



INDIVIDUAL FINAL EXAMINATION: DECEMBER 2024

Course number: **ATSC 201** Section number: 101
Course name: Meteorology of Storms. Duration: 100 minutes

Candidate name _____

Student number _____ Candidate signature _____

Special instructions: Open books, notes, laptops, iPads, and calculator. Open access to the internet. No other electronics (no cell phones, ear phones). Indicate your name, student ID, Test Form (All exams this term are Test Form A), and all your answers on the Bubble sheet. Each question has only one best answer. Don't leave any questions unanswered (if you don't know the answer, then guess). Good luck!

Instructor name: Roland Stull

This examination consists of 8 pages (including this cover sheet & bubble sheet). Check to ensure that it is complete. Students ARE allowed to separate all the exam sheets from each other. Students must turn in ALL pages of this exam. The bubble sheet will be marked by computer for the multiple-choice questions, and other questions involving maps or diagrams will be marked by hand. Please do NOT re-staple the bubble sheet to the exam packet.

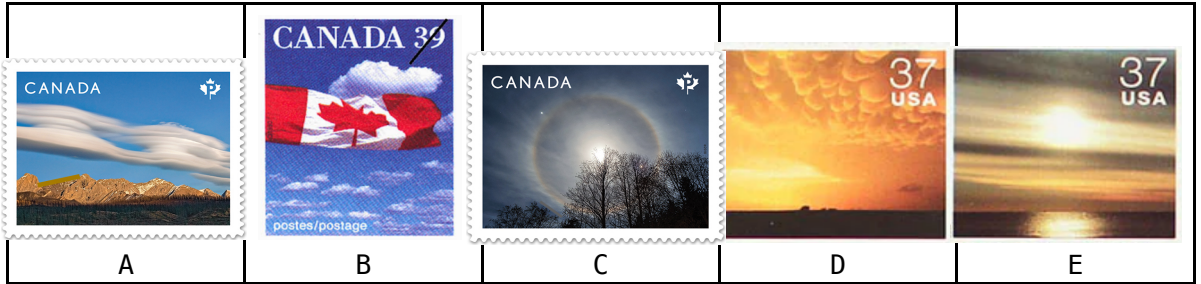
Rules governing formal examinations

1. Each examination candidate must be prepared to produce, upon the request of the invigilator or examiner, his or her UBC card for identification.
2. Examination candidates are not permitted to ask questions of the examiners or invigilators, except in cases of supposed errors or ambiguities in examination questions, illegible or missing material, or the like.
3. No examination candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave during the first half hour of the examination. Should the examination run forty-five (45) minutes or less, no examination candidate shall be permitted to enter the examination room once the examination has begun.
4. Examination candidates must conduct themselves honestly and in accordance with established rules for a given examination, which will be articulated by the examiner or invigilator at the start of the examination. Should dishonest behaviour be observed by the examiner(s) or invigilator(s), pleas of accident or forgetfulness shall not be received.
5. Examination candidates suspected of any of the following, or any other similar practices, may be immediately dismissed from the examination by the examiner/invigilator, and may be subject to disciplinary action:
 - i. speaking or communicating with other examination candidates, unless otherwise authorized;
 - ii. purposely exposing written papers to the view of other examination candidates or imaging devices;
 - iii. purposely viewing the written papers of other examination candidates;
 - iv. using or having visible at the place of writing any books, papers or other memory aid devices other than those listed above under Special Instructions or authorized by the examiner(s);
 - v. using or operating electronic devices including but not limited to telephones or similar devices other than those authorized by the examiner(s)—(electronic devices other than those authorized by the examiner(s) must be completely powered down if present at the place of writing);
 - vi. copying, scanning, or photographing any parts of the exam to take or transmit outside of the exam room;
6. Examination candidates must not destroy or damage any examination material, must hand in all examination papers, and must not take any examination material from the exam room without permission of the examiner or invigilator.
7. Examination candidates must follow any additional examination rules or directions communicated by the examiner(s) or invigilator(s).

Instructions: Put your answers on the bubble sheet, unless otherwise stated in the question. Only one best answer for each question. You may separate all the sheets from each other. Put your name on all papers and turn them in to the invigilators. Total points = 100, which is roughly 1 minute per point for the individual exam.

(points) Question

Clouds are sometimes used in postage stamps.



points
2
2
2

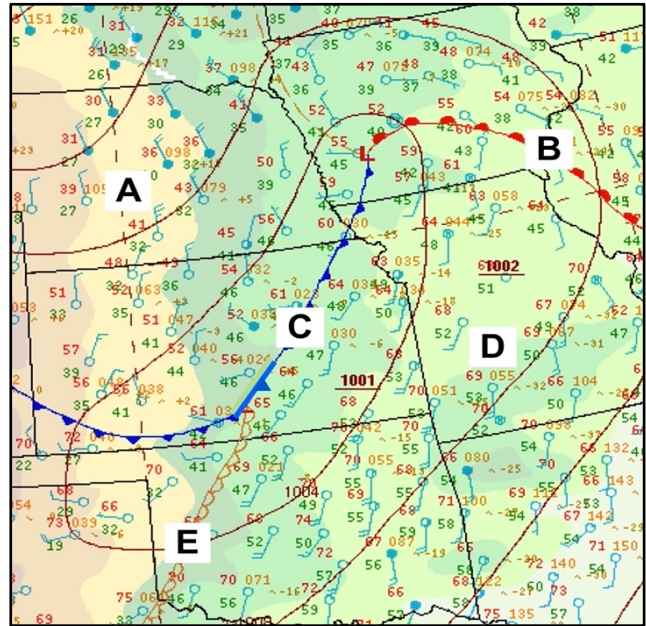
Question

- Which stamp (A, B, C, D or E) shows altostratus clouds?
- Which stamp (A, B, C, D or E) shows cirrostratus clouds?
- Which stamp (A, B, C, D or E) shows cumulus humilis clouds?

Using the weather map at right, at which location (A, B, C, D, or E) is:

2
3
3
5

- is a cold front?
- is a cP air mass?
- is a dry line.
- What is **NOT** likely to happen during the next 4 hours at a farm located at the upper-right corner of the map at right?



- light winds ESE, shifting to S.
- overcast with cumuliform clouds
- rain starting soon
- pressure falling, then rising
- temperature increasing

map info:

T & Td in (°F),
wind in knots.

5

- Which statement is TRUE?
 - Winds circulate clockwise around tropical cyclones in the N. Hemisphere.
 - Winds circulate clockwise around extratropical cyclones in the N. Hemisphere.
 - The global-scale vertical circulation in the tropics is called the Bergeron cell.
 - The thermal-wind effect explains how thermals rise to trigger thunderstorms.
 - The 100 to 50 kPa Thickness is proportional to average virtual temperature.

Use this IR image from a satellite for the next 3 questions. At which location (A, B, C, D, E) is/are

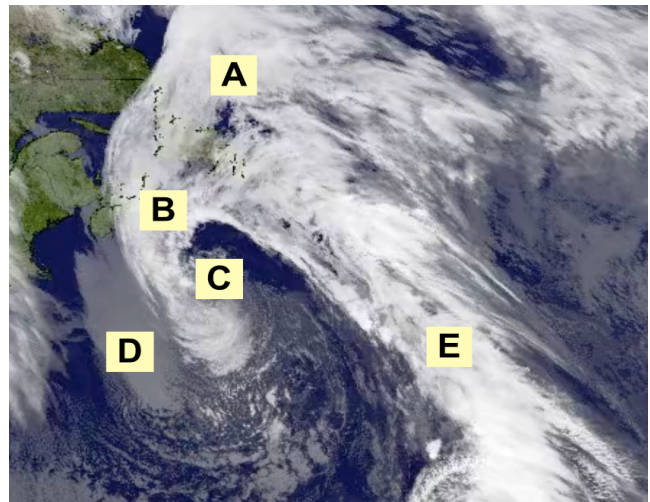


Image Location: Atlantic ocean near Canadian East coast.

2

9 a cold front?

2

10 warm frontal clouds?

2

11 low-altitude cloud tops?

2

12 a low-pressure center?

3

13 The cyclone in the image above is likely in its ____ stage.

A) cyclogenesis

D) cyclolysis

B) mature

E) (bad premise. It is actually an

C) frontogenesis

anticyclone.)

4

14 If the image at right indicates a downburst at location E, then the most likely location of the Doppler radar is (A, B, C, D, or E)?

4

15 Which equation explains why pressure decreases more slowly with height in warm air than in cold air?

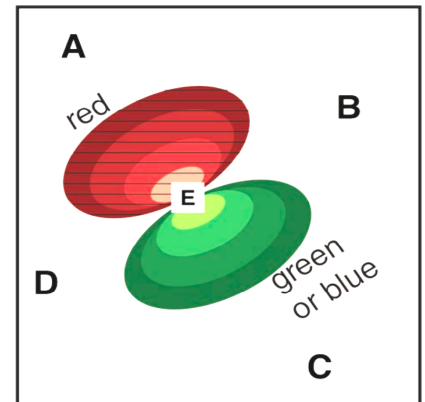
A) hydrostatic

D) hypsometric

B) geostrophic

E) hydrophobic

C) gravimetric



8

16 Which statement is TRUE?

A) Winds are fast in jet streaks because of a strong vertical pressure gradient.

B) The vertical temperature gradient is adiabatic just above the tropopause.

C) Cyclogenesis is strong when the upper-air trough is stacked above the surface low.

D) Boundary layer winds tend to weaken surface lows, but strengthen surface highs.

E) Winds are fast in jet streaks because of a strong horizontal pressure gradient.

4

17 The subtropical and polar jet streams in the **Southern** Hemisphere blow from:

A) east and east, respectively.

D) west and east, respectively.

B) west and west, respectively.

E) south and north, respectively.

C) east and west, respectively.

8

18 The phase speed (m/s, relative to the ground) of a 5000 km wavelength barotropic Rossby wave at 60°N, embedded in a jet stream of $U = 30$ m/s, is approximately

A) 15.4

B) 22.7

C) 30.0

D) 37.3

E) 43.8

- 19 Comparing extratropical vs. tropical cyclones, which statement is FALSE?
 A) Vertical stacking of low pressure is bad for extratropical cyclones.
 B) Tilting of low pressure is bad for tropical cyclones.
 C) Tropical cyclones have warm cores, while extratropical cyclones have cold cores.
 D) Strong environmental wind shear is good for supercell thunderstorms.
 E) Strong environmental wind shear is good for hurricanes.
- 20 The recent extratropical cyclone bomb that affected southwestern BC had a central sea-level pressure of 94.3 kPa when the storm was at peak intensity. If it had been a tropical cyclone with that central pressure (compared to an ambient environmental sea-level pressure of 100 kPa), then what would be its likely category on the Saffir-Simpson Hurricane hurricane scale?
 A) Cat. 1 B) Cat. 2 C) Cat. 3 D) Cat. 4 E) Cat. 5

To answer the following questions, analyze the attached surface weather map, to identify extratropical cyclone centers and fronts, using ONLY the plotted wind directions.

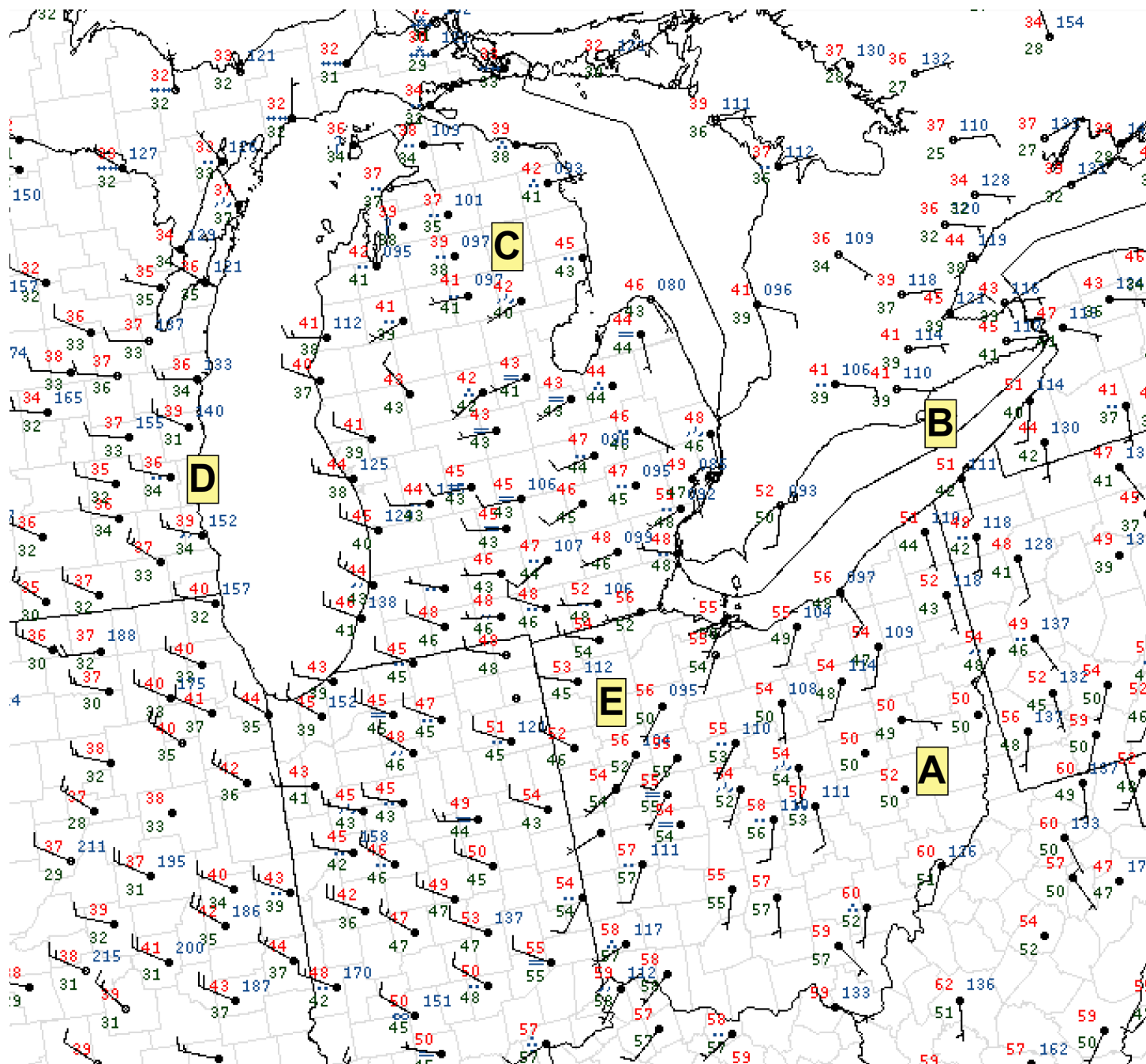
- 21 At which location (A, B, C, D, E) is a warm front?
- 22 At which location (A, B, C, D, E) do you expect to see convective clouds (e.g., thunderstorms) and convective precipitation?
- 23 At which location (A, B, C, D, E) is an mT airmass?

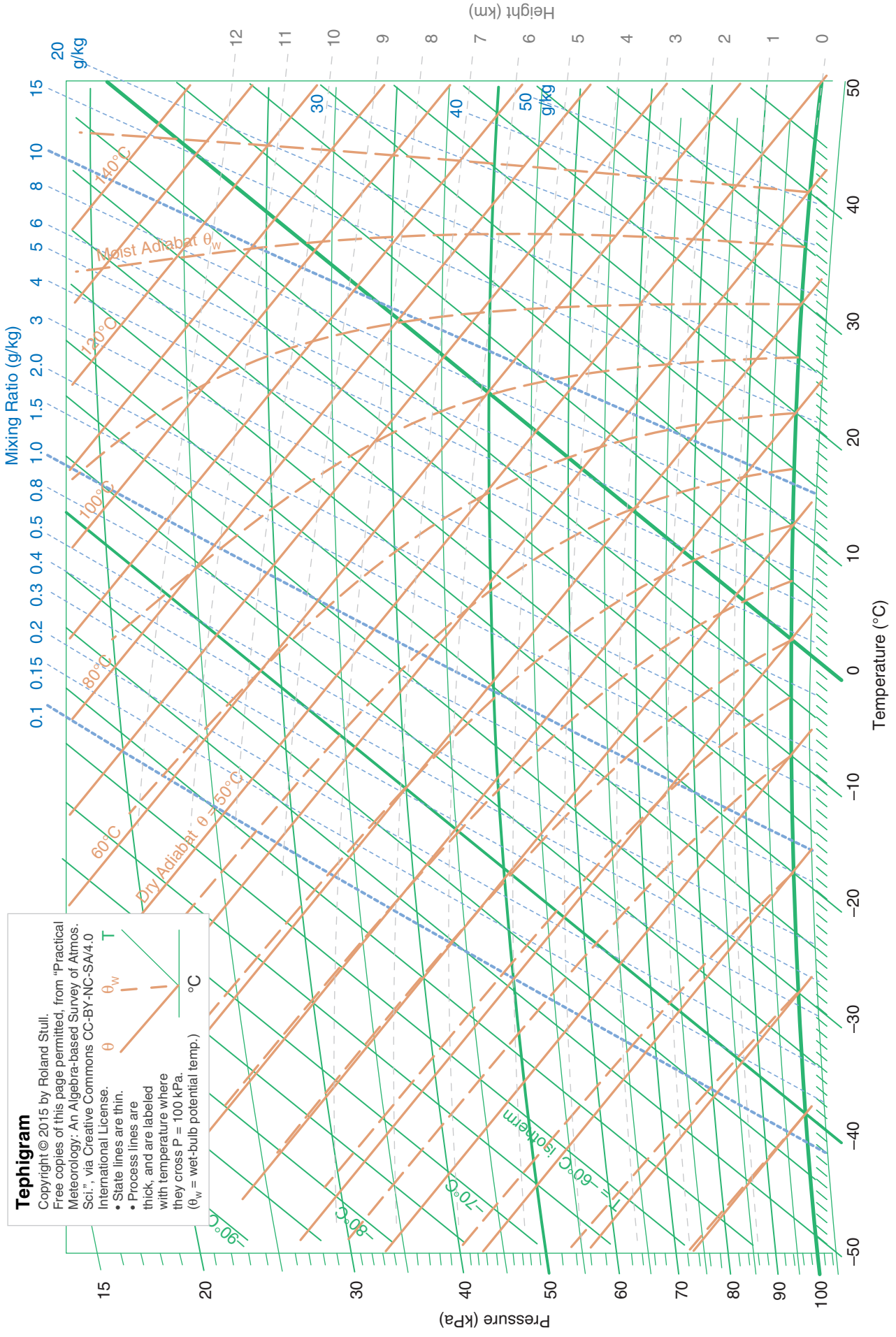
Plot this sounding on the attached thermo diagram to answer the next questions.

P (kPa)	T (°C)	Td (°C)
100	20	1
90	9	
48	-35	
30	-48	
20	-48	

- 24 The lifting condensation level (LCL) is at ____ (kPa)
 A) 90 B) 85 C) 80 D) 75 E) 70
- 25 If a thunderstorm forms, its equilibrium level is at ____ kPa.
 A) 48 B) 40 C) 30 D) 20 E) 10
- 26 Which statement is TRUE
 A) A thunderstorm in this environment is easy to trigger.
 B) A thunderstorm in this environment is difficult to trigger.
 C) The tropopause is approximately at 48 kPa.
 D) The potential temperature of the environment at 100 kPa is 1°C.
 E) The relative humidity of the environment at 100 kPa is 10%.

-end of exam-





Tephigram
 Copyright © 2015 by Roland Stull.
 Free copies of this page permitted, from "Practical Meteorology: An Algebra-based Survey of Atmos. Sci.", via Creative Commons CC-BY-NC-SA4.0 International License.

- State lines are thin.
- Process lines are thick, and are labeled with temperature where they cross $P = 100 \text{ kPa}$. ($\theta_w =$ wet-bulb potential temp.)

θ θ_w T
 °C

Use this page for notes & calculations.
See the bubble sheet on the back.

