

**Instructions:** You can consult only your own lecture notes and photocopies/print-outs of slides and materials from any textbook. Exchange of lecture notes is strictly prohibited.

Read the questions carefully. State all assumptions clearly. All abbreviations carry usual meanings.

[ $C_p = 1004 \text{ J K}^{-1} \text{ kg}^{-1}$ ;  $C_v = 717 \text{ J K}^{-1} \text{ kg}^{-1}$ ;  $L_v = 2.5 \times 10^6 \text{ J kg}^{-1}$ ;  $M_w = 18.016$ ;  $R^* = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

- ✓ 1. An air parcel at 950 hPa altitude has initial  $T = 19^\circ\text{C}$  and  $T_d = -4^\circ\text{C}$ .

[Use the  $T-\phi$  gram sheet as required and SUBMIT IT ALONG THE ANSWER SHEET. Write your name and Entry No. in the  $T-\phi$  gram sheet] (Marks 2 + 1 + 4 + 3 = 10)

- ✓ (a) What is the minimum possible height for cloud base, if the air rises?
- ✓ (b) How much moisture will be condensed out when it rises to 500 hPa?
- ✓ (c) 50% of the moisture is precipitated out and the air starts its descent. At 600 hPa, it gets mixed with another air with  $w = 2 \text{ g/kg}$  and  $T = -5^\circ\text{C}$ . What will be  $w_s$  of the mixed air?
- ✓ (d) Find the final  $T$ ,  $T_d$  and  $RH$  at 1000 hPa.

2. Answer any five questions (use diagram, if required). (Marks 2 × 5 = 10)

- ✓ (a) The Kohler equation can be simplified as:  $S_{eq} = 1 + \frac{a}{r} - \frac{b}{r^3}$ . Derive an expression for the critical radius in terms of  $a$  and  $b$ .
- (b) Is Bergeron process essential to produce stratiform rain? Why?
- ✓ (c) Why Cirrus clouds formed by homogeneous nucleation are found in the upper troposphere only?
- ✓ (d) Is temperature inversion essential in case of freezing rain or sleet? Why?
- ✓ (e) Why do cyclones produce intense rainfall?
- (f) Why do subtropical and polar jets weaken during July relative to January?
- ✓ (g) Calculate the Coriolis force per unit mass on a wind moving at 10 km/hr northward at  $30^\circ\text{N}$  latitude. Assume  $\Omega = 0.707 \times 10^{-4} / \text{sec}$ .