x^3} = 1$. **(10)**

Contd P/2

MATH 121

SECTION – B

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

5. (a) Simplify the equation $5x^2 - 2xy + 5y^2 + 2x - 10y - 7 = 0$ by suitable translation and rotation of axes. **(18)**

   (b) Identify the conic $16x^2 - 24xy + 9y^2 - 104x - 172y + 44 = 0$ and reduce it to its standard form. **(17)**

6. (a) Find the equations of the two lines represented by the equation $abx^2 + (a^2 + b^2)\,xy + aby^2 + ab\,(a - b)\,(x - y) - a^2b^2 = 0$. Show that they are equidistant from the origin. **(18)**

   (b) Prove that the straight lines represented by the equation $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ will be equidistant from the origin if $f^4 - g^4 = c\,(bf^2 - ag^2)$. **(17)**

7. (a) Prove that the limiting points of the system of circles $x^2 + y^2 + 2gx + c + \lambda\,(x^2 + y^2 + 2fy + k) = 0$ subtend a right angle at the origin if $\frac{c}{g^2} + \frac{k}{f^2} = 2$. **(18)**

   (b) Find the length of the intercept made by the parabola $y^2 = 4ax$ on the line $y = mx + c$ and deduce the condition for tangency. **(17)**

8. (a) Prove that the locus of the middle points of the portions of the tangents to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ included between the axes is the curve $\frac{a^2}{x^2} + \frac{b^2}{y^2} = 4$. **(18)**

   (b) Prove that the product of the perpendiculars from foci to any tangent to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is constant. **(17)**

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L-1/T-1/CHE Date : 27/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **CHEM 111** (Inorganic Chemistry)

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 are Effective Atomic Number (EAN) and EAN rule? Using EAN rule, explain formation of carbonyl complexes of transition metals having even and odd atomic numbers. Cite suitable examples. **(15)**

   (b) What are organometallic compounds? Comment on the possibility of formation of the following complex compounds: **(12)**

   $Cr(C_6H_6)_2$, $Fe(C_5H_5)_2$, $Mn(C_3H_5)(CO)_4$, $Fe(C_4H_6)(CO)_3$

   name the organic ligands present in the complexes.

   (c) Show the splitting of d-orbitals in case of octahedral ligand field. Calculate the energy of an electron in t_{2g} and in e_g orbital in terms of D_q value. **(8)**

2. (a) What is the basis of the Valence Bond Theory (VBT) of complex compounds? Mention the steps to be followed in complex formation according to VBT. Cite two examples in cases of complexes of chromium and iron with suitable ligands. **(12)**

   (b) What is Crystal Field Stabilization Energy (CFSE)? Calculate CFSE for d^{1-10} electrons for octahedral ligand field in low spin case. **(10)**

   (c) Discuss the factors which affect the splitting of d-orbitals. **(8)**

   (d) What is the main limitation of valance bond theory of complex compounds? Discuss how the limitation is considered to be minimized. **(5)**

3. (a) What is gyromagnetic ratio? A complex, $[CoF_6]^{3-}$ has a magnetic moment of 4.898 B.M. Show the formation and possible structure of the complex ion. **(10)**

   (b) Establish the geometrical structure of PCl_5, NH_4^+ and H_2O according to VSEPR model. **(9)**

   (c) Discuss the influence of lone pair and unpaired electron in determining the geometrical structures of the following species: **(9)**

   NO_2, NO_2^- and NO_2^+

   (d) From the following spectrum of a complex, $[Ti(H_2O)_6]^{3+}$, calculate the CFSE. What type of transition occurs there? **(7)**

Contd P/2

CHEM 111

4. (a) What is Schrödinger wave equation? Deduce the equation and comment on its solution. **(12)**

   (b) What is the wave length of a photon (in nm) emitted during a transition from the n_i = 5 state to n_f = 2 state in the hydrogen atom? **(8)**

   (c) Group the species that are isoelectronic: **(8)**

   Be^{2+}, F^-, Fe^{2+}, N^{3-}, He, S^{2-}, Co^{3+}, Ar

   (d) What is meant by the term 'shielding of electrons' in an atom? Using the Li atom as an example, describe the effect of shielding on the energy of electrons in an atom. **(7)**

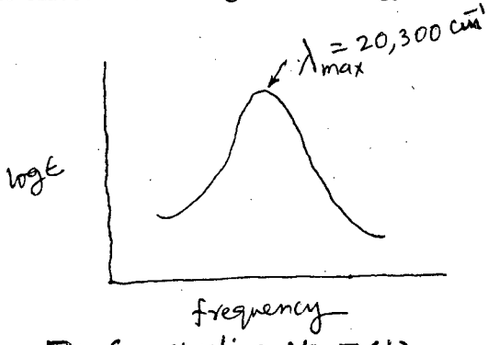

Fig. for question No. 3(d)

SECTION – B

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

5. (a) What are wrought iron, pig iron and steel? Discuss the process of conversion of pig iron into steel by the Bessemer process. **(6+10=16)**

   (b) Discuss the effect of carbon, sulphur and silicon on the properties of cast iron. **(12)**

   (c) Write a note on "case hardening". **(7)**

6. (a) Explain the terms "Hard and soft acids and bases" with appropriate examples. 'AgI_2^- ion is more stable than AgF_2^- ion' – explain it in the light of SHAB principle. **(10)**

   (b) Discuss the principle involved in the extraction of silver by the cyanide process. **(10)**

   (c) How do you explain the stability of Cu^{+1} and Cu^{+2} compounds? Write short notes on (i) cuprous oxide and (ii) silver oxide. **(5+10=15)**

7. (a) Compare carbon group elements with respect to electronic configuration, reactivity of tetrahalides and stability of hydrides. **(18)**

   (b) Matter and radiation have a "dual nature" – Explain. **(8)**

   (c) Define electron affinity. State the broad trend in electron affinity across any period. **(4+5=9)**

8. (a) Describe molecular orbital theory? How does it differ from valence bond theory? **(8+5=13)**

   (b) Determine the hybridization state of the central (underlined) atom in each of the following molecules: (i) $\underline{Be}H_2$, (ii) $\underline{Al}I_3$ and (iii) $\underline{P}F_3$. Describe the hybridization process and determine the molecular geometry in each case. **(9)**

   (c) Predict whether each of the following molecules has a dipole moment: (i) BrCl, (ii) BF_3, (iii) CH_2Cl_2. **(6)**

   (d) Write short note on effective nuclear charge. **(7)**
