THE OPEN UNIVERSITY OF SRI LANKA

CREDIT CERTIFICATES FOR FOUNDATION COURSES IN SCIENCE

TAF2501 – PHYSICS -3

FINAL EXAMINATION

DURATION – THREE HOURS

Date: 23rd June 2019 **Time: 0930-12 30 Hours**

Part -A

- The Question paper consists of 25 multiple choice questions
- Answer all the questions
- Answers for the Multiple Choice Questions, should be provided by placing X in the relevant cage indicating the most appropriate answer in the MCQ answer sheet provided
- At the end of the examination you should submit the question paper with answer sheet.
- Maximum marks for this part is 40%.

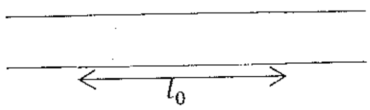
(1) If the fractional change in the volume of solid, when heated from 10 °C to 110 °C is 0.0027, the linear expansivity of the material of the solid is,

(1) $27 \times 10^{-6}K^{-1}$ (2) $3 \times 10^{-6}K^{-1}$ (3) $27 \times 10^{-4}K^{-1}$ (4) $3 \times 10^{-7}K^{-1}$ (5) $9\times 10^{-6}K^{-1}$

(2) A rectangular block is heated from 0 °C to 100 °C. The percentage increase in its length is 0.1 %. What would be the percentage increase in its volume?

(1) 0.1% (2) 0.3% (3) 0.01% (4) 0.03% (5) None of the above

(3) A liquid of volume expansivity γ forms a liquid thread of length l_0 inside a tube made of material of linear expansivity α as shown in the figure. If the temperature is increased by an amount of θ, the length of the liquid thread will become



(1) l_0 (2) $l_0\frac{(1+\gamma\theta)}{(1+\alpha\theta)}$ (3) $l_0(1+\gamma\theta)(1+2\alpha\theta)$ (4) $l_0\frac{(1+\gamma\theta)}{(1+2\alpha\theta)}$ (5) $l_0\frac{(1+\gamma\theta)}{(1+3\alpha\theta)}$

(4) A water fall is 84 m high. Assuming that half of the kinetic energy of the flowing water is converted to heat, what would be the rise in temperature? (Specific Heat Capacity of water = 4200 $Jkg^{-1}K^{-1}$)

(1) 0.1°C (2) 0.2°C (3) 0.3°C (4) 0.4°C (5) 0.8°C

(5) 10 g of steam of 100 °C is mixed with 10 g of ice at 0 °C. The final temperature of the mixture will most likely to be

(1) 30°C (2) 40°C (3) 50°C (4)less than 50°C (5) greater than 50°C

(6) At the atmospheric pressure, the specific latent heat of fusion of ice and specific latent heat of vaporization of water are 3×10^5 J Kg^{-1} and 20×10^5 J kg^{-1} respectively. If the specific heat capacity of water is 4×10^3J $K^{-1}Kg^{-1}$, then the minimum amount of energy required to convert 2 kg of ice at 0 °C to steam of 100 °C under atmospheric pressure is,

(1) 20×10^5J (2) 24×10^5J (3) 27×10^5 J (4) 30×10^5J (5) 54×10^5J

(7) A vessel containing 0.5 kg of liquid is heated by a coil of 15 W. It attains a steady state temperature of 70 °C. When the heater is switched off the initial rate of fall of temperature is 1.2 K min^{-1}. What would be the value of specific heat capacity of the liquid? (neglect the heat capacity of the container)

(1) 15 $J\,kg^{-1}K^{-1}$ (2) 25 $J\,kg^{-1}K^{-1}$ (3) 150 $J\,kg^{-1}K^{-1}$ (4) 1250 $J\,kg^{-1}K^{-1}$

(5) 1500 $J\,kg^{-1}K^{-1}$

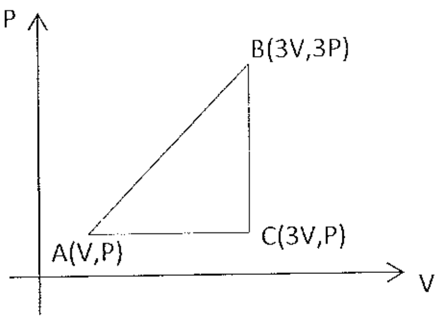
(8) A fish in a lake release an air bubble of volume $2.5\times 10^{-7}m^3$. This bubble subsequently releases a volume of $10^{-6}\,m^3$ air into atmosphere. If the atmospheric pressure is 10^5 Pa and density of water is 10^3kg m^{-3}, depth of the position of the fish is,

(1) 30 m (2) 40 m (3) 50 m (4) 60 m (5) 80 m

(9) A gas at 27 °C and pressure of 30 atm allowed to expands to 15 times larger volume at atmosphere pressure (1 atm) . The final temperature of the gas is,

(1) 27°C (2) 54°C (3) 273°C (4) -123°C (5) 373°C

(10)



An ideal gas is taken around the path ABCA as shown in the figure. What would be the work done during a cycle?

(1) PV (2) 2PV (3) 3PV (4) 4PV (5) 0

(11) Saturated vapour pressure at room temperature (20°C) and at the dew point (10°C) are 17.54 Hgmm and 8.02 Hgmm respectively. The relative humidity of the atmosphere is,

(1) 22 % (2) 46 % (3) 30 % (4) 56 % (5) cannot be calculated

(12) Rate of heat flow in well lagged cylindrical rod is Q. If the length and radius are doubled and , what would be the new rate of heat flow? (Temperature differences between two ends are same)

(1) 8Q (2) Q (3) 2Q (4)$\frac{Q}{8}$ (5)$\frac{Q}{4}$

(13) In a thermodynamic process, the pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas. If the initial energy of the gas is 30 J, What would be the final internal energy?

(1) 2 J (2) 12 J (3) 18 J (4) 22 J (5) 28 J

(14) A sphere of radius r and mass m is hanging from a light string and half of it is immersed in a liquid of density ρ and the surface tension T. What is the tension F of the string?

(1)F=mg+$2\pi rT$ (2) F=$2\pi rT$ (3)F=mg+$\pi r^2 T+\frac{2}{3}\pi r^3 \rho g$ (4) F=mg+$2\pi rT - \frac{2}{3}\pi r^3 \rho g$

(5) F=$2\pi rT$- $\frac{2}{3}\pi r^3 \rho g$

(15) An air bubble of radius r is formed at a depth h inside a container of a liquid of density ρ. If π is the atmospheric pressure and T is the surface tension of the liquid, then the total pressure inside the bubble?

(1)$\frac{2T}{r}+h\rho g$ (2)$\frac{2T}{r}-h\rho g$(3)$\pi+h\rho g+\frac{2T}{r}$ 4)$\pi+h\rho g-\frac{2T}{r}$ (5)$\pi+\frac{4T}{r}$

(16) What would be the energy needed to double the radius of a soap bubble of radius r, without changing temperature? (Surface tension of the soap film is T)

(1)$2\pi r^2$T (2)$4\pi r^2$T(3)$8\pi r^2$T(4)$12\pi r^2$T (5)$24\pi r^2$T

(17) Energy needed to break a large mercury drop of radius 'R' into n drops of radius 'r' is,

(Surface tension of mercury is T)

(1)$(4\pi R^2-4\pi r^2)$nT (2) $(4\pi r^2 n-4\pi R^2)$T (3)$(\frac{4}{3}\pi R^3-\frac{4}{3}\pi r^3)$T (4)$(2\pi R^2-n2\pi r^2)$T
(5) $(\frac{4}{3}\pi R^3-\frac{4}{3}\pi r^3)$nT

(18) A flat plate of area 'A' is placed on a flat surface and separated from it by a film of oil of thickness 'd' whose coefficient of viscosity is η. What would be the force required to cause the plate to slide at the constant velocity V?

(1) η AV (2) 6πηaV (3)ηAVd (4) ηAV/d (5) 6πηa

(19) V_1 and V_2 be the volumes of two liquids flowing out of the same tube in same interval of time and the η_1 and η_2 are the coefficient of viscosity respectively. What would be the correct relationship?

(1) $\frac{\eta_1}{\eta_2}=\frac{v_1}{v_2}$ (2)$\frac{\eta_1}{\eta_2}=\frac{v_2}{v_1}$ (3)$\frac{\eta_1}{\eta_2}=\frac{v_1^2}{v_2^2}$ (4)$\frac{\eta_1}{\eta_2}=\frac{v_2^2}{v_1^2}$ (5)$\frac{\eta_1}{\eta_2}=\left(\frac{v_1}{v_2}\right)^{\frac{1}{4}}$

(20) A solid ball of volume V is dropped into a viscous liquid. It experience a viscous force F. If a solid ball of volume 8V and the same material is dropped into the same liquid, the viscous force is (in both situations velocities are same)?

(1) F (2) 2F (3) 3F (4) 8F (5) 16 F

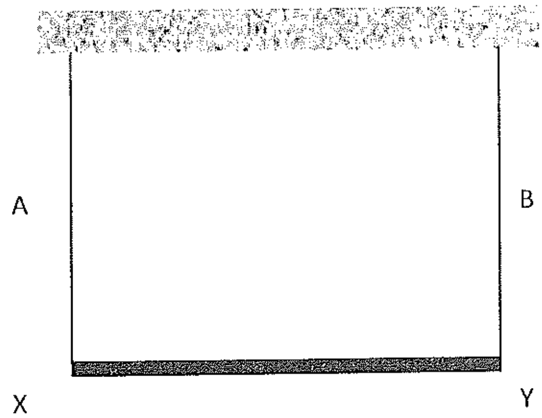
(21) Two spherical rain drops of equal size are falling vertically through air with terminal velocity V. They coalesce to form a large drop. What would be the terminal velocity of the large drop?

(1) $\frac{V}{2}$(2) V (3)$2^{\frac{1}{2}}V$ (4) $2^{\frac{2}{3}}V$ (5) 2^3V

(22) The material of the human bone has young's modulus 10^{10}N m^{-2} . It fracture when the compressive strain exceeds 1% the maximum load. The load that can be sustained by a bone of cross-section area of 3× $10^{-4}m^2$ is

(1) 3× 10^2N (2) 3× 10^4N (3) 3× 10^6N (4) 3× 10^8N
(5) 3× 10^{10}N

(23)A smooth light plank XY of length L is supported horizontally by two cables A and B of equal lengths as shown in the figure. The area of cross-section and young's modulus of B is half of those of A. Calculate the distance from X to a point where a weight W can be placed to have same elongation in both A and B.



(1)L/2 (2) L/3 (3) L/5 (4) L/8 (5) L/16

(24) A wire is stretched by a force F. The developed strain and the young's modulus of the material is 'S' and Y. What would be the work done per unit volume in the wire?

(1) $\frac{S^2}{2Y}$ (2) $Y\frac{S^2}{2}$ (3) $\frac{1}{2}FS$ (4) $\frac{Y}{2S^2}$ (5) $\frac{1}{2}FS^2$

(25) A uniform rubber cord of L (m) length long and area of cross-section A (m^2) is suspended vertically. If the density of the rubber is ρ (kgm^{-3}) and Young's modulus Y (N m^{-2}) what would be the extension of the cord under its own weight?

(1) $\frac{L^2\rho g}{Y}$ (2) $\frac{L^2\rho g}{2Y}$ (3) $\frac{L^2\rho g}{4Y}$ (4) $\frac{LA\rho g}{2Y}$ (5) $\frac{Y}{L^2\rho g}$

End of the part A

Part - B

- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earn fifteen(15) marks, amounting to total of 60% marks.**

(1) You have been asked to perform an laboratory experiment to find out the specific latent heat of fusion of ice, using the method of mixtures.

(a) Prepare a list of items needed to perform this experiment **(Marks 02)**

(b) What are the measurements, you are taking? **(Marks 04)**

(c) Write down the equation needed to calculate the latent heat of fusion of ice, using the measurements you are taken in 'b'. **(Marks 05)**

(d) What are the precautions you take in order to obtain accurate results? **(Marks 02)**

(e) Describe one experimental technique you are taking in order to minimize the error due to exchange of heat with surrounding. **(Marks 02)**

(2)(a).State the Boyls' Law and Charles Law and use them to derive the equation of state PV=nRT **(Marks 05)**

(b).Calculate the value of 'R' in SI units.(At S.T.P, 1 mol of Ideal gas occupy $22.4 \times 10^{-3} m^3$ of volume) **(Marks 04)**

(c). A mercury barometer tube with scale attached, has a small air volume above the mercury column. The top of the tube is 1 m above the level of the mercury in the reservoir. When the tube is vertical, the height of the mercury column is 700 mm. When the tube is inclined of 60^0 to the vertical, the reading of the mercury level on the scale is 950 mm. What would be the atmospheric pressure? **(Marks 06)**

(3) (a) State the Newton's Law of Cooling? **(Marks 03)**

(b) State under what conditions the law is valid? **(Marks 02)**

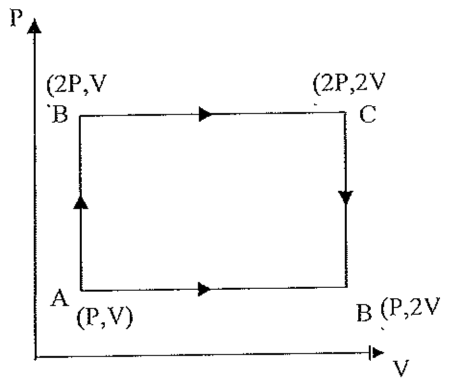
(c) A heater is immersed in a calorimeter contains some liquid at 30°C. It attains the steady temperature at 70°C . If another heater of high power is used and the steady temperature is 110 °C. Calculate the ratio $\frac{\text{Power of the second coil}}{\text{Power of the first coil}}$.

(04 marks)

(d) When a metal cylinder of mass 5× 10^{-2} kg of heat capacity 500 J $kg^{-1}K^{-1}$ is heated by an electric heater work with continuous power and initial rate of rise in temperature is 5 K min^{-1}. After some time the heater is switched off and initial rate of fall of temperature is 0.5 K min^{-1} .What is the rate at which the cylinder gain heat immediately before the heater is switched off? **(06 marks)**

(4) (i) State the First law of thermodynamics **(02 marks)**

(ii) An ideal mono-atomic gas is taken around the cycle. ABCDA as shown in P-V diagram. What is the work done during the cycle?



(04 marks)

(III)IAt the temperature 100^0C and pressure of 1× 10^5Pa , 1 kg of steam occupies 1.67 m^3, at the same mass of water occupying only 1.04 × $10^{-3}m^3$. For a system consisting 1 kg of water changing to steam of 100^0C at 1× 10^5Pa pressure calculate,

(a) The heat supplied to the system.

(b) The work done by the system

(c) The increase in the Internal energy of the system. **(09 marks)**

(5) (a) Define the 'Surface tension " of a liquid. **(02 marks)**

(b)Derive an expression for excess pressure in an air bubble of radius 'r' liquid of surface tension 'T' **(03 marks)**

(c) Sphere of radius 'r' is hanging from a light string and half of it immersed in a liquid of density 'ρ'.
(Surface tension of the liquid is 'T' and the density of the material of the sphere is (σ')

(i) What is the surface tension force acting on the sphere
(ii) Determine the tension of the string **(06 marks)**

(d) Calculate the pressure inside air bubble of radius 3 mm which is formed 1000 m below a water surface. **(04 marks)**
(surface tension of the water is 0.072 N m^{-1}, Density of water 1000 $kg\ m^{-3}$, atmospheric pressure $10^5\ N\ m^{-2}$)

(6) (a) Viscous force F acting on a sphere of radius 'a' moving with velocity V in a fluid of viscosity η is given by F= $6\pi\eta^x a^y v^z$. Find the values of x, y and z. **(03 marks)**

(b) A small sphere of radius 'a' falling from the rest through a viscous medium of viscosity η and density 'ρ'. Describe the motion of the sphere. Explain why it attains a constant velocity called terminal velocity? **(05 marks)**

(c)Derive an expression for the terminal velocity of the sphere.
Density of the material of the sphere is 'σ'. **(03 marks)**

(d)Draw velocity-time (v-t), displacement-time (s-t) and acceleration-time (a-t) curve for the motion of the sphere. **(04 marks)**