HW3 Answer Key

ATSC 201 2025

Total mark out of 50

Ch2: A5g, A13g, A15g.

Ch8: A12g, A13g, A18g, A19g

Ch10: A1g, A5g, A6c, A8g.

Chapter 2

A5g) **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: $\delta s = \Phi r * \cos(C*(d - dr)/dy)$

where:

Φr =	0.40910518	rad
C =	6.28318531	rad
dr =	171	for 2025 (June 20)
dy =	365	for 2025

	22-Dec	23-Mar	22-Jun
δs (rads)	-0.40872639	0.01584149	0.40886274
δs (deg)	-23.4182973	0.90765026	23.4261095

Use eq. 2.6: $\sin(\Psi) = \sin(\phi) * \sin(\delta s) - \cos(\phi)*\cos(\delta s)*\cos((C*tUTC/td)+\lambda e)$

where:

ϕ =	45.5089	degN=	0.79428014	rad
λe =	-73.5617	degE=	-1.2838939	rad
td =	24.0	h		

time zone of Montreal:

tUTC = t + 4 hours	EDT	(for Mar23 and Jun22)
tUTC = t + 5 hours	EST	(for Dec22)

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	Ψ (deg)		
t(h)	**22-Dec**	**23-Mar**	**22-Jun**
0	-67.88	-42.06	-19.97
1	-64.20	-43.57	-21.05
2	-56.32	-41.36	-19.46
3	-46.61	-35.91	-15.37
4	-36.23	-28.14	-9.18
5	-25.74	-18.89	-1.37
6	-15.51	-8.80	7.63
7	-5.83	1.66	17.44
8	2.97	12.10	27.75
9	10.51	22.13	38.24
10	16.34	31.27	48.55
11	19.98	38.81	58.04
12	21.06	43.83	65.33
13	19.47	45.38	67.89
14	15.38	43.11	64.21
15	9.19	37.53	56.33
16	1.37	29.62	46.61
17	-7.63	20.26	36.23
18	-17.44	10.11	25.75
19	-27.74	-0.36	15.51
20	-38.24	-10.78	5.83
21	-48.55	-20.74	-2.97
22	-58.03	-29.77	-10.51
23	-65.32	-37.17	-16.33
24	-67.88	-42.06	-19.97

Check: Units ok. Physics ok.
Discussion: Montreals' winter lumonosity is similar to Vancouver's.

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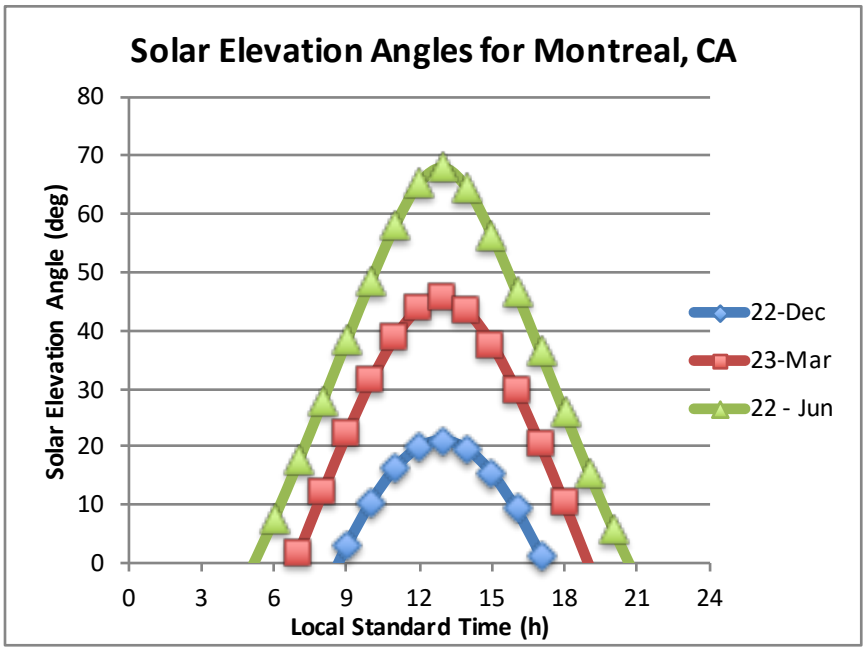

A13g) **Find the kinematic heat fluxes at sea level, given these regular fluxes (W/m^2): g) 400.**

Given: ΓH = 400 W/m^2

Find: FH = ? K*m/s

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

FH = 0.324939074 K*m/s

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

A15g) **Plot Planck curves for the following blackbody temperatures (K): f) 1500.**

Given: T = 1500 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	7.60E-29
0.2	1.67E-09
0.3	1.95E-03
0.4	1.38E+00
0.5	5.49E+01
0.6	5.41E+02
0.7	2.46E+03
0.8	7.01E+03
0.9	1.48E+04
1	2.53E+04
1.1	3.77E+04
1.2	5.04E+04
1.3	6.26E+04
1.4	7.32E+04
1.5	8.20E+04
1.6	8.86E+04
1.7	9.33E+04
1.8	9.60E+04
1.9	9.72E+04
2	9.70E+04
2.1	9.57E+04
2.2	9.36E+04
2.3	9.08E+04
2.4	8.76E+04
2.5	8.41E+04
2.6	8.04E+04
2.7	7.66E+04
2.8	7.28E+04
2.9	6.91E+04

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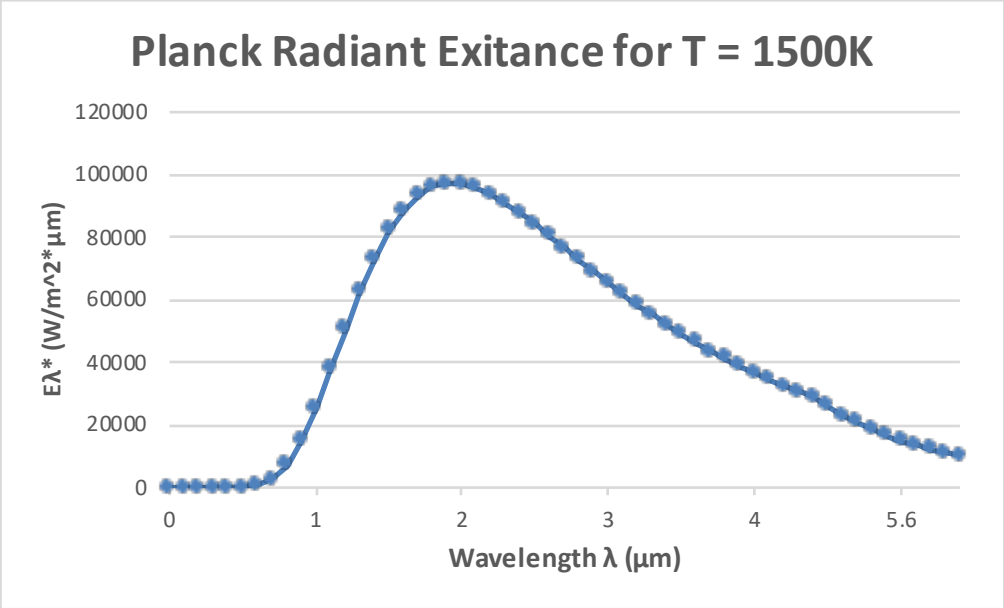
3	6.54E+04
3.1	6.18E+04
3.2	5.84E+04
3.3	5.51E+04
3.4	5.20E+04
3.5	4.90E+04
3.6	4.62E+04
3.7	4.35E+04
3.8	4.10E+04
3.9	3.87E+04
4	3.64E+04
4.1	3.44E+04
4.2	3.24E+04
4.3	3.06E+04
4.4	2.88E+04
4.6	2.57E+04
4.8	2.30E+04
5	2.06E+04
5.2	1.84E+04
5.4	1.66E+04
5.6	1.49E+04
5.8	1.35E+04
6	1.22E+04
6.2	1.10E+04
6.4	1.00E+04



Check: Units ok. Physics ok.

Discussion: The temperature of this object (1500K) is similar to very hot lava. The peak wavelength is in the infrared range.

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Chapter 8
A12g

Find the range to a radar target, given the round-trip (return) travel times (μs) of:	g) 100

Given:

t= 100 us = 1.00E-04 s

Find: range of radar target

Use eq. 8.16 R= c*t/2

c= 3.00E+08 m/s

R= 1.50E+04 m

Check: Units ok. Physics ok.
Discussion: The radar target is slightly farther than 15km which only requires a round-trip time of 100 us since radar pulses travel at the speed of light.

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A13g

Find the radar max unambiguous range for pulse repetition frequencies (s–1) of: g) 1000

Given:

PRF= 1000 s-1

Find: maximum unambiguous range

Use eq. 8.17 Rmax=c/(2*PRF)

c= 3.00E+08 m/s

Rmax= 1.50E+05 m

Check: Units ok. Physics ok.

Discussion: The radar's max unambiguous range is 150km which puts it in the C band

HW3 Answer Key

A18g

For a radar with 0.5° elevation angle mounted on a 10 m tower, calculate and plot the height of the radar-beam centerline vs. range from 0 to 500 km, for the following beam curvature factors ke, and name the type of propagation: g) 1.75

Given:

ke=	1.75				
z1=	10	m			
ψ=	0.5	°	=	0.00872665	rad
Ro=	6371	km	=	6371000	m

Find: height of radar-beam centerline

Use eq. 8.21 Rc=Ro*ke

Rc= 11149250 m

Use eq. 8.22 z=z1-Rc+sqrt(R^2+Rc^2+2*R*Rc*sin(ψ))

R (km)	R (m)	z (m)	z (km)
0	0	10	0.01
5	5000	54.75373932	0.05475374
10	10000	101.7495841	0.10174958
15	15000	150.9875059	0.15098751
20	20000	202.4674751	0.20246748
25	25000	256.1894605	0.25618946
30	30000	312.1534299	0.31215343
35	35000	370.3593495	0.37035935
40	40000	430.8071841	0.43080718
45	45000	493.4968972	0.4934969
50	50000	558.4284511	0.55842845
55	55000	625.6018066	0.62560181
60	60000	695.0169231	0.69501692
65	65000	766.6737589	0.76667376
70	70000	840.5722706	0.84057227
75	75000	916.7124138	0.91671241

80	80000	995.0941424	0.99509414
85	85000	1075.717409	1.07571741
90	90000	1158.582166	1.15858217
95	95000	1243.688362	1.24368836
100	100000	1331.035946	1.33103595
105	105000	1420.624866	1.42062487
110	110000	1512.455068	1.51245507
115	115000	1606.526496	1.6065265
120	120000	1702.839093	1.70283909
125	125000	1801.392802	1.8013928
130	130000	1902.187562	1.90218756
135	135000	2005.223314	2.00522331
140	140000	2110.499996	2.1105
145	145000	2218.017542	2.21801754
150	150000	2327.77589	2.32777589
155	155000	2439.774972	2.43977497
160	160000	2554.014722	2.55401472
165	165000	2670.49507	2.67049507
170	170000	2789.215946	2.78921595
175	175000	2910.177278	2.91017728
180	180000	3033.378994	3.03337899
185	185000	3158.82102	3.15882102
190	190000	3286.503279	3.28650328
195	195000	3416.425695	3.4164257
200	200000	3548.58819	3.54858819
205	205000	3682.990684	3.68299068
210	210000	3819.633095	3.8196331
215	215000	3958.515343	3.95851534
220	220000	4099.637342	4.09963734
225	225000	4242.999008	4.24299901
230	230000	4388.600255	4.38860025
235	235000	4536.440994	4.53644099
240	240000	4686.521138	4.68652114
245	245000	4838.840594	4.83884059
250	250000	4993.399273	4.99339927
255	255000	5150.19708	5.15019708
260	260000	5309.233921	5.30923392
265	265000	5470.509701	5.4705097
270	270000	5634.024322	5.63402432
275	275000	5799.777686	5.79977769
280	280000	5967.769692	5.96776969
285	285000	6138.000241	6.13800024
290	290000	6310.469229	6.31046923

295	295000	6485.176553	6.48517655
300	300000	6662.122108	6.66212211
305	305000	6841.305786	6.84130579
310	310000	7022.72748	7.02272748
315	315000	7206.387081	7.20638708
320	320000	7392.284479	7.39228448
325	325000	7580.419561	7.58041956
330	330000	7770.792215	7.77079221
335	335000	7963.402325	7.96340233
340	340000	8158.249776	8.15824978
345	345000	8355.334452	8.35533445
350	350000	8554.656232	8.55465623
355	355000	8756.214997	8.756215
360	360000	8960.010627	8.96001063
365	365000	9166.042998	9.166043
370	370000	9374.311986	9.37431199
375	375000	9584.817468	9.58481747
380	380000	9797.559314	9.79755931
385	385000	10012.5374	10.0125374
390	390000	10229.75159	10.2297516
395	395000	10449.20176	10.4492018
400	400000	10670.88778	10.6708878
405	405000	10894.80951	10.8948095
410	410000	11120.96682	11.1209668
415	415000	11349.35957	11.3493596
420	420000	11579.98763	11.5799876
425	425000	11812.85085	11.8128509
430	430000	12047.9491	12.0479491
435	435000	12285.28224	12.2852822
440	440000	12524.85012	12.5248501
445	445000	12766.65259	12.7666526
450	450000	13010.68953	13.0106895
455	455000	13256.96076	13.2569608
460	460000	13505.46616	13.5054662
465	465000	13756.20557	13.7562056
470	470000	14009.17884	14.0091788
475	475000	14264.38581	14.2643858
480	480000	14521.82635	14.5218263
485	485000	14781.50028	14.7815003
490	490000	15043.40745	15.0434075
495	495000	15307.54771	15.3075477
500	500000	15573.9209	15.5739209

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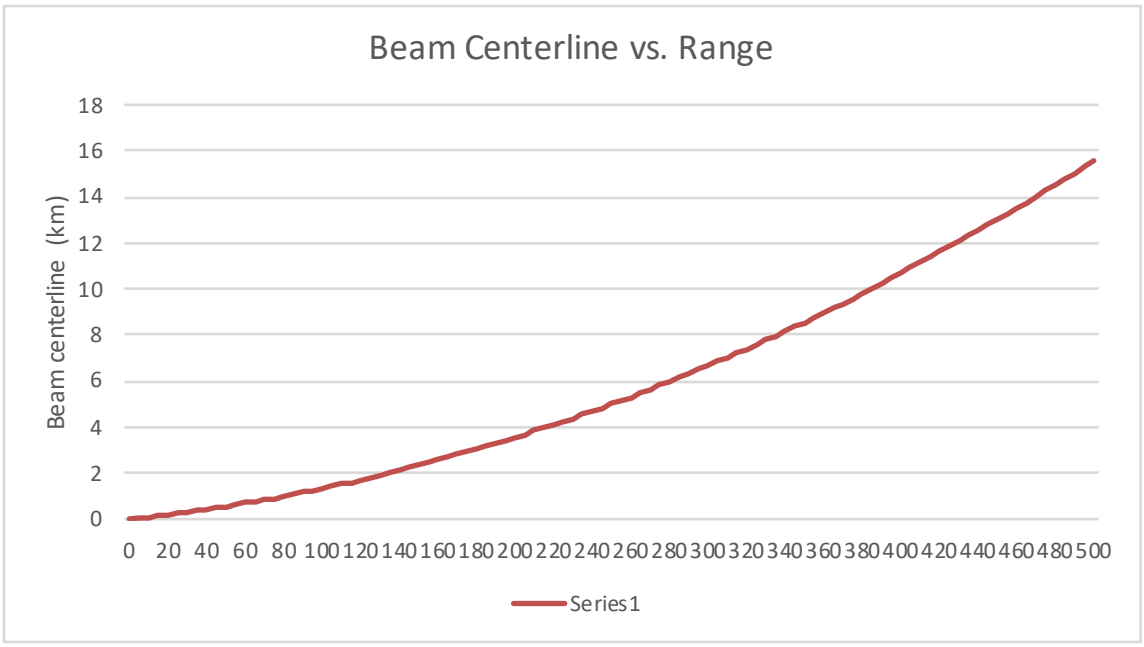


Propagation type: subrefraction

Check: Units ok. Physics ok.
Discussion: The beam centerline height increases as the range increases which indicates subrefraction which is typical of an unstable atmosphere

HW3 Answer Key

A19g

Use the simple Z-R relationship to estimate the rainfall rate and the descriptive intensity category used by pilots and air traffic controllers, given the following observed radar echo dBZ values: g) 52

Given:

dBZ= 52 dBZ

Find: Rainfall rate and descriptive intensity

Use eq. 8.29 a1*10^(a2*dBZ)

a1= 0.017 mm/hr
a2= 0.0714 dBZ-1

RR= 87.75036293 mm/hr

Precipitation category: extreme

Check: Units ok. Physics ok.
Discussion: This rainfall rate is considered extreme which could create dangerous conditions for pilots.

Chapter 10

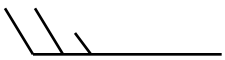
A1g) **Plot the wind symbol for winds with the following directions and speeds:**
g) W at 27kt.

Given: M = 27 kt
direction = W

Find: Applicable wind symbol.

From Table 10-1:
full barb 10 speed units
half barb 5 speed units

27 is closer to 25 than 30 so draw symbol for 25
25 kt = 2 full barbs + 1 half barb



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

A5g) **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: g) 99.8 kPa.**

Given:	Δx =	500	km
	P@A =	99.8	kPa
	P@B =	100.1	kPa

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

Use eq. 10.9a: $FxPG/m = -(1/\rho)*(\Delta P/\Delta x)$

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 =	99800	Pa
P@B =	100100	Pa
ΔP =	300	Pa

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

FxPG/m = -0.0005 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.

A6c) **Suppose that U = 8m/s and V = -3 m/s, and latitude = 45 deg. Calculate centrifugal force components around a: c) 400km radius low in S. hemisphere**

Given:	U =	8	m/s
	V =	-3	m/s
	lat =	45	degS
	R =	400	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

Southern Hemisphere, low pressure:

s= -1

Convert R(km) to R(m):

R = 400000 m

M = 8.54400375 m/s

FxCN/m = 6.408E-05 m/s^2
FyCN/m = 0.00017088 m/s^2

Check: Units ok. Physics ok.
Discussion: These components correspond to a force pointing NNW.

A8g) **What is the magnitude and direction of Coriolis force/mass in Los Angeles, USA, given: g) U(m/s) = -5, V(m/s) = -5.**

Given:	U =	-5	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: $|FCF/m| = 2*\Omega*|\sin(\phi)*M|$
or
use eq. 10.18b: $|FCF/m| = |fc*M|$
and eq. 10.16: $fc = 2*\Omega*\sin(\phi)$

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

	M =	7.07106781	m/s
and			
	Ω =	7.29E-05	s^-1

|FCF/m| = 5.77E-04 m/s^2
Direction is towards the Northwest

Check: Units ok. Physics ok.

Discussion: The force is 90° to the wind's right in the N.H so the coriolis force will be towards the northwest, since the observed wind is northeasterly.