

Name: \_\_\_\_\_

- Please hand in the lab as ONE PDF document on Moodle.
- Please make sure the pages are in order
- Please make sure it's legible (open your PDF file to double check 😊)
- Thank you.

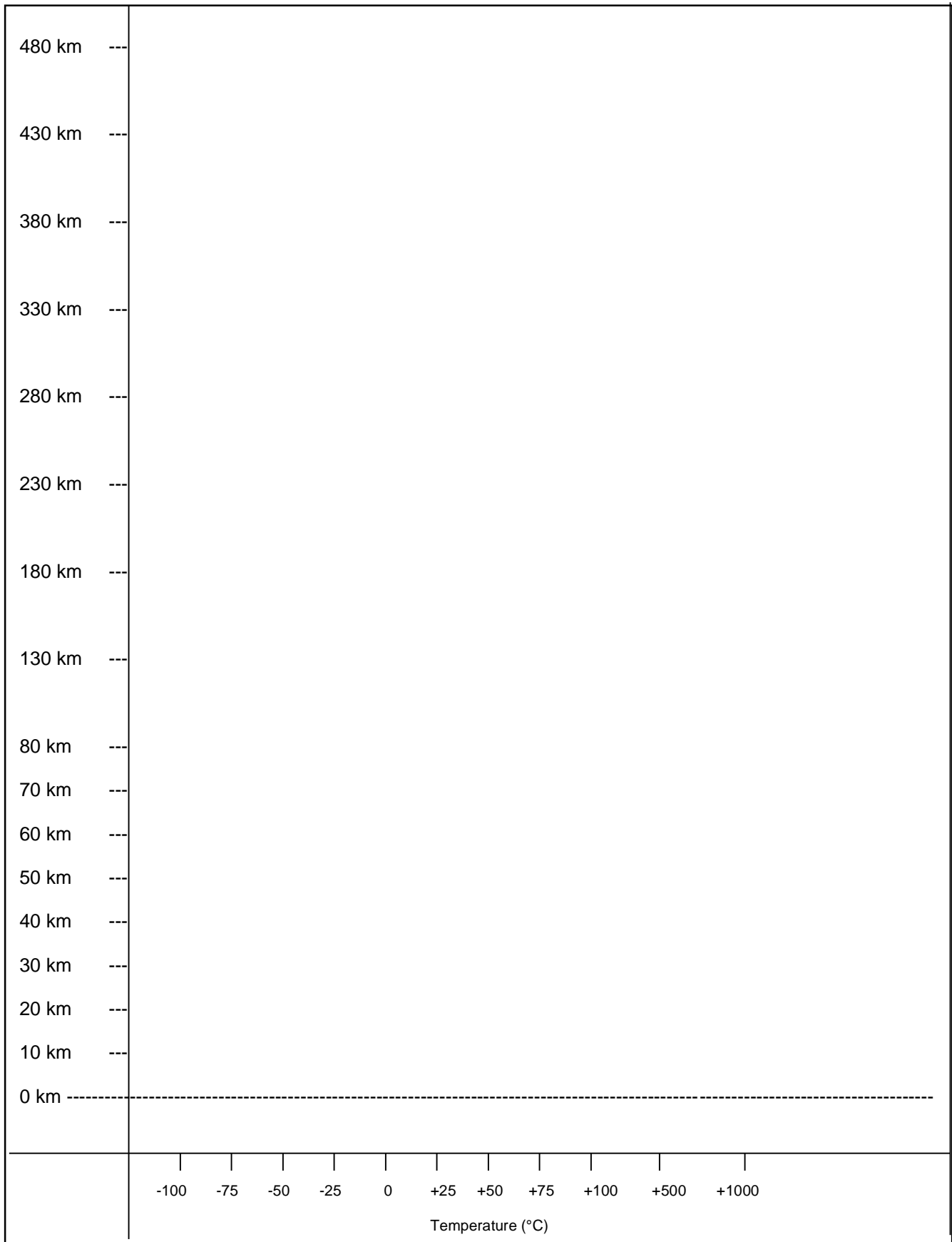
**CRANDALL UNIVERSITY**  
**GEOGRAPHY 1023**  
**Lab 2: The Atmosphere & Energy Balances**

**Reference:** Chapter 3-4, text and notes

This lab will consider the structure and function of the Earth's atmosphere, and the energy balances within the atmosphere.

**I. The Atmosphere**

1. For this section you will need to refer to **4CE Figure 3.1, "Profile of the modern atmosphere," p.67 and Figure 3.3a "Temperature profile plots temperature changes with altitude" on p. 70 (3CE Figure 3.2, p.63)**. You will be drawing a diagram on the next page – you are welcome to use pencil crayons (colored pencils) so your diagram is easier to read!
  - a. On the diagram on the next page, draw on and label (4CE p.70):
    - the equatorial tropopause
    - the stratopause
    - the mesopause
    - the thermopause
  - b. On the diagram, draw on (in the correct location) and label (4CE, p.70):
    - an aurora
    - the ozone layer
  - c. Draw a line showing the temperature changes, as you rise through the various levels, beginning at a pleasant wintry 0°C. **Note that this will be similar to the yellow line in your text, 4CE Figure 3.3a/b p.70 (3CE Figure 3-2), except your line is 15°C cooler till -57°C, then it's the same as in the text** (the surface temperature no longer affects it)
    - using this line (from 1.d.), what will the temperature be at the tropopause? \_\_\_\_\_°C
    - using this line (from 1.d.), what will the temperature be at the stratopause? \_\_\_\_\_°C
    - using this line (from 1.d.), what will the temperature be at the mesopause? \_\_\_\_\_°C



2. For this question you will need to refer to **Figure 3.2b, “Density decreases with altitude,” 4CE p.68 (3CE, p.64), diagram (b), “Pressure Profile”**. Note that the right hand column is labeled “%.”

The e-text version does not have percentages. You need this version (<https://rossway.net/wp/wp-content/uploads/2020/01/Figure-3.2-4th-Cdn-Edition.pdf>)

- a. What is the altitude below which **50%** of the atmospheric mass occurs? \_\_\_\_\_
- b. What is the altitude below which **90%** of the atmospheric mass occurs (Note this is **the inverse or reverse** of the information on Figure 3.2b. On Figure 3.3, the altitude that is labeled “10%” refers to the point where 90% of the atmospheric mass is below that point and 10% is above it – this is the altitude you want!) \_\_\_\_\_
- c. What is the point below which **99%** of the atmospheric mass occurs (1% of the mass is above it)? \_\_\_\_\_
- d. What is the point below which **99.999%** of the atmospheric mass occurs (0.001% of mass above it)? \_\_\_\_\_
3. Imagine you are flying from Toronto to Vancouver, at an altitude of 10 km (about 34,000 feet). Using Figure 3.2b ...
- a. What percentage of the **depth** or thickness of the atmosphere is below you?  
(The atmosphere is about 480 km deep/thick; you are at an altitude of 10 km.  
Therefore  $10 / 480 \times 100\%$  will give you the percentage below you): \_\_\_\_\_%
- b. What percentage of the **depth**/thickness of the atmosphere is above you?  
 $100 -$  (your answer from 3a): \_\_\_\_\_%
- c. Approximately what percentage of the atmospheric **mass** would be below you?  
Using Figure 3-2b and your answers from Question 2 you can estimate this: \_\_\_\_\_%
- d. Approximately what percentage of the atmospheric **mass** would be above you?  
 $100 -$  (your answer from 3c): \_\_\_\_\_%
- e. Using the temperature line from Page 2 of this lab, approximately what would be the temperature outside the airplane at an altitude of 10 km? (Remember that your air starts at **0° at 0 km**) \_\_\_\_\_°C

The point? Think about all of this the next time you fly ... How does this all make you feel (you don't have to answer this in the lab. It's simply for you to consider ...)

## II. Surface Energy Balances

### A. Albedo

For this section you need to refer to **4CE Figure 4.6, “Various albedo values,” p.96 (3CE, Figure 4.5, p.89)**.

1. Consider Farmer Greene-Grass, who owns a section on of land on the margin of a major city. Currently his land is mostly natural grass. He is considering selling out to Stuff Mart, a major retail chain, who will build a combination of retail buildings with dark-coloured tar and gravel roofs, and asphalt parking lots.

How would those changes affect the albedo of Greene-Grass's land? (check one)

- the albedo would not change
- the albedo would increase
- the albedo would decrease

2. On a hot summer day, what practical difference would those changes make to what you would feel?

- the ground and air would both feel cooler
- the ground would feel the same, the air warmer
- the ground would feel warmer, the air the same
- both the ground and the air would feel warmer
- the ground would feel cooler, the air the same
- the ground would feel warmer, the air cooler
- the ground would feel cooler, the air warmer
- there would be no difference in how the ground or air temperatures

3. Greene-Grass sold out! Stuff Mart and its parking lot are built. After the **first** snowfall of the season, how would the albedo of the parking lot change from its normal albedo?

- the albedo would not change
- the albedo would increase
- the albedo would decrease

4. Greene-Grass wisely entered into a snow removal contract with Stuff-Mart. His advice to the Manager is that, for albedo reasons, the snow will melt more quickly if he leaves it on the ground, rather than plowing it clear to reveal the asphalt. Is he telling the truth? Why or why not? (pick **ONE**)

- He is correct; snow melts faster when it's flat
- He is correct; snow has higher albedo
- HE is correct; snow has lower albedo
- He is NOT correct; exposed asphalt has lower albedo
- He is NOT correct; exposed asphalt has higher albedo
- It makes no difference if he clears the snow or not

### III. Daily Radiation Budgets

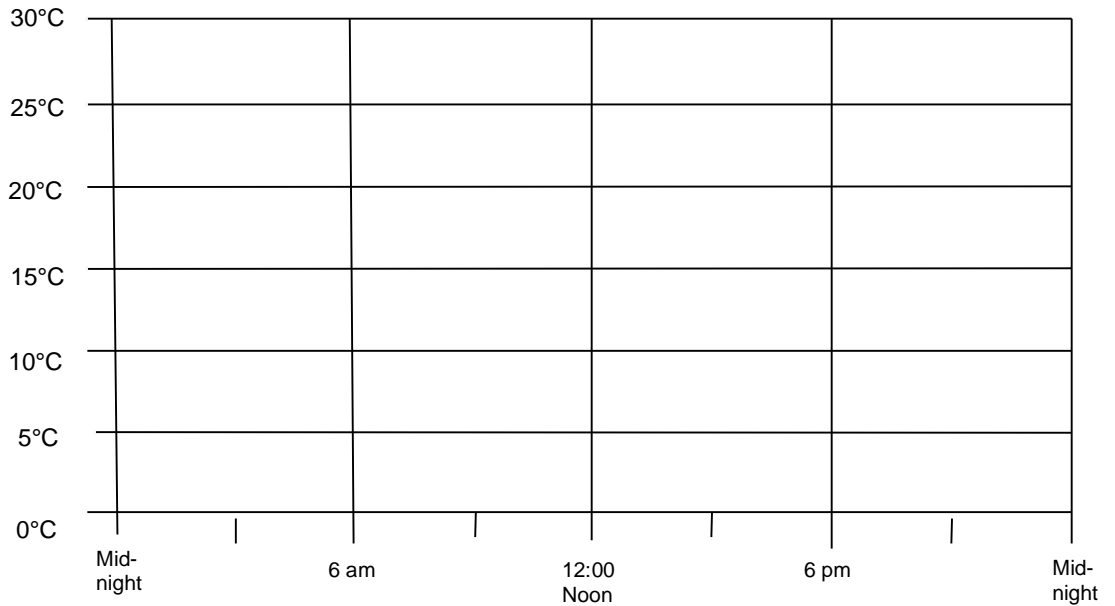
*For this section you WILL want to refer to "Daily radiation and temperature curves," 4CE, Figure 4.11, p. 103 (3CE, Figure 4.13, p.96). Use that diagram!*

Note that, perhaps contrary to your first intuitive thought, the warmest part of the day is NOT at noon, when there is maximum insolation (for the exam, know WHY this lag exists!). As a runner, I can assure that the warmest time of a winter day is NOT noon. The coolest time in the summer is NOT midnight.

Imagine a typical spring day in Narnia ...

1. King Edmund tells you that on this day, the coolest temperature during the 24-hour period on March 21 (sunrise @ 6 a.m. and sunset @ 6 p.m.) was a cool 5°C. The warmest temperature during the 24-hour period was a lovely 25°C.

- a. From what you know about the relationship between insolation and temperature, draw a daily radiation curve (see Figure 4.11) for the day ... **(use the graph on the next page)**



b. Below, indicate at approximately what time of the entire 24 hour period do you think it reached 25°C? (write "25" beside your choice) When do you think it reached 5°C? (write "5" beside your choice)

\_\_\_\_\_ at sunset (6 p.m.)      \_\_\_\_\_ at midnight      \_\_\_\_\_ at about 3 p.m.  
 \_\_\_\_\_ at dawn (6 a.m.)      \_\_\_\_\_ at about 9 a.m.      \_\_\_\_\_ at noon

c. If High King Peter wished to eat lunch on the terrace outside his castle, Cair Paravel, at 12:00, noon, approximately what temperature do you think it might be (a well-informed guess)? \_\_\_\_\_°C

d. Queen Susan wishes to serve a royal banquet on the same outdoor terrace right at sunset, 6:00 p.m. (1800 hours). Approximately what temperature do you estimate might it be? \_\_\_\_\_°C

e. Queen Lucy, fed up with foreign diplomats, leaves the banquet at midnight (00 hours) to go stargazing. Approximately what temperature do you estimate it might be? \_\_\_\_\_°C

f. King Edmund, a runner, wants to go for a comfortable jog at **the coolest time of the day**. When would you recommend he go for his run?  
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g. Conversely, if King Edmund wanted to invite his colleagues for a run and see them sweat at **the hottest time of the day**, when would you recommend he take the others for a run?  
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