WINTER– 16 EXAMINATION
Model Answer

Subject Code: 17102

Important Instructions to examiners:

1) *The answers should be examined by key words and not as word-to-word as given in the model answer scheme.*
2) *The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.*
3) *The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.*
4) *While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.*
5) *Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.*
6) *In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.*
7) *For programming language papers, credit may be given to any other program based on equivalent concept.*

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.		**Attempt any NINE of the Following:**	**18**
	a)	**Define Elastic limit.**	**2**
		Elastic limit: It is the maximum value of the stress upto which the body shows elasticity.	
	b)	**Define Poisson's ratio.**	**2**
		Poisson's ratio: It is defined as the ratio of lateral strain to longitudinal strain.	
	c)	**Define coefficient of viscosity. Write down its SI unit.**	**2**
		Definition	1
		SI Unit	1
		Coefficient of viscosity: - The coefficient of viscosity η is defined as the viscous force developed between two liquid layers of unit surface area in contact which maintains unit velocity gradient.	
		SI Unit: - Ns / m^2	
	d)	**Calculate the pressure at a depth 12 m inside the water.**	**2**
		Formula and substitution	1
		Answer with unit	1

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	d)	$P = h\rho g$ $P = 12 \times 10^3 \times 9.81$ **$P = 1.177 \times 10^5$ N/m^2**	
	e)	**Define capillarity or capillary action.** **Capillarity: -** The rise or fall of a liquid inside the capillary is called as capillarity.	**2** 2
	f)	**State law of thermal conductivity. State its S.I. unit.** **Statement** **unit** **Statement:** It states that the amount of heat flowing through metal rod at steady state is directly proportional to i) Cross-sectional area of rod (A) ii)Temperature difference between two surfaces of the conductor (θ_1- θ_2) iii) Time for which heat flows. (t) and inversely proportional to iv)Distance between two surfaces. **S.I. unit: watt/m ^{o}K**	**2** 1 1
	g)	**Distinguish between isothermal process & adiabatic process** **Any two points**	**2** 2

ISOTHERMAL PROCESS	**ADIABETIC PROCESS**
Volume & pressure changes at constant temperature.	Volume & pressure changes at changing temperature.
Gas is filled in a good conductor of heat.	Gas is filled in a bad conductor of heat.
Transfer of heat takes place.	There is no transfer of heat.
Volume changes are made slowly.	Volume changes are made rapidly.
Gas obeys Boyle's law i.e. PV= constant.	Gas does not obeys Boyle's law Here PV^{γ} = constant.
Expansion of gas takes place.	Compression of gas takes place.
Ex. Boiling of water.	Ex. Bursting of cycle tyre.

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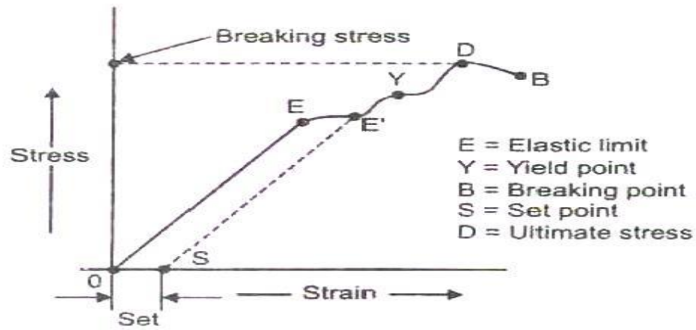
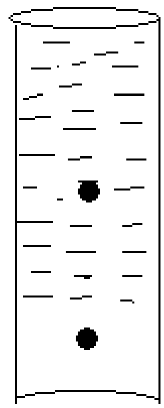
1.	h)	**100 ml of air is measured at 20 ^{0}C. If the temperature of air is raised to 50 ^{0}C. What will be its volume? Pressure of air remains constant.** **constant.** **Formula** **Answer with unit** **Given** V_1 = 100 ml V_2 =? t_1 = 20 ^{0}C t_2 = 50 ^{0}C T_1 = 20 + 273 T_2 = 50 + 273 T_1 = 293 ^{0}K T_2 = 323 ^{0}K $V_1/T_1 = V_2/T_2$ $V_2 = V_1 \times T_2 / T_1$ $V_2 = 100 \times 323 / 293$ **V_2 = 110.24 ml.**	**2** 1 1
	i)	**Define: (i) Amplitude (ii) Frequency.** **Each definition** **Amplitude-**It is defined as the maximum displacement of the particle from either side of mean position. **Frequency -**The number of cycle or oscillation or vibration completed in one second is called as frequency**.**	**2** 1
	j)	**A body produces wave of wave length 33 cm. What is the frequency of vibration if velocity of propagation is 330 m/s?** **Formula** **Answer with unit** **Given** Wavelength (λ) = 33 cm = 33 x 10^{-2} m Velocity (V)= 330 m/s Frequency (n) =?	**2** 1 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
1.	j)	We have, $V = n\lambda$ $n = V/\lambda$ $n = 330/33 \times 10^{-2}$ **$n = 10 \times 10^{2}$ Hz.**	
	k)	**Define free and forced vibrations.** **Each definition** **Definition** **Free vibrations:** If a body vibrates freely on its own frequency then such vibration are called free vibrations. **Forced vibrations**: If a body vibrates other than its natural frequency then such vibration is called as forced vibration.	**2** 1
	l)	**State the formula for velocity of sound by resonance tube method.** **Formula:** V = 4nL or V = 4n (l + 0.3D)	**2**
2.		**Attempt any FOUR of the following:**	**18**
	a)	**Define: Young's modulus, Bulk modulus, Rigidity modulus of Elasticity. Give relation between them.** **Each Definition** **Relation** **Young's modulus(Y):** Within elastic limit the ratio of longitudinal stress to longitudinal strain called Young's modulus. **OR** It is the ratio of tensile stress to tensile strain. **Bulk Modulus(K):** Within elastic limit the ratio of volume stress to volume strain is called Bulk modulus. **OR** It is the ratio of volume stress to volume strain. **Modulus of Rigidity(η):** Within elastic limit the ratio of shearing stress to shearing strain is called modulus of rigidity. **OR** It is the ratio of shearing stress to shearing strain. **Relation between Y , η and K:-** $Y = \frac{9\eta K}{3K + \eta}$ **OR** $\frac{1}{Y} = \frac{1}{3\eta} + \frac{1}{9K}$	**4** 1 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	b)	**Explain stress-strain diagram.** **Diagram** **Explanation**  A graph or diagram of stress and strain is shown as above. **OE** Portion is straight line which indicates that stress is proportional to strain. The wire obeys Hooke's law upto the point E this point is called elastic limit. **EE'** Portion is curved towards strain axis this shows that increase in strain is more, than increase in stress. In this region stress is not proportional to strain. Between any point E and E' if all load is removed then some permanent elongation/ Expansion / increase in length takes place in the wire this is called set. When wire is again loaded, a new straight line SE' is obtained which obey Hooke's law. Some portion after the point Y is almost parallel to strain axis this shows that strain increases without increase in stress just like wire flows. This is called plastic flow. The point at which the plastic flow begins is called yield point. During the plastic flow the wire becomes thin and thin. Some weak points called neck are formed in the wire. At weakest point (neck), wire breaks. The maximum stress upto which wire can be loaded or wire can bear is called breaking stress. Point B is breaking point. Before point B the point D is ultimate stress point. It is the max. stress the wire is capable of withstanding.	4 1½ 2½
	c)	**Derive Stoke's formula in viscosity.** **Derivation** Consider a metal sphere placed on the surface of liquid taken in glass jar. Its observed that after covering certain distance, metal sphere attains a constant velocity. Metal sphere falling freely through a liquid experiences three forces i) Weight of the metal sphere in the downward direction ii) Force of viscosity in the upward direction. iii) Up thrust force in the upward direction By Archimedes's principle Up-thrust force = Loss of weight of body in liquid = Weight of liquid displaced	4

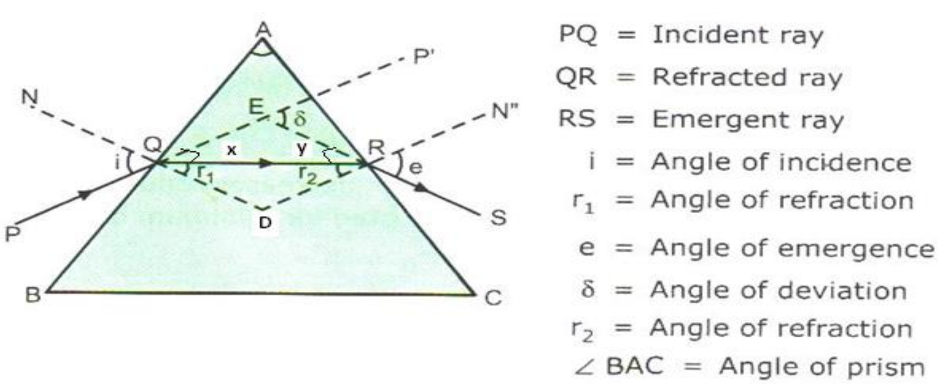
Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	c)	Since metal sphere falls with constant velocity, the total upward force is equal to the downward force. Total upward force = The downward force [Force of viscosity] + [up thrust force] = weight of the metal sphere [$6\pi\eta r v$]+ [Weight of liquid displaced] =[Mass of metal sphere X g]  $[6\pi\eta r v]+\frac{4}{3}\pi r^3\rho g=\frac{4}{3}\pi r^3 d g$ $[6\pi\eta r v]=\frac{4}{3}\pi r^3 d g-\frac{4}{3}\pi r^3\rho g$ $6\pi\eta r v=\frac{4}{3}\pi r^3 g(d-\rho)$ $\eta=\frac{\frac{4}{3}\pi r^3 g(d-\rho)}{6\pi r v}$ $\eta=\frac{2}{9}\frac{r^2 g(d-\rho)}{v}$ Where, η = Coefficient of viscosity of liquid r = radius of metal sphere d= density of metal sphere ρ = density of liquid v= terminal velocity	1 1 1 1

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	d)	**Define Reynold's number. State its significance.** **Definition.** **Significance.** **Reynolds Number:** It is a dimensionless quantity that is used to determine the nature of flow of liquid through a tube. **Significance:** (1) When R is less than 2000 liquid flow is streamline. (2) When R is between 2000 to 3000 liquid flow is unstable. (3) When R is greater than 3000 liquid flow is turbulent.	**4** 1 3
	e)	**A capillary tube of diameter 1 mm is dipped in water. How far will the water rise in the tube of surface tension of water is 7.2 x 10^{-2} N/m? Density of water = 1 x 10^{3} kg/m^{3}.** **Formula and substitution.** **Answer with unit.** **Given:** diameter(d) = 1 mm = 1 x 10^{-3} m, r =0.5 x 10^{-3} m, T = 7.2 x 10^{-2} N/m ρ = 1 x 10^{3} kg/m^{3}, g = 9.81 m/s^{2}, for water $\theta = 0^{0}$,Cos 0 =1 $T = \frac{hr\rho g}{2\cos\theta}$ $h = \frac{2T}{r\rho g}$ h = 2 x 7.2 x 10^{-2} / 0.5 x 10^{-3} x 10^{3} x 9.81 **h = 0.0293 m**	**4** 2 2
	f)	**Find the quantity of heat conducted in 5 minutes across a silver sheet of size 40 cm x 30 cm of thickness 3 mm. If its two faces are at temperatures of 40 ^{0}C and 25 ^{0}C, k for silver = 0.1 kcal/m ^{0}C S.** **Formula and substitution.** **Answer with unit.**	**4** 2 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
2.	f)	**Given:** t = 5 minutes = 5 x 60 =300 Sec, A= 40 cm x 30 cm = 1200 cm^2 = 1200 x 10^{-4} m^2 d = 3 mm = 3 x 10^{-3} m, θ_1 = 40 ^0C, θ_2 =25 ^0C, k = 0.1 kcal/m ^0C S, Q =? We have, $Q = \frac{k \times A(\theta_1 - \theta_2) \times t}{d}$ $Q = \frac{0.1 \times 1200 \times 10^{-4}(40-25) \times 300}{3 \times 10^{-3}}$ **Q = 18000 kcal**	
3.		**Attempt any FOUR of the following:**	**16**
	a)	**State and explain three modes of transmission of heat.** **State (Names)** **Explanation**	**4** 1 3

1. Conduction **2.** Convection **3.** Radiation

Conduction	**Convection**	**Radiation**
1. It is the process of transfer of heat from a part of a body at higher temperature to a part of body at lower temperature without actual movement of particles.	1. It is the process of transfer of heat from a part of a body at higher temperature to a part of body at lower temperature with actual movement of particles.	1. It is the process of transfer of heat from a body at higher temperature to a body at lower temperature without necessity of intervening medium
2 If metal rod is heated at one end, its other end gets heated.	2. Heating of water in a beaker.	2. Heat from sun reaches the earth.
3. Material medium is essential.	3. Material medium is essential.	3. Material medium is not essential.
4. Metal rod itself acts as a medium.	4. Liquid itself acts as a medium.	4. Medium may be present like air or no medium. i.e. vacuum.
5.It has applications like-Heat sink in electronic circuits, Safety lamp, Ice box etc.	5. It has applications like- Formation of trade winds, Room ventilation system, monsoons etc.	5. It has applications like- Use of white clothes, Heat radiators in car, In activation of HIV etc.

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	b)	**Define Cp and Cv and Derive relation between them.** **Each definition.** **Derivation.** **Specific heat of a gas at constant volume(Cv):** Specific heat of a gas at constant volume is defined as the amount of heat required to increase the temperature of unit mass of a gas by one degree at constant volume. **Specific heat of a gas at constant pressure(Cp):** Specific heat of a gas at constant pressure is defined as the amount of heat required to increase the temperature of unit mass of a gas by one degree at constant pressure. In case of Cv whatever may be amount of heat is supplied is used to increase only temperature of gas because volume of gas is constant. In case of Cp whatever may be amount of heat is supplied is used to i) increase temperature of gas ii) increase volume of gas Thus in case of Cp, some addition heat is required for expansion. Cp = Cv + Heat required to increase the volume of a gas. Cp = Cv + H Cp = Cv +W/J………. by Joule's law Cp = Cv + P (V_2-V_1)/J **Cp – Cv = R/J** This is the relation between Cp and Cv.	**4** 1 2
	c)	**Derive prism formula.** **Diagram.** **Derivation.**  	**4** 2 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	c)	Let PQ be the incident ray obliquely incident on refracting face AB. At point Q the ray enters from air to glass therefore at Q the incident ray is refracted and travels along QR by making $\angle r_1$ as angle of refraction. At point R the ray of light enter from glass to air and get refracted along RS. From ΔEQR $\delta = x + y$ $\delta = (i - r_1) + (e - r_2)$ $\delta = (i + e) - (r_1 + r_2)$ ----(1) From ΔQDR $\angle r_1 + \angle r_2 + \angle QDR = 180^0$ -----------------(2) As AQDR is cyclic quadrilateral $\angle A + \angle QDR = 180^0$ -----------------------------(3) By comparing eq.(2) and(3) $A = r_1 + r_2$ -----------------------------(4) Substituting above value in eq.(1) Eq.(1) becomes $\delta = (i + e) - A$ $\delta + A = (i + e)$ ---------------------------(5) If $\delta = \delta m$ $i = e$ And $r_1 = r_2 = r$ Equation (5) Becomes $A + \delta m = i + i$ $A + \delta m = 2i$ $i = \frac{A + \delta m}{2}$ And equation (4) becomes $A = r + r$ $A = 2r$ $r = \frac{A}{2}$	

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	c)	According to Snell's law $$\mu = \frac{\sin i}{\sin r}$$ Substituting values of i and r in above equation $$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$ Above formula is called as prism formula	
	d)	**Numerical aperture of fiber is 0.244 and refractive index of cladding is 1.48. calculate refractive index of core and acceptance angle.** **Formula and Substitution.** **Answer with unit.** **Given** μ_{core} = ? μ_{clad} = 1.48 N_A =0.244 N_A= Sin θ_a where θ_a, is called acceptance cone angle. $(N_A)^2 = (\mu_{core})^2 - (\mu_{clad})^2$ $(\mu_{core})^2 = (N_A)^2 + (\mu_{clad})^2$ $(\mu_{core})^2 = (0.244)^2 + (1.48)^2$ $\mu_{core} = 1.49999$ $\boldsymbol{\mu_{core} = 1.50}$ $\sin\theta_a = N_A$ $\theta_a = \sin^{-1}(N_A)$ $\theta_a = \sin^{-1}(0.244)$ $\boldsymbol{\theta_a = 14.12^0}$	**4** 2 2

Q. No.	Sub Q.N.	Answer	Marking Scheme
3.	e)	**Define transverse wave. State its three characteristics.** **Definition.** **Any three points.** **Transverse waves:** The wave in which direction of vibration of particles of material medium is perpendicular to the direction of propagation of wave is called transverse wave. **Characteristics of transverse wave.** 1. The wave in which direction of vibration of particles of material medium is perpendicular to the direction of propagation of wave is called transverse wave. 2. Wave travels in form of alternate crests and trough. 3. Density and pressure of medium remain same. 4. Wave travels through solid only e.g. Light wave	**4** 1 3
	f)	**Calculate velocity of sound if resonating length 14 cm is observed for tuning fork of frequency 512 Hz.** **Formula and Substitution.** **Answer with unit.** **Given:** n = 512 Hz. $L = 14 \text{ cm} = 14 \times 10^{-2}$ m V=? **Formula –** $V = 4nL$ $V = 4 \times 512 \times (14 \times 10^{-2})$ **$V = 286.72$ m/s**	**4** 2 2