

31 Jan 2003
TAM

PROBLEM SET 1 ATMO 445/545 DUE FEB 5

You will have to study the links
on the class web page

3(4)

1- ANSWER THE FOLLOWING QUESTIONS FOR
THE NATIONAL WEATHER SERVICE WSR-88D
WEATHER RADAR

a) WHAT IS THE POWER OUTPUT
AT THE KLYSTRON 750 KW KW

b) WHAT IS THE POWER LOSS FROM THE
KLYSTRON TO THE ANTENNA FEED 275 KW KW

2 dB dB

ANTENNA POWER = 475 KW

c) IF THE FIRST SIDE LOBE, RELATIVE TO
THE ANTENNA POWER TRANSMITTED, IS
-29 dB THEN THE POWER IN SIDE LOBE IS 598 KW
598 W

d) CALCULATE THE SHORTEST AND LONGEST
UNAMBIGUOUS RANGES IF THE RADAR IS
OPERATING IN SHORT PULSE MODE
115 Km to 472 Km Km

NOTE: YOU'LL HAVE TO LOOK AHEAD TO
PP 105 + 106 IN THE TEXT

3) If the pulse duration is 2 μ s then the pulse length is 600 m m

4) If the pulse duration is 2 μ s AND the PRF is 500 Hz, calculate the following -
ASSUME THE ANTENNA ROTATION RATE IS 1 RPM (REVOLUTION PER MINUTE) -

The amount of time the ANTENNA is TRANSMITTING POWER during 1 revolution .065 s

The amount of time the ANTENNA is RECEIVING POWER DURING 1 REVOLUTION 59.945 s

3 orders of magnitude difference!

5(6)
2 - CONSIDER A POLICE TRAFFIC RADAR GUN, AS TYPIFIED BY THE ASTROPRODUCTS "PHANTOM" RADAR

a) POWER TRANSMITTED RANGE IS 10 to 20 $\frac{mi}{mw}$ $\frac{mi}{mw}$

b) BEAM WIDTH IS ~12 degrees

c) Pulse LENGTH IS Zero m

Continuous Wave

OR "TRIGGER" time $\times c =$ length for a single shot or pulse

1) MAXIMUM RANGE AT WHICH THE BEAM DIAMETER IS \leq THE WIDTH OF AN INTERSTATE TRAFFIC LANE (CONSIDER A TRAFFIC LANE TO BE 5m wide)

~ 24 m

2) A HIGHWAY PATROL OFFICER "CLOCKS" you speeding at 90mph along I-10 NW of TUCSON. SHE STATES THAT THE READING IS COMPLETELY ACCURATE. DESCRIBE ALL THE CONDITIONS THAT MUST BE MET FOR HER TO MAKE THIS STATEMENT.

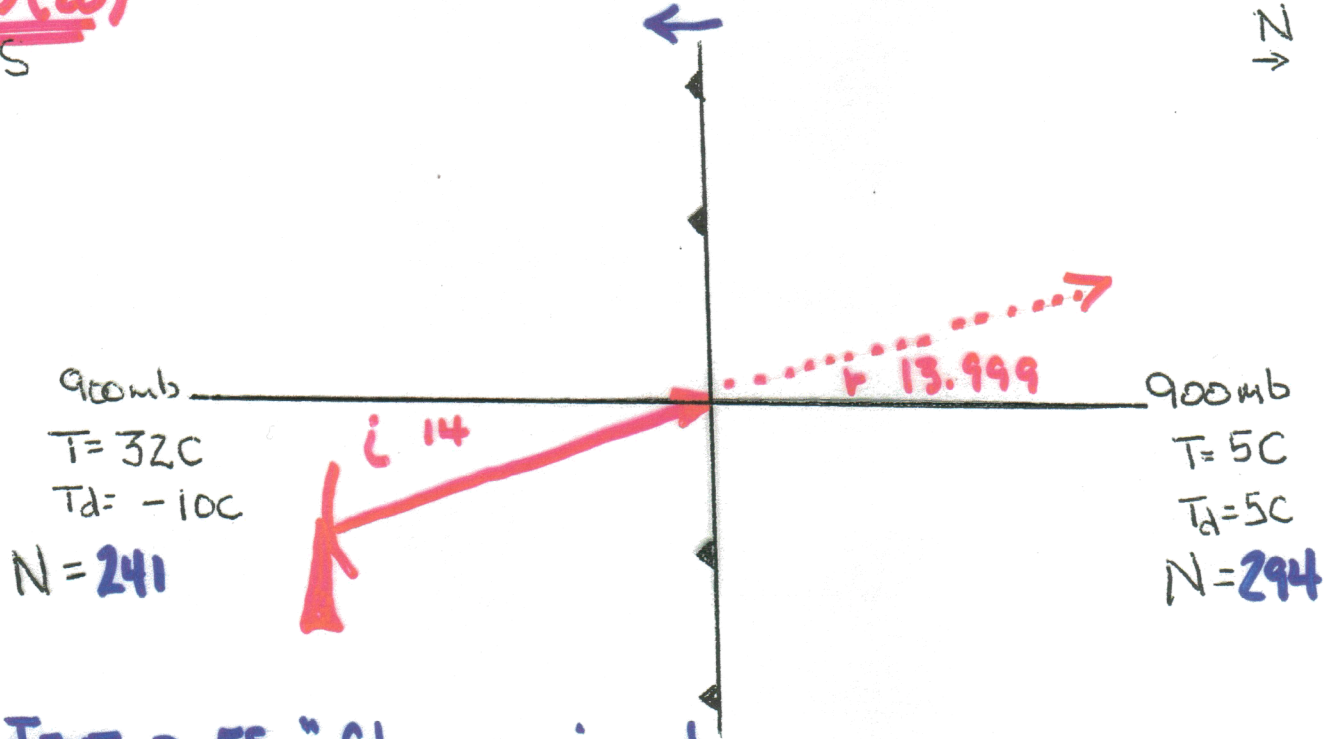
Looking For:

- * RADAR GUN CALIBRATED AND WORKING PROPERLY
- * RADAR GUN POINTED DIRECTLY HEAD ON - NO ANGLES
- * NO other MOVING TARGETS IN radar beam
- * NO UNUSUAL or EXTREME ATMOSPHERIC CONDITIONS

3- BEAM PROPAGATION AND ATMOSPHERIC REFRACTION

a) A VERY STRONG COLD FRONT IS APPROACHING (MOVING AWAY FROM) A WSR88-D RADAR AT 20 m/s. THE RADAR IS OPERATING IN VCP-11. THE CENTER OF ONE OF THE TRANSMITTED BEAMS INTERSECTS THE FRONT AT 900 MB AT ANGLE OF 14 DEGREES RELATIVE TO HORIZONTAL. WHAT IS THE ANGLE OF REFRACTION FOR THE FRONT APPROACHING ~13.999 DEGREES AND FOR THE FRONT MOVING AWAY ~14.001 DEGREES?

12.5(20)
← S



RE: TEXT P. 55 "CHANGES IN REFRACTION ARE USUALLY MUCH STRONGER IN VERTICAL DIRECTIONS THAN IN HORIZONTAL DIRECTIONS."

SKETCH, **IN RED**, ONE OF YOUR ANSWERS ON THE ABOVE DIAGRAM. CONSIDER THE FRONT TO BE A SINGULAR, VERTICAL DISCONTINUITY WITH THERMODYNAMIC CONDITIONS ON EITHER SIDE AS INDICATED ON DIAGRAM

36 12.5(20)

b) CONSIDER JOE FLETCHER'S ACCOUNT OF FLYING OVER THE OCEAN "LOOKING" FOR A RESEARCH RADAR'S BEAM IN HIS PAPER ON THE HISTORY OF RADAR. IF THAT RADAR BEAM WERE COMPLETELY TRAPPED (OR "DUCTED") AT AND BELOW 100m MSL, THE TEMPERATURE AT 100m MUST HAVE BEEN AT LEAST ~ 10 C.

OTHER CONDITIONS OF IMPORTANCE WERE:

WARM, DRY AIR WAS BLOWING FROM THE LAND OVER THE OCEAN, WHICH HAD AN SST OF 10C.

THE AIR AT THE SEA SURFACE HAD $T = 10C$ AND $RH = 100\%$.

THE AIR AT 100m HAD A MIXING RATIO OF $6g/kg$. NOTE this means $T_{990} \geq 6.2^{\circ}C$

SEA LEVEL PRESSURE WAS 1000mb AND PRESSURE DECREASED 1mb/10m WITH HEIGHT.

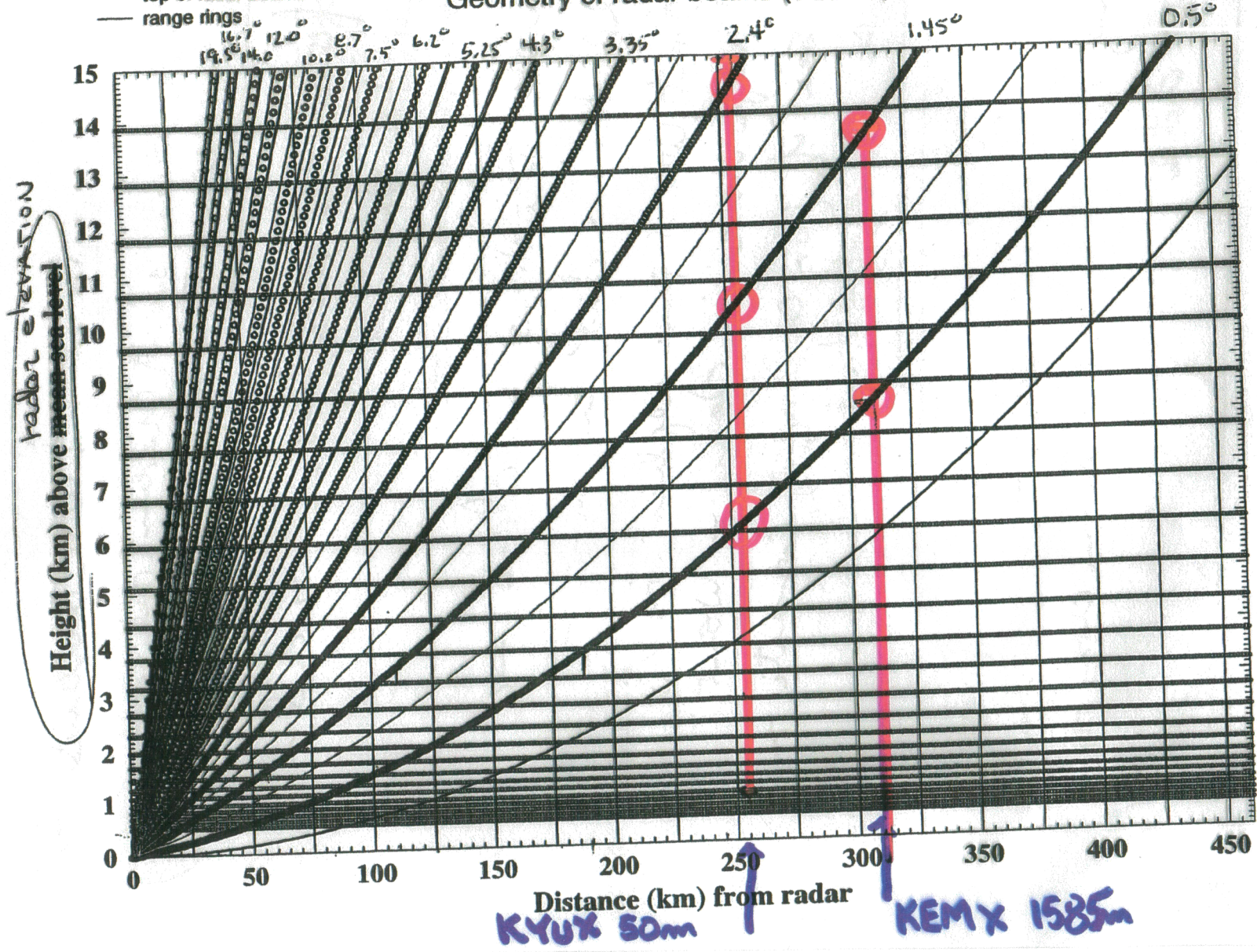
$$N_{1000} \approx 332 \text{ Nunits}$$

$$\text{if } \Delta N / \Delta H \leq -157 \text{ Nunits/Km}$$

$$\text{THEN } N_{990} \leq 316 \text{ Nunits}$$

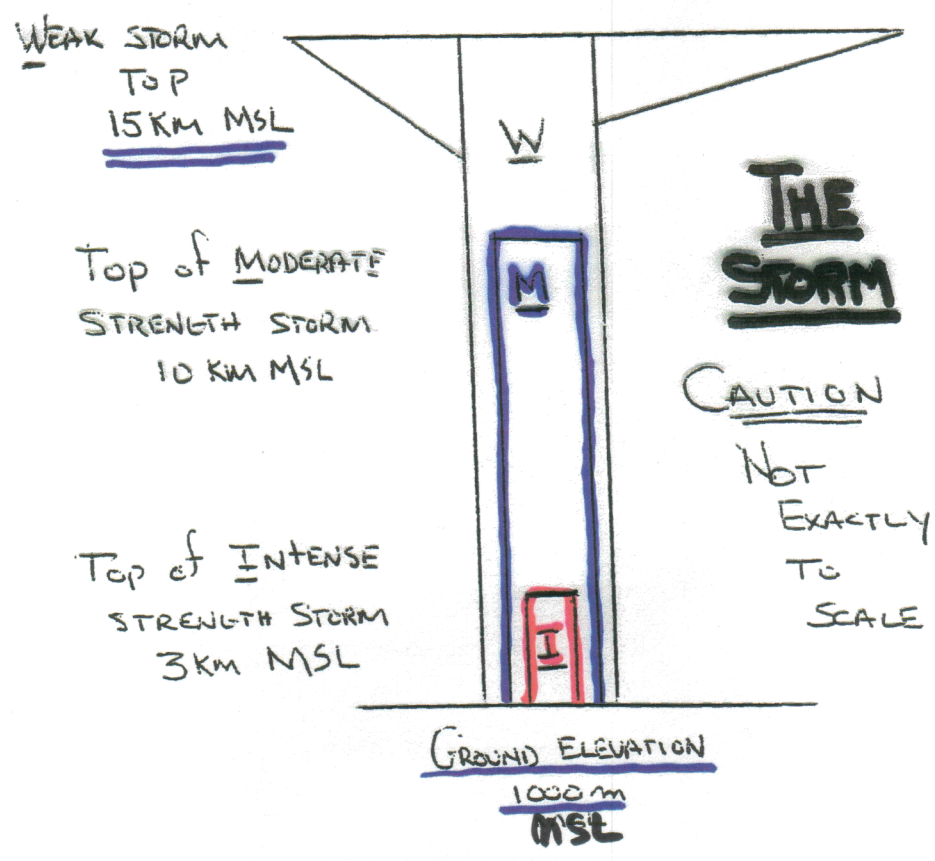
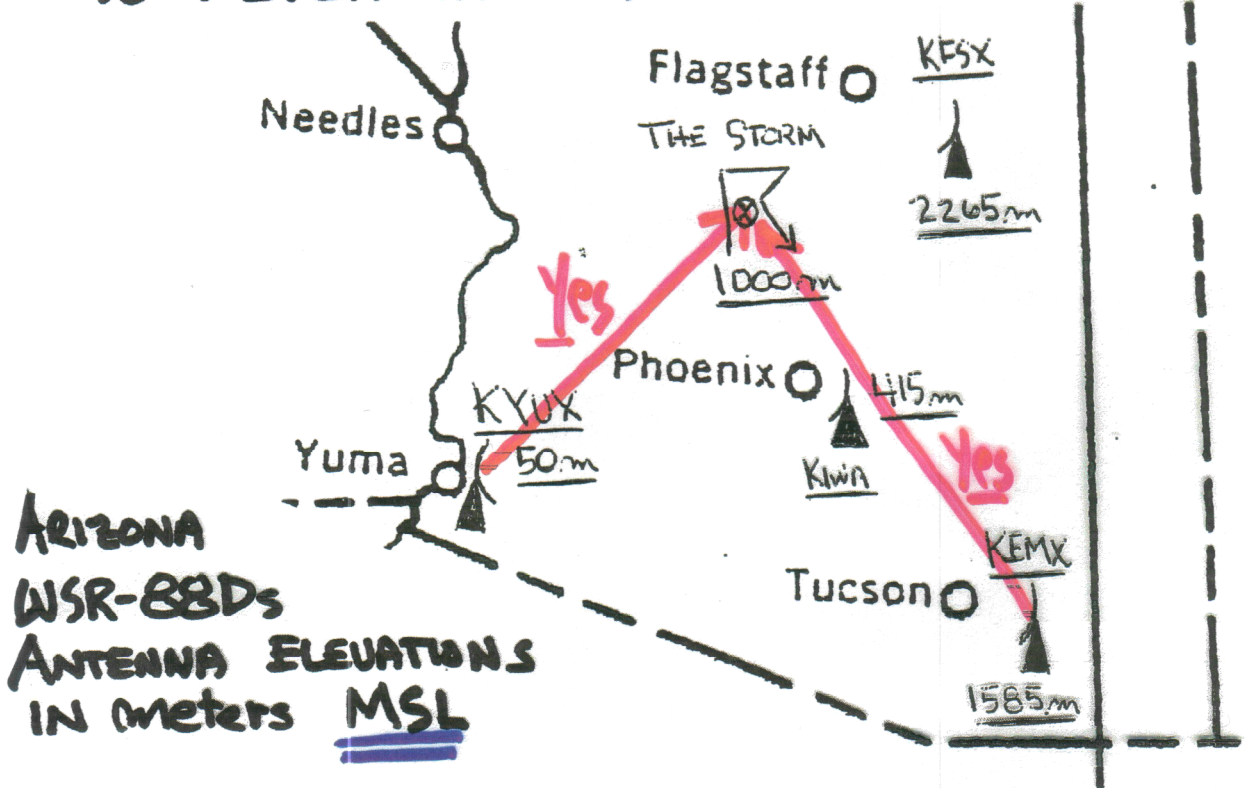
- center of radar bins
- center of grid cells
- bottom of radar beams
- top of radar beams
- range rings

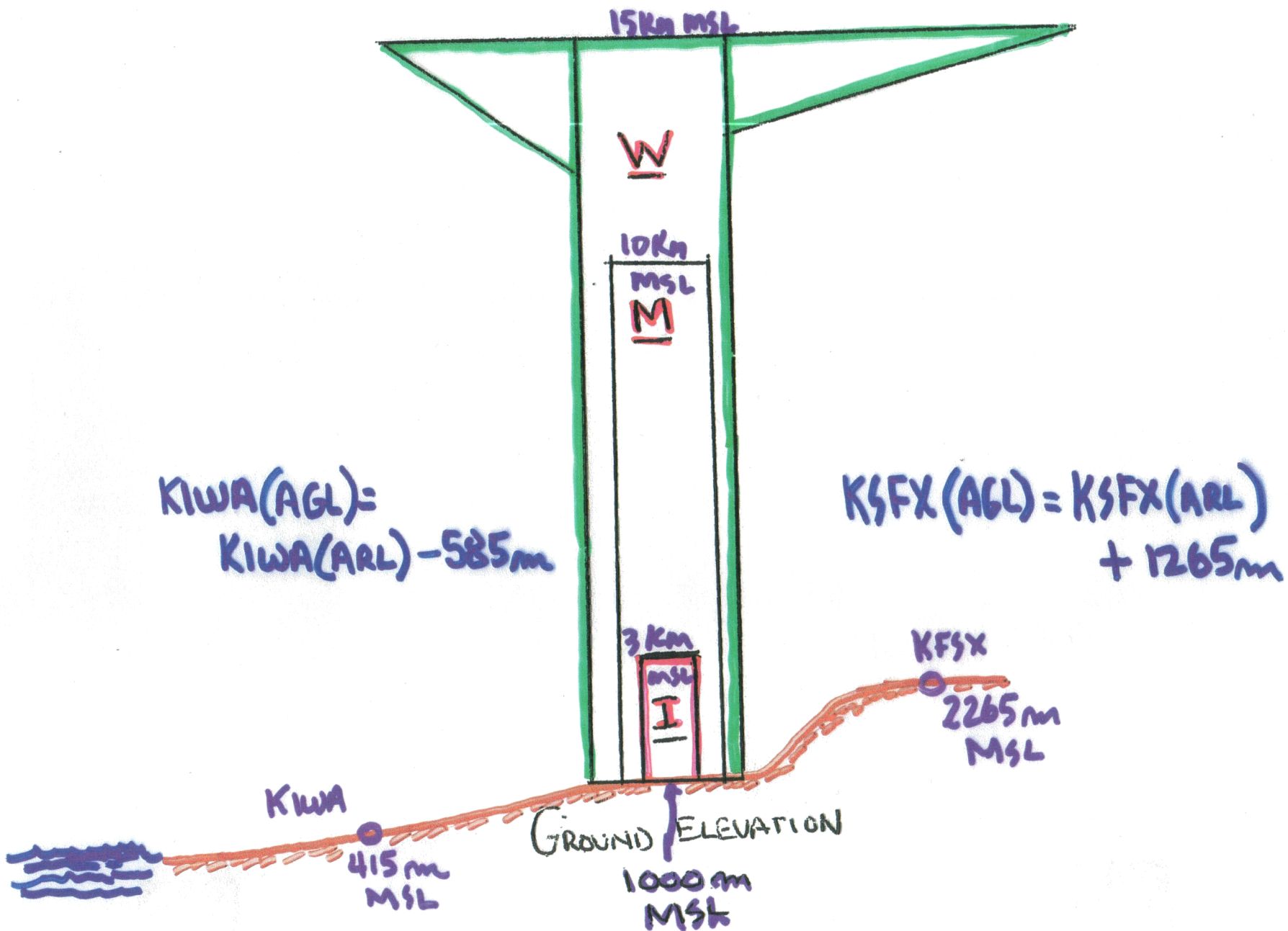
Complete Volume Scan every 5 minutes
 Geometry of radar beams (VCP11)

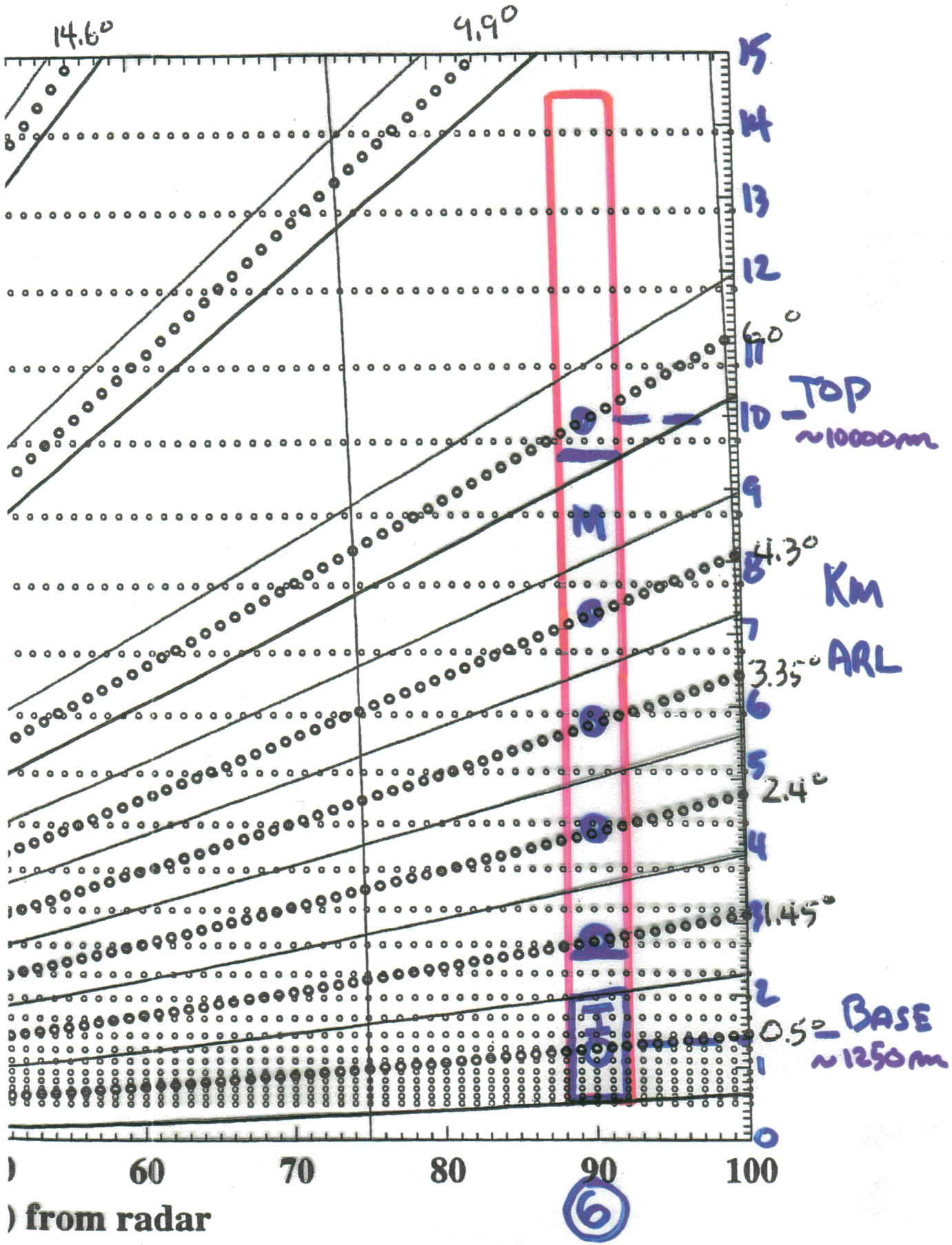


25(40)

USE THIS MAP AND THE STORM DRAWING TO DETERMINE ANSWERS FOR THIS QUESTION.

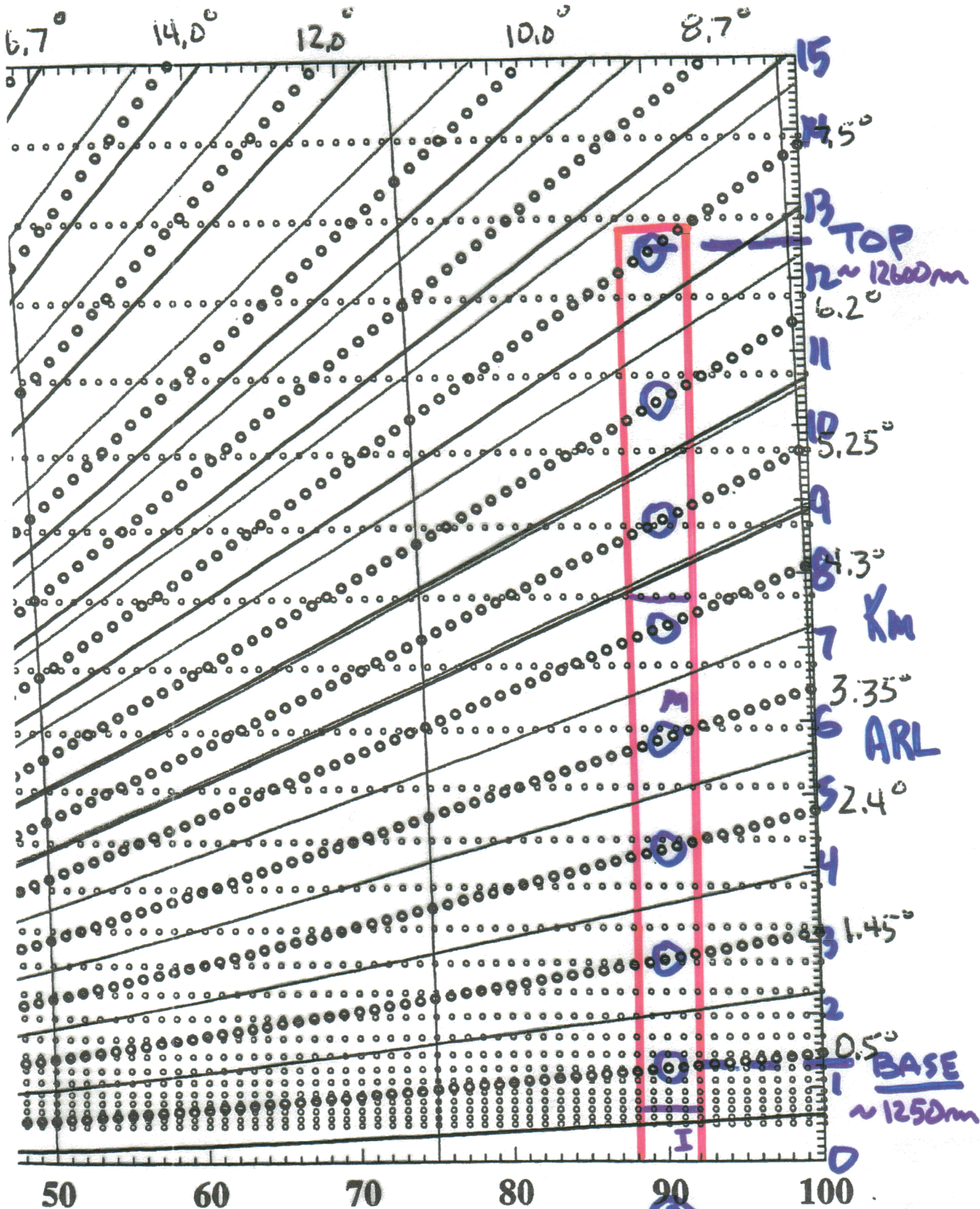






KIWA
VCP-21

$$KIWA(AGL) = KIWA(ARL) - 585m$$



KFSX
VCP-11

$$KBSX(AGL) = KFSX(ARL) + 1265m$$

#4

OTHER DETAILS

THE STORM IS LOCATED FROM EACH RADAR AT RANGE OF: KFSX 90 km KIWA 90 km KYUX 255 km

KEMX 310 km KFSX IS OPERATING IN VCP11

KIWA IS OPERATING IN VCP21

RADARS CAN "DETECT" STORM ECHO IF AT LEAST HALF THE BEAM IS FILLED BY STORM. RADARS DETECT INTENSITY LEVELS ONLY IF ENTIRE BEAM FILLED BY THAT INTENSITY OF STORM. "HEIGHTS" OF ALL STORM FEATURES DETERMINE BY HEIGHTS OF RADAR BEAM CENTERS. ASSUME "STANDARD" REFRACTION. ARL = HEIGHT ABOVE RADAR ANTENNA ELEVATION. AGL = HEIGHT ABOVE GROUND SURFACE AT STORM LOCATION.

DETERMINE THE FOLLOWING

KIWA

KFSX

STORM BASE ~1250 mARL ~665 mAGL ~1250 mARL ~2515 mAGL

STORM TOP ~10000 mARL ~9415 mAGL ~12600 mARL 13865 mARL

MAX STORM STRENGTH

I

M

BONUS KYUX Yes

KEMX Yes

Note: STORM "BASE" is lowest height of radar detected STORM Echo
STORM "TOP" is highest height of radar detected STORM Echo