HW 1 Answer Key

ATSC 201 Fall 2023
Chapter 1: A1e, A3e, A5e, A6e, A9e, A14e, A15e
Total mark out of 25

A1e)
(4 marks)

Find the wind direction (degrees) and speed (m/s), given the (U,V) components: d) (8,0) knots

Given:	U =	8	knots
	V =	0	knots

Find: alpha (wind direction) M (wind speed)

Using eq. 1.1:

M = (U^2 + V^2)^0.5

Using eq. 1.2a:

alpha = 90deg - (360deg/C)*arctan(V/U) + alpha0

	C =	360	deg
if U > 0	alpha0 =	180	deg
	M =	8	knots
	=	4.11556507	m/s

M =	**4.12**	**m/s**
alpha =	**270.00**	**deg**

Checks: Units ok. Physics ok.
Discussion: The wind is coming from the W with a magnitude of 4.12 m/s.

A3e)
(3 marks)

Convert the following UTC time to local time in your own time zone: e) 12:45

Given: 12:45 UTC

Find: local time

Using eqs. from Table 1-1

DT = UTC - beta

ST = UTC - alpha

Vancouver's time zone is "U" (Pacific)

beta =	7:00	PDT
alpha =	8:00	PST

Currently, local time is PDT.

DT =	**5:45**	**PDT**
for partial marks: ST =	**4:45**	**PST**

Checks: Units ok.

Discussion: Vancouver is currently in Pacific Daylight Time, so it is presently 7 hours behind UTC time.

A5e) (2.5 marks)

Find the pressure in kPa at the following heights above sea level, assuming an average T = 250K: d) 25 km.

Given:	z (m) =	30,000	ft	"="	9144
	avg T =	250	K		
Find:	P	?	kPa		

Using eq. 1.9a:

P = Po * e^(-(a/T)*z)

where:	Po =	101.3250	kPa
	a =	0.0342	K/m

P =	**29.0**	**kPa**

Checks: Units ok. Physics ok.

Discussion: At 30,000 ft =~9km above sea level, the pressure is reduced to 29 kPa

A6e)
(3 marks)

Use the definition of pressure as a force per unit area, and consider a column of air that is above a horizontal area of 1 square meter. What is the mass of air in that column: e) Between pressure levels 100 and 20 kPa

Given:	Pbottom =	100	kPa
	Ptop =	20	kPa
	A =	1	m^2

Find: Δm = ? kg
mass of air between Pbottom and Ptop

Using eq. 1.11:
Δm = (A/g)*(Pbottom - Ptop) where g = 9.81 m/s^2

Convert Pbottom(kPa) and Ptop(kPa) to Pbottom(Pa) and Ptop(Pa):

Pbottom =	100000	Pa
Ptop =	20000	Pa

Δm = 8154.94 kg

Checks: Units ok. Physics ok.
Discussion: This is a calculation of the air mass between 100 and 20 kPa pressure that exists over 1 square meter of area.

A9e)
(2.5 marks)

Convert the following temperatures: e) 303 K = ?°C

Given: $T_{°K}$ = 303 K

Find: $T_{°C}$ = ? °C

Using equation 1.7b:
$T_{°C} = T_K - 273.15$

$T_{°F}$ = 29.85 °C

Checks: Units ok.
Discussion: 29.85°C should be one of the hottest days in the summer in Vancouve

A14e)
(4.5 marks)

What is the geopotential height and geopotential, given the geometric height? e) 500m

Given:	H =	500	m
Find:	z = ?		m
	Φ = ?		m^2/s^2

Using eq. 1.14b:

z = Ro*H /(Ro - H)

where the radius of the Earth, Ro = 6356.766km = 6,356,766m.

Ro = 6356766 m

And using eq. 1.15:

Φ= g*H   where g = 9.81 m/s^2

H = 499.960675 m

z =	**499.96**	**m**
Φ =	**4904.61**	**m^2/s^2**

Checks: Units ok. Physics ok.

Discussion: The difference between the geometric height and the geopotential height is negligible at 500ft.

A15e)
(5.5 marks)

What is the standard atmospheric temperature, pressure, and density at the following geopotential height: e) 200m ?

Given:	H =	200	m
		0.2	km
Find:	T = ?		degC

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P =	?	kPa
ρ =	?	kg/m^3

Using eqs. 1.16 for H < 11km:

T = 288.15-6.5*H

T = 286.85 K
13.70 degC

Using eq. 1.17 for H < 11km:

P = 101.325*(288.15/T)^[-5.255877]

P = 98.95 kPa

Using and rearranging eq. 1.18:

ρ = P / Rd*T where Rd = 0.287053 kPa*m^3 / K*kg
gas constant for dry air

ρ = 1.20165096 kg/m^3

Checks: Units ok. Physics ok.

Discussion:

At 200m, the air not noticeably colder
and has a similar pressure

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