ATSC 201 2023
Total mark out of 44
Ch2: A5g, A13e, A15e.
Ch10: A1e, A4e, A5e, A6a, A8e, A9e.

Chapter 2

A5g) (10.5 marks)

Plot the local solar elevation angle vs. local time for 22 December, 23 March, and 22 June for the following city: g) Montreal, Canada

Given: The location Montreal, Canada
d (22-Dec) = 356

d (23-Mar) = 82

d (22-Jun) = 173

Find: Ψ (deg) = ?

Use eq. 2.5: δs = Φr * cos(C*(d - dr)/dy)

where:	Φr =	0.40910518	rad
	C =	6.28318531	rad
	dr =	172	for 2023
	dy =	365	

	22-Dec	23-Mar	22-Jun
δs (rads)	-0.4089688	0.00880235	0.40904456
δs (deg)	-23.4321862	0.50433732	23.4365271

Use eq. 2.6: sin(Ψ) = sin(ϕ) * sin(δs) - cos(ϕ)*cos(δs)*cos((C*tUTC/td)+λe)

where:	ϕ =	45.5019	degN=	0.794157971	rad
	λe =	-73.5674	degE=	-1.28399335	rad
	td =	24.0	h		

time zone of Montreal:

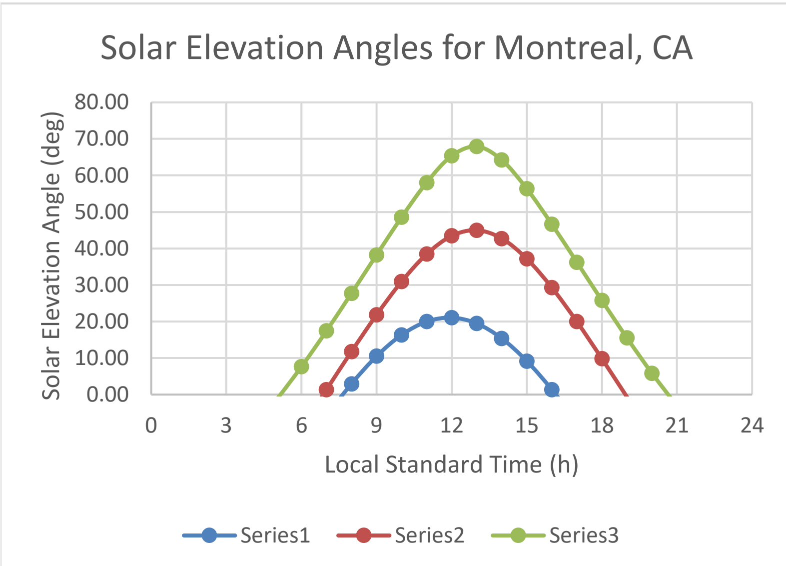
tUTC = t + 4 hours EDT (for Mar23 and Jun22)

HW3 Answer Key

tUTC = t + 5 hours EST (for Dec22)

	Ψ (deg)		
t(h)	22-Dec	23-Mar	22-Jun
0	-67.90	-42.46	-19.96
1	-64.22	-43.98	-21.05
2	-56.34	-41.76	-19.46
3	-46.62	-36.28	-15.37
4	-36.24	-28.47	-9.18
5	-25.75	-19.20	-1.36
6	-15.52	-9.10	7.63
7	-5.84	1.36	17.44
8	2.96	11.80	27.75
9	10.50	21.82	38.25
10	16.33	30.94	48.56
11	19.97	38.45	58.05
12	21.05	43.44	65.34
13	19.46	44.98	67.90
14	15.37	42.73	64.22
15	9.18	37.18	56.34
16	1.37	29.30	46.63
17	-7.63	19.96	36.24
18	-17.44	9.83	25.76
19	-27.75	-0.64	15.52
20	-38.24	-11.07	5.84
21	-48.56	-21.05	-2.96
22	-58.04	-30.10	-10.50
23	-65.34	-37.54	-16.32
24	-67.90	-42.46	-19.96

Check: Units ok. Physics ok.
Discussion: Montreal's winters are a similar to Vancouver's



A13e) **Find the kinematic heat fluxes at sea level, given these regular fluxes (W/m^2): e) 600.**
(2.5 marks)

Given: **F**H = 600 W/m^2

Find: FH = ? K*m/s

Use eq. 2.11: FH = **F**H / rho*Cp
where rho *Cp = 1231 (W/m^2)/(K*m/s)

FH = **0.487408611** K*m/s

Check: Units ok. Physics ok.
Discussion: This amount of heat flux is just slightly higher than the advective heat flux of a 1m/s wind blowing air with a temperature excess of about 0.5C

A15e)
(5 marks)

Plot Planck curves for the following blackbody temperatures (K): e) 2500.

Given: T = 2500 K

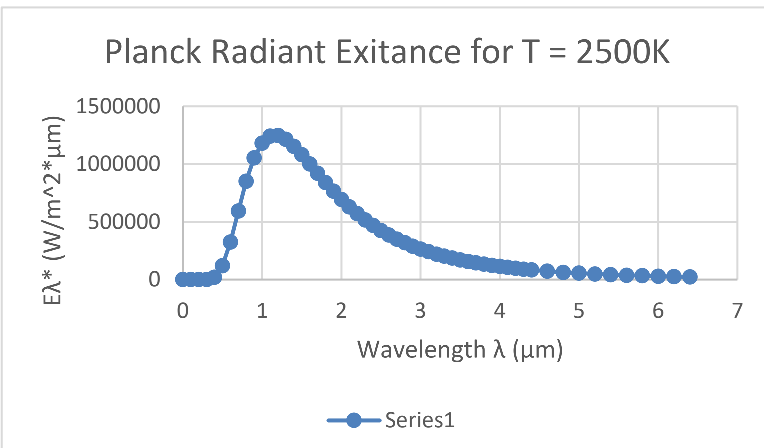
Find: Planck curve of blackbody object with temp T.

Use eq. 2.13: Eλ* = c1/(λ^5 *(e^(c2/λ*T)-1))

where c1 = 3.74E+08 W*μm^4/m^2
c2 = 1.44E+04 μm*K

λ (μm)	**Eλ***
0	0
0.1	3.61E-12
0.2	3.63E-01
0.3	7.06E+02
0.4	2.04E+04
0.5	1.19E+05
0.6	3.26E+05
0.7	5.94E+05
0.8	8.53E+05
0.9	1.05E+06
1	1.18E+06
1.1	1.24E+06
1.2	1.25E+06
1.3	1.21E+06
1.4	1.15E+06
1.5	1.08E+06
1.6	1.00E+06
1.7	9.21E+05
1.8	8.41E+05
1.9	7.66E+05
2	6.95E+05
2.1	6.30E+05
2.2	5.71E+05
2.3	5.17E+05
2.4	4.69E+05
2.5	4.25E+05
2.6	3.86E+05
2.7	3.50E+05

2.8	3.18E+05
2.9	2.90E+05
3	2.64E+05
3.1	2.41E+05
3.2	2.21E+05
3.3	2.02E+05
3.4	1.85E+05
3.5	1.70E+05
3.6	1.56E+05
3.7	1.44E+05
3.8	1.33E+05
3.9	1.23E+05
4	1.13E+05
4.1	1.05E+05
4.2	9.73E+04
4.3	9.03E+04
4.4	8.39E+04



Check: Units ok. Physics ok.

Discussion: The temperature of this object (2500K) is about the temperature of an incandescent light bulb The peak wavelength is higher energy than visible light.

Chapter 10

A1e) (3 marks)

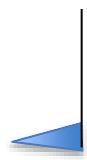
Plot the wind symbol for winds with the following directions and speeds:
e) S at 48kt.

Given: M = 48 kt
direction = S

Find: Applicable wind symbol.

From Table 10-1:
Pennant 50 speed units

48 knots its closer to 50 than 45, so draw the symbol for 50.
48 kt = shaft with one pennant



Check: direction and symbol ok.
Discussion: If only the pressure gradient force was acting here, high pressure would be to the S and low pressure would be to the N

A4e)
(4 marks)

Find the advective "force" per unit mass given the following wind components (m/s) and horizontal distances (km): e) V = 3, ΔU = 10, Δy = 10.

Given:	V=	3	m/s
	ΔU =	10	m/s
	Δy =	10	km

Find:	FxAD/m =	?	m/s^2
	FyAD/m =	?	m/s^2

Use eq. 10.8a:
FxAD/m = -U*(ΔU/Δx) -V*(ΔU/Δy) -W*(ΔU/Δz)

Use eq. 10.8b:
FyAD/m = -U*(ΔV/Δx)-V*(ΔV/Δy) - W*(ΔV/Δz)

Convert Δx(km) to Δx(m):
Δy = 10000 m

Since ΔV is not given, we can assume ΔV = 0. Therefore, FyAD/m = 0.

Since U and W were not given, we can assume that V = 0 and W = 0.
Hence:

FxAD/m = -V *(ΔU/Δy)

FyAD/m =	**0**	**m/s^2**
FxAD/m =	**-0.003**	**m/s^2**

Check: Units ok. Physics ok.
Discussion: The advective force is negative,
therefore advection is accelerating the wind to the West.
(slowly)

A5e)
(4 marks)

Town A is 500km west of town B. The pressure at town A is given below, and the pressure at town B is 100.1kPa. Calculate the pressure-gradient force/mass in between these two towns: e) 99.4 kPa.

Given:	Δx =	500	km
	P@A =	99.4	kPa
	P@B =	100.1	kPa

Find:	FxPG/m =	?	m/s^2
	FyPG/m =	?	m/s^2

Use eq. 10.9a: FxPG/m = -(1/ρ)*(ΔP/Δx)

where ρ = 1.2 kg/m^3

Convert Δx(km) to Δx(m):

Δx = 500000 m

Convert P@A(kPa) to P@A(Pa) and P@B(kPa) to P@B(Pa):

P@A =	99400	Pa
P@B =	100100	Pa
ΔP =	700	Pa

Since town A is 500km to the west of town B, there is no pressure change in the North - South direction.

FxPG/m = -0.00116667 m/s^2

Check: Units ok. Physics ok.

Discussion: The PGF is negative because
air flows east to west from town B to town A.
The force is very small because the pressure difference is very small.

A6a)
(5.5 marks)

Suppose that U = 8m/s and V = -3 m/s, and latitude = 45 deg. Calculate centrifugal force components around a: d) 500km radius low in N. hemisphere

Given:	U =	8	m/s
	V =	-3	m/s
	lat =	45	degS
	R =	500	km

Find:	FxCN/m =	?	m/s^2
	FyCN/m =	?	m/s^2

Use eq. 10.13a: FxCN/m = +s *(V*M)/R
Use eq. 10.13b: FyCN/m = -s *(U*M)/R

where M = (U^2 + V^2)^1/2

North Hemisphere, low pressure:

The force is 90° to the wind's right in the N.H so the coriolis force will be towards the east

Convert R(km

R = 500000 m

M = 8.54400375 m/s

FxCN/m = -5.1264E-05 m/s^2
FyCN/m = -0.0001367 m/s^2

Check: Units ok. Physics ok.

Discussion: These components correspond to a force pointing SSW.

A8e)
(4 marks)

What is the magnitude and direction of Coriolis force/mass in Los Angeles, USA, given: e) U(m/s) = 0, V(m/s) = -5.

Given:	U =	0	m/s	
	V =	-5	m/s	
	lat =	34.0522	degN	of Los Angeles, USA

Find: |FCF/m| = ? m/s^2
Direction of FCF/m.

Use eq. 10.18a: |FCF/m| = 2*Ω*|sin(ϕ)*M|
or
use eq. 10.18b: |FCF/m| = |fc*M|
and eq. 10.16: fc = 2*Ω*sin(ϕ)

where M = (U^2 + V^2)^1/2
M = 5 m/s
and
Ω = 7.29E-05 s^-1

|FCF/m| = 4.08E-04 m/s^2
Direction is towards the West
or 270deg

Check:
Discussion: The wind is blowing towards north and the drag force is directly opposite the wind so is therefore towards the south.

A9e)
(5.5 marks)

Same wind components as exercise A8, but find the magnitude and direction of turbulent drag force/mass in a statically neutral atmospheric boundary layer over an extensive forested region.

Given:	U =	0	m/s
	V =	-5	m/s
	lat =	34.0522	degN
Find:	|FTD/m| =	?	m/s^2

Direction of FTD/m.

Use eq. 10.20: |FTD/m| = wt *(M/zi)

where M = (U^2 + V^2)^1/2
and wt = CD*M for statically neutral conditions

Hence:

CD =	0.02	over forests.
zi =	1	km
	(other zi values allowed)	

Convert zi(km) to zi(m):

zi =	1000	m

(values of CD and zi given in Sample Application pg. 300;
or could be estimated given the latitude of LA)

M =	5	m/s
wt =	0.10	m/s

|FTD/m| = 0.0005 m/s^2

Direction: towards North

Check: Units ok. Physics ok.
Discussion: