THE OPEN UNIVERSITY OF SRI LANKA
ADVANCED CERTIFICATES IN SCIENCE
TAF2525-PHYSICS – 3
FINAL EXAMINATION
DURATION – THREE HOURS

Date : 9th December 2021 Time :1.30-4.30 pm

Part -A

- The Question paper(Part A) 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%.

(01) Consider following statements about Moment of Inertia I

(A) It's depend only on mass m

(B) It's a scalar quantity

(C) It's Units is kg^2m^2

Of the above statements,

((I.) only A & B are correct (ii) Only B & C is correct (iii) Only B is correct

(iv) All are correct (v) All are incorrect

(02). A flywheel of moment of inertia 10 kg m^2 about the perpendicular axis through the center, is connected to a motor. The motor accelerates the flywheel from rest to 300 revolutions in a minute. What would be the work done on the flywheel in joules?

(i) 500 π^2 (ii) 900 π^2 (iii) 1800 π^2 (iv) 4000 π^2 (v) 6000 π^2

(03) A rocket caries 2.0 x 10^4 kg of liquid oxygen in a tank of cross section 4 m^2. At the lift off the rocket accelerates vertically upward at 2 m s^{-2} relative to earth. The pressure on the bottom of the tank at the lift off is,

(1) 2 x 10^4 N m^{-2} (2) 4 x 10^4 N m^{-2} (3) 8 x 10^4 N m^{-2} (4) 6 x 10^4 N m^{-2} (5) 7.2 x 10^4 N m^{-2}

(04) A constant torque acting on a uniform circular wheel changes its angular momentum from **A** to 5**A** in 8 seconds. The magnitude of this torque is,

(1) 3A/4 (2) A (3) A/2 (4) A /4 (5) 2A

(05) A rotor of mass **m** kg and radius of gyration **r** (m) is rotating at a speed of **n** rpm. If the

Rotor comes to rest after **t** seconds, the frictional torque at the bearing is,

(1) 2π mr^2 n/ 60 x t (2) mr^2 n/t (3) mr^2 / 60x t (4) mr^2 n /60xt (5) cannot be calculated

(06) A child of mass m is sitting on a swing of negligible mass. The swing is attached to its pivot by two ropes, each of length r. The maximum speed of the child during a swing is found to be V. The maximum tension in each rope is,

(1) $\frac{mg}{2}+\frac{mv2}{2r}$ (2) mg $+\frac{mv2}{r}$ (3) $\frac{mv2}{r}$ (4) mg $-\frac{mv2}{r}$ (5) mg

(07) Equal masses of two liquids of densities d_1, d_2, are added together. If the liquids mix together without causing any change, then What is the density of the composite liquid?

(1) $\frac{d1+d2}{2}$ (2) $\frac{d1d2}{2}$ (3) $\frac{2d1d2}{d1+d2}$ (4) $\frac{d1+d2}{d1d2}$ (5) Cannot calculate

(08) $\frac{1}{4}$ th of the total volume of a body is immersed in water with density 1000 kg m^{-3}. What would be the density of the object?

(1) 200 kg m^{-3} (2) 250 kg m^{-3} (3) 300 kg m^{-3} (4) 2000 kg m^{-3} (5) 4000 kg m^{-3}

(09)A uniform horizontal circular platform of mass 200 kg is rotating at 10rpm about the vertical axis passing through its centre with.a boy of mass 50 kg is standing at it's edge.If the boy moves to the centre of platform, the frequency of rotation would become,

(Moment of Inertia of a disc= ½ m r^2)

(1) 7,0 rpm (2) 7.5 rpm (3) 15 rpm (4) 20 rpm (5) 25 rpm

(10)The reading of a spring balance when a block is suspended from it in air is 60N.When the block is fully submerged in water the reading is 40N. What would be the relative density of the block?

(1) 2 (2) 3 (3) 6 (4) 8 (5) 1

(11) What would be the energy required to split a drop of radius **r** into **2 identical** drops? (The surface tension of the liquid is **T**)

(1) $4\pi r^2T$ (2) $8\pi r^2T$ (3) $4\pi r^2$ (3)T (4) $4\pi r^2 (2^{1/3}-1)T$ (5)$4/3.\pi\ r^3.T$

(12) Two drops of equal size are falling through air with constant velocity of Vms^{-1} .If two drops coalesce, what would be the new velocity?

(1) $V\ ms^{-1}$ (2) $2V\ ms^{-1}$ (3) $V.\sqrt{2}\ ms^{-1}$ (4) $2V.\sqrt{2}\ ms^{-1}$ (5) $V.\ 2^{2/3}\ ms^{-1}$

(13). Specific heat capacity of a material is $2 \times 10^3\ J\ kg^{-1}\ K^{-1}$
Then
(i). If you supply 2.0 J, to 1 kg of material increase in temp. 1K
(ii). If you supply 2.0J, to 1g of material increase in temp is 1K
(iii). If you supply 1J, to 1kg of material increase in temp. 1K
(iv). If you supply 2.0×10^3 J to 1kg of material increase in temp. 100K
(v). If you supply2.0×10^3J to 1g of material increase in temp. is 100K

(14) . An electric heater has to supply hot water of 40^0C at a constant rate of 1 kgs^{-1} from water at 30^0C. The minimum power of the heating element should be
($C_w = 4200\ J\ kg^{-1}\ k^{-1}$)
(i). 4.2×10^4 W (ii). 4.2×10^3 W (iii). 1.2×10^4 W (iv).1.8×10^4 W
(v). 1.8×10^3 W

(15) A given mass of water is in a vessel. When a 90 W heater is immersed in water, the temperature of water increases and comes to a steady value at 35^0C. If a 180W heater is used the steady temp. is 45^0C. What should be the room temperature?

(i). 10^0C (ii). 15^0C (iii). 20^0C (iv). 25^0C (v). 30^0C

(16) . One end of a lagged rod of length l at 100^0c. The other end is connected to ice at 0^0c. If thermal conductivity of the rod is K, and cross-section is **A** and specific Latent Heat of fusion of ice if **L**. Find the amount of Ice melted in 30 mins.

(i)KA 120,000/L.I (ii) KA 180,000/ L.I (iii) KA30/ L .I (iv) L.I /KA 30000

(v) KA/100 L.I

(17) In the Searle's method to find out the thermal conductivity of a good conductor, a long rod of the material is used.This is to,

(i) obtain measurable heat flow

(ii)obtain the steady state condition

(iii)ensure radial flow of heat

(iv)make lagging easy

(v) make a measurable temperature difference

(18)100g of steam of 100 °C is mixed with 100 g of ice at 0 °C. The final temperature of the mixture will most likely to be (Latent heat of vaporization is greater than Latent heat of fusion of water)

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

(19)The air in a room has 12 g of water vapour per m^3.16 g of water vapour is required to saturation of m^3.The relative humidity of the room is

(i) 25 % (ii) 50 % (iii) 60 % (iv) 75 % (v) 80 %

(20)During an adiabatic expansion the increase in volume is associated with ,

(1) decrease in pressure and decrease in temperature

(2)decrease in pressure and increase in temperature

(3) increase in pressure and decreasing in temperature

(4) no change in pressure and increase in temperature

(5) increase in pressure and increase in temperature

(21)The concentration of water vapour inside a closed room at a certain temperature is 35.0 gm^{-3} and relative humidity is 70%.If the air inside the room is made to saturate with water vapour at the same temperature the new water vapour concentration inside the room is,

(1)24.0 gm^{-3} (2) 40.0 gm^{-3} (3) 50.0 gm^{-3} (4) 60 gm^{-3} (5) 100.0 gm^{-3}

(22)Consider following statements.

(A)Saturated Vapour obeys gas laws.

(B)Saturated vapour pressure do not varies with temperature.

(C) Saturated vapour is in equilibrium with the mother liquid.

Of the above,

(1)Only (A) & (B) correct (2) Only (A) & (C) correct (3) Only (B) & (C) correct

(4)only (C) correct (5) only (B) is correct

(23) A vessel contains 0.5 kg of liquid and 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)

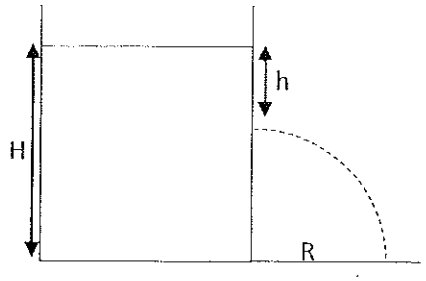
(1) 15 J $kg^{-1}K^{-1}$(2) 25 J $kg^{-1}K^{-1}$(3) 150 J $kg^{-1}K^{-1}$ (4) 1250 J $kg^{-1}K^{-1}$

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

(24)A lead bullet is fired at a speed of 200 ms^{-1} into a tree in which it stops. Assuming that two third of the heat produced goes to the bullet, what would be the increased temperature in the bullet? (Specific Heat Capacity of lead is 130 J $kg^{-1}K^{-1}$)

(1)103^{0}C (2) 140^{0}C (3) 180^{0}C (4) 200^{0}C (5) 206^{0}C

(25) Water stands at a height H in a large tank whose sides are vertical. A hole is made in one of the walls of the tank at a depth h below the surface of water. The distance R from the foot of the wall where the emerging stream of water strike the floor is,



(1) $\sqrt{h(H-h)}$ (2) $\sqrt{hH}$ (3) $2\sqrt{h(H-h)}$ (4) $2\sqrt{h\,H}$ (5) $\sqrt{2gh}$

Part - B

- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earns fifteen (15) marks, amounting to total of 60% marks.**
- **You have to show the steps involved in solving problems. No marks are awarded for the mere final answer without proper steps.**

(01) (a) Define following terms

(i) Specific Heat Capacity (ii)Specific Latent Heat of Fusion

(03 marks)

(b)Briefly describe how would you determine the specific latent heat of fusion of ice (L) by method of mixtures.

You have to focus on the following

- Apparatus used,
- precautionary steps that one should follow when ice is added into the calorimeter
- Experimental techniques to avoid errors **(12 marks)**

(02) (a)State the first law of thermodynamic **(02 marks)**

(b) Describe what is meant by (i)an adiabatic and (ii) an isothermal change of state of a gas **(02 marks)**

(c)Explain clearly and concisely why, for a fixed mass of perfect gas, the heat capacity at constant pressure is greater than the heat capacity at constant volume.

(03 marks)

(d) In changing the state of a gas adiabatically from an equilibrium state A to another equilibrium state B, an amount of work equal to 22.3 J is done on the system. If the gas is taken from state A to B via a process in which the net heat absorbed by the system is 39.3 J, how much is the net work done by the system in the latter case? **(08 marks)**

(03)(a)Define the Thermal conductivity of a substance? **(04 marks)**

(b)Describe the **Searl Method** to determine the thermal conductivity of a good thermal conductor. **(06 marks)**

(c)In Searl experiment to determine K, the readings of the thermometers inserted in the holes at a distance of 5cm from each other are 80^0C and 70^0C.If a 1kg of water flows through the apparatus in 6 minutes, calculate the

Thermal conductivity of the material of the bar.

The radius of the bar= 2cm

Inflow temperature and outflow temperature is 30^0C and 40^0C respectively.

Specific Heat Capacity of water is 4200 J $kg^{-1}K^{-1}$ **(05 marks)**

4. (a) Write down an expression for force acting on a sphere of radius **a** moves with a speed of **v** through a fluid of viscosity η .(Storks Law).Show that this expression is dimensionally correct. **(03 marks)**

(a) A deep pond is filled with water of density $\mathbf{d_0}$. A sphere of radius **a** made out of a material of density **d** ($d < d_0$) is released form rest form the bottom of the pond. The bottom of the pond is at a depth of d from the surface of water.

(b)Describe the motion of the sphere and show that it attains a terminal velocity in the water after sometime. **(06 marks)**

(c) Neglecting the air friction and the loss of energy when the sphere travels through water, find at what height will the speed of the sphere becomes zero again. (viscosity of water is η) **(06 marks)**

5. (a) Define following terms.

i. Moment of inertia of a particle about a given axis

ii.Angular momentum

iii. Torque **(03 marks)**

(b) A flywheel is connected to a shaft of diameter 20mm.The moment of Inertia of the flywheel is 1.5 kg m^2.The flywheel is made to rotate by winding a long string around the shaft and then pulling it with a steady force of 4.0 N.

I. What is the torque applied to the flywheel and shaft?

ii.What is the angular acceleration of the flywheel and shaft?

iii. What is the final angular velocity of the flywheel, If the string becomes detached after 6 s ? **(12 marks)**

6.(a) Write the Bernoulli's equation with all symbols defined. **(03 marks)**

(b)State the conditions under which the Bernoulli's equation is valid. **(03 marks)**

(C) Air flows over the upper surfaces of the wings of an aero plane at a speed of 120 ms^{-1},and past the lower surfaces of the wings at 110 ms^{-1}.

Calculate the lift force on the aero plane if it has a total wing area of 20 m^2.

(Density of air = 1.29 kgm^{-3}) **(09 marks)**