

**Semester Examination-2021**  
**Class & Sem:- M.Sc. Physics, III Semester,**  
**paper title:- Advanced Atmospheric Physics,**  
**paper coder:- MPH E-306**

**Time: 3 hour**

**Max. Marks: 70**

**Min. Pass: 40%**

**Note:** Question Paper is divided into two sections: **A and B**. Attempt both the sections as per given instructions.

**Section A**

**Note: Attempt FIVE questions from this Section (6 marks each).**

- A1. What do you mean by virtual temperature? Derive its expression.
- A2. Giving the concept of air parcel, derive the expression and find the value of dry adiabatic lapse rate.
- A3. What is relation between mixing ratio and specific humidity? Calculate the vapour pressure  $e$  of the air containing mixing ratio  $5.5 \text{ g kg}^{-1}$  at total pressure of  $1026.8 \text{ hPa}$ .
- A4. State the relationship among saturation mixing ratio, saturation vapour pressure and relative humidity. At certain instant RH is  $85\%$  at temperature of  $20^\circ \text{C}$ . Find dew point temperature.
- A5. Find the expression for drop growth rate by collection of droplets.
- A6. A drop enters the base of cloud with a radius  $r_0$ . After growing while travelling up & down it reaches cloud base again with radius  $R$ . Find out on what parameters the radius  $R$  depends.
- A7. What can be the basis of artificial modification of clouds & precipitation? What techniques can be adopted for the modification?
- A8. Explain the growth of ice particles in cold clouds by rimming.
- A9. Define the terms vorticity & divergence. Derive an expression for vorticity distribution within a flow characterised by counter-clockwise solid body rotation with angular velocity  $\omega$ .
- A10. At  $300 \text{ hPa}$  level along  $40^\circ \text{N}$  during winter the zonally averaged zonal wind is eastward at  $20 \text{ m/s}$  and zonally averaged meridional component is southward at  $30 \text{ cm/s}$ . Estimate the vorticity & divergence averaged over the polar cap region pole-ward of  $40^\circ \text{N}$ .

**Section B**

**Note: Attempt FOUR questions from this Section (10 marks each).**

- B1. Explain first law of thermodynamics and deduce Joule's law from it. Define two specific heats of gas and derive relation between them.
- B2. If the ratio of number densities of oxygen atoms to hydrogen atoms at a geopotential height of  $2000 \text{ km}$  is  $105$ , calculate the ratio of these atoms at geopotential height of  $1400 \text{ km}$ , assuming an isothermal atmosphere between these two levels.
- B3. What is equivalent potential temperature? Derive its expression.
- B4. State and explain Normand's rule. How can it be applied to find the net effects of ascent followed by descent of air parcel?

B5. Derive an expression for fractional change  $d\theta'/\theta'$  in the potential temperature  $\theta'$  of air parcel of a cloudy air produced by entrainment  $dm$  of the mass of unsaturated air. B6. Giving theory of growth of cloud droplets in warm clouds, find the expression of growth rate (by condensation (i) by collection.

B6. Find the expression for height of critical energy barrier  $\Delta E^*$  in the graph between increase in the energy of the system due to formation of droplet and its radius. Determine the fractional changes in  $\Delta E^*$  and critical radius  $r$  if surface tension  $\sigma$  is increased by 10%.

B7. Explain the growth of ice particles from vapour phase.

B8. Explain the geostrophic wind, gradient wind and thermal wind.