MASTER OF SCIENCE EXAMINATION, 2017

(2nd Year, 1st Semester)

MATHEMATICS

Unit - 3.4 (B1.14)

(Dynamical Meteorology and NWP-I)

Full Marks : 50 Time : Two Hours

The figures in the margin indicate full marks.

(Symbols/Notations have their usual meanings)

Answer Q. No. 1 and any *two* from the rest.

1. Answer any *two* :

(a) What do you mean by a perfect gas ? Show that, for a perfect gas, the equation of state can be expressed as

$$p\alpha = \frac{R^*}{m} T \ .$$

Represent this equation in the form of graphs by plotting specific volume vs. pressure for isothermal process. What

[*Turn over*]

is the name of such a diagram ? Further show that for a number of perfect gases, the equation of state can be expressed as

$$p\alpha = \frac{R^*}{\bar{m}} T \, . \qquad 9$$

(b) (i) What do you understand by isentropic flow ? Show that for isentropic flow

$$p\alpha^{\gamma} = \text{constant} \, .$$

(ii) Show that, for an ideal gas, change in entropy is given by

$$\Delta \varphi = c_v \ln\left(\frac{p_2}{p_1}\right)\left(\frac{\alpha_2}{\alpha_1}\right)^{\gamma} \, . \qquad 5+4$$

(c) Derive the area equivalence of the tephigram starting from Clapeyron's diagram. Discuss the important features of the tephigram. 9

2. (a) Obtain the pressure equation for the constant lapse rate atmosphere. Discuss how pressure changes when temperature decreases with altitude as well as when temperature increases with altitude. Find the height of the atmosphere with a constant positive lapse rate. 8

[*Turn over*]

(b) Deduce the Clausius-Clapeyron equation in the form

$$\frac{de_s}{dT} = \frac{L_{12}}{T(\alpha_2 - \alpha_1)}$$

Interpret the above equation. 8

3. (a) Show that the rate of change of Latent heat of evaporation with absolute temperature is equal to the difference between the specific heat at constant pressure of the vapour and the specific heat of the liquid. 8

(b) What are the basic assumptions for inertia motion ? Show that for inertia motion, the airparcel moves with a constant speed. Derive the equation for the circle of inertia. Determine the inertial period at the equator and at the poles. 8

4. (a) Deduce the atmospheric energy equation and interpret each term. 8

(b) Obtain the thermal wind equation. What do you mean by a barotropic atmosphere ? Show that for a barotropic atmosphere there can be no increase of geostrophic wind with height. 8