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~~H. Moore~~
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LS-A

CALIFORNIA BOARD OF REGISTRATION FOR
CIVIL AND PROFESSIONAL ENGINEERS

August 25, 1965

1965 LAND SURVEYOR EXAMINATION

PART A

Closed Book

INSTRUCTIONS TO EXAMINEE:

Time Allowed - Four Hours

The first day of this examination consists of two parts of four hours each (morning and afternoon). Each part will be weighted proportionately. The total grading weight for the first-day part of the examination is 100.

Part A consists of 60 problems. All problems have equal weight, and all problems are required.

Detach the last sheet from this booklet. This is your Answer Sheet for this part of the examination. Show only the appropriate answer in the space provided on the answer sheet. If a choice is provided, you may enter only the appropriate letter in the space provided. If no choice is provided, enter the word or words, or the numerical answer, as appropriate for the problem. Grading will be based only on the answers shown.

You may use any available space on this booklet for computations. When you have completed Part A, return only the Answer Sheet to the proctor. Be sure that your identification number is shown.

No texts, notes, or any other reference material are permitted in this part of the examination. No work will be accepted after the close of the examination period. Slide rules are permitted.

You may keep the examination questions.

Calculators or computers of any type are prohibited in this part of the examination.

SHOW YOUR ANSWERS ON THE ANSWER SHEET

25

24

NOTE: Various types of questions are included herein. Enter only the appropriate answer in the space provided on the Answer Sheet.

1. The A, B, C, and D scales adopted for use on most slide rules are based upon

   (A) common logarithms OK
   (B) hyperbolic functions
   (C) natural logarithms
   (D) polar logarithms
   (E) logarithms of logarithms

2. The area of a zero circle is most commonly associated with

   (A) a Beaman arc
   (B) a drafting machine
   (C) a pantographic
   (D) an alidade
   (E) a polar planimeter OK

3. The shape of the earth is most closely described as that of

   (A) a sphere
   (B) a spheroid OK
   (C) an oblate ellipsoid
   (D) an oblate spheroid of revolution
   (E) an ovaloid

OK 4. An imaginary vertical line projected from the center of the earth through the point at which you are standing would point to Zenith.

OK 5. The type of surveying which takes into account the shape of the earth is defined as Geodetic surveying.

OK 6. The Gunter chain is 66 feet long. It consists of 100 links. Each link is 7.92 inches long.

OK 7. There are in one statute mile 80 Gunters chains.

✓8. What is the number of significant figures in each of the following:

(A) 732 - 3

(B) 732.38 - 5

OK (C) 0.000065 - 2

(D) 10.00732 7

(E) 0.07320 - 4

✓9. Name four types of triangles other than a right triangle.
obtuse, oblique, acute, spherical isosceles scalene

✓10. When using common logarithms, if you wish to

(1) multiply two numbers, you would add the logarithms. OK

(2) divide two numbers, you would subtract the logarithms. OK

(3) take the square root of one number, you would use the logarithm and divide by two. OK

✓11. Vertical curves are usually arcs of

(A) a cycloid

(B) a circle

(C) an ellipse

(D) a parabola OK

(E) a catenary

✓12. What is the month and date of each of the following?

Mar. 21 ✓(A) vernal equinox Mar. 21 C

(B) winter solstice ~~Dec 21~~ Dec 21
Summer " ~~June 21~~ Jun 21

13. The sine of 25° is equal to 0.4226, and the tangent of 25° is equal to 0.4663. The cosine of 25° is equal to .906307 and the versin. of 65° is equal to ~~0.0647~~.
0.09463C
versine = 1-cos
cos = sin/tan

sin 25 = cos 65
vers = 1-cos

14. On a topographic map, a contour line is one which connects points of Equal Elev. The vertical distance between two adjacent contours is called the Contour Interval. Contour lines which are very closely spaced usually indicate a steep slope OK

✓15. Write in the answer space the formula for the area of each of the figures shown in terms of the symbols that are given:

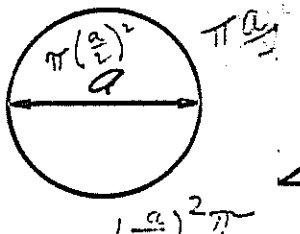


FIG. 1 $\left(\frac{a}{2}\right)^2\pi$

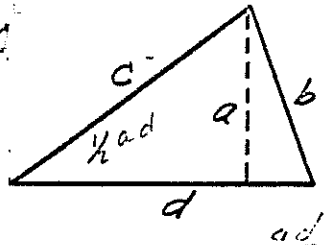


FIG. 2 $\frac{ad}{2}$

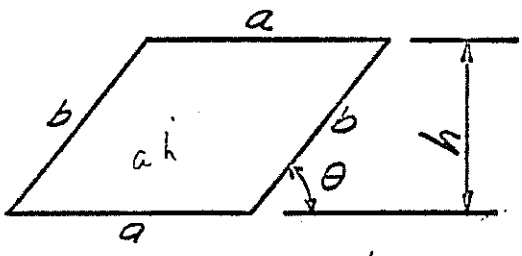


FIG. 3 ah

✓16. If the magnetic bearing of a line is S 47°30'W, and the magnetic declination is 12°10'W, what is the true bearing of the line?

S 59°40'W

✓17. The following azimuths are reckoned from North

AB - 187°12'	S 7° 12' W	S 7°12' W
BC - 273°47'	N 3° 47' W	N 86° 13' W
CD - 318°48'	N 41° 48' W	N 41°12' W
DE - 0°48'	N 0° 48' E	N 0° 48' E
EF - 73°00'	N 73° 00' E	N 73° 00' E

What are the corresponding bearings?

✓18. A full circle contains 360° degrees.
✓ A full circle contains 6400 circular mils.

✓19. The function of an angle which is equal to $\frac{1-\cos}{2}$ and is also equal to half the versed sine is called the (HAVERSINE)

✓20. The seller of a plot of land is called the grantor.
The buyer of said plot is called the grantee.
(The terms seller and buyer are not answers to this question.)

21. The power of the State to condemn private land for public use is called eminent domain

✓22. A map has a scale of $\frac{1}{40,000}$. How many feet on the ground is represented by a line on the map 5" long? 16,667 ft

.0833 × 5 × (40000) =

$\frac{12}{40000} = \frac{5}{x}$

23. When a map scale is shown as $\frac{1}{40,000}$, this is called the Representative ~~Reduction Fraction~~ fraction.

24. What is the South azimuth of a line whose bearing is recorded as S 37°10'47" E. 322° 49' 13"

25. When a ruling grade is reduced to allow for resistance due to curvature, it is said to be Flattened Compensated

26. The number of standard time zones in the continental United States (excluding Alaska and Hawaii) is

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

27. The tangent of an angle is 5/12. Determine the value of each of the following:

(A) sine 5/13
(B) cosine 12/13
(C) secant 13/12
(D) cosecant 13/5

28. Standard time zones in the United States are established on longitude intervals of

(A) 5°
(B) 10°
(C) 15°
(D) 20°
(E) 25°

OK

29. Complete each of the following:

(A) A line measured as 49 chains and 27 links is equal to 3257.82 feet. 49.27 × 66

(B) A line measured as 29½ rods is equal to 486.75 feet. 29.5 × 16.5

(C) A line measured as 18.93 meters is equal to ~~7415.17~~ 62.1055 feet. 18.93 × 3.2808

(D) An area of one acre is equal to $\frac{10}{160}$ square rods. 10 sq chains = 1 acre
1 chain = 4 rods

30. Fill in the correct answer in each of the blank spaces provided.

(A) Polaris is in the stellar constellation called Ursa Minor (Minoris). Ursa Minor

(B) The apparent elevation of Polaris measured at a point on the earth's surface is equal to the Latitude at that point.

(C) The northern celestial hemisphere is to Polaris as the southern celestial hemisphere is to Southern Cross (CRUX) OK

(D) Observations to determine azimuth are usually made when Polaris is at elongation. OK

31. A line was measured a total of six times. The readings taken were as follows:

961.38	961.42	961.48
961.37	961.46	961.41

961.42

What is the most probable length of the line measured?

32. Electronic computers are designated by one of two different categories. What are the two categories?

(A) digital (B) (analogue)

33. Circular curves are generally classified in one of three general categories. These are: Simple Compound Reverse

34. In the circular curve shown, the line connecting the PC and the PT is called the long cord.

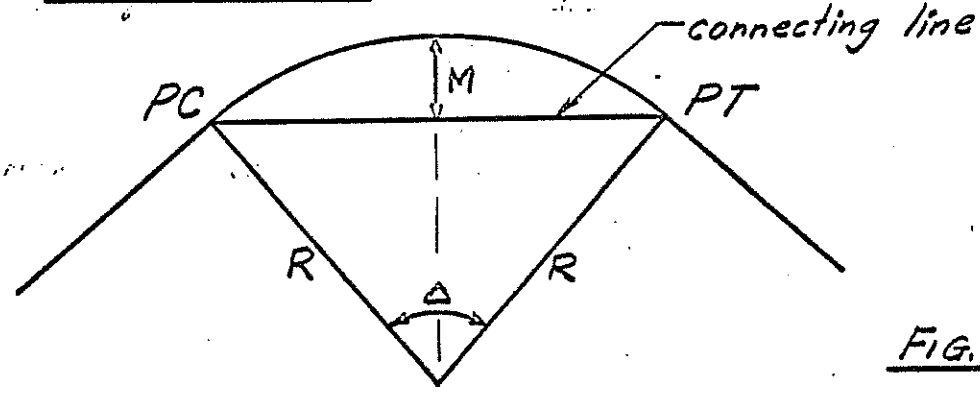


FIG. A34

35. Write the equation for M in terms of the symbols shown. Refer to the figure of Problem 34. M = R Versine ½Δ

36. Volumes of earth work for cut or fill sections are usually computed by two different formulas. The names of these formulas are the Average End area and ~~Prismoidal~~ Double end area Prismoidal Formula

37. Volumes computed by the two formulas of Problem 36 frequently will vary slightly. The difference between the two computed volumes is called the ~~Prismoidal~~ Prismoidal Correction.

38. The difference between apparent time and civil time at a given instant is called the Time Equation.

39. What is the GCT when it is 3^h16^m P.M. Central Standard Time?
9h 16m P.M.

40. The Land Surveyors' Act requires that a Record of Survey Map be filed with the appropriate county official. The dimensions of this map are stated to be ~~18" x 24"~~ 18X26 or ~~12" x 18"~~ 18X13. (Two answers required)

41. When an alluvial deposit is attached to the land of a riparian owner, the owner acquires title to such land. The term applied to this land growth is Accretion

42. A survey for patent to a mining claim can only be legally signed and submitted by a Mineral Surveyor.

43. Theodolites are generally classified as one of two types of instrument. These types are Directional and Repeating.

44. Write the intials of two federal agencies that are actively engaged in precision survey work in California. USC&GS & GLO & USGS

45. A transit has a stadia interval factor of 98. The value of C = f + c = 1.0 feet. If the intercept on the rod for a horizontal sight is 5.25', what is the distance to the rod?

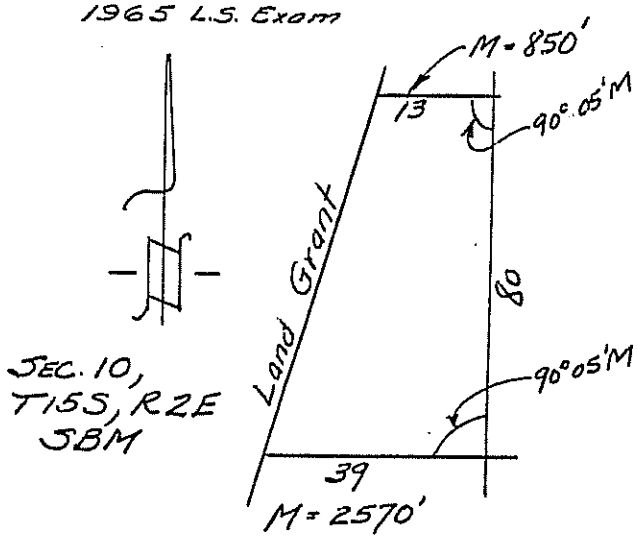
5.15

5.25 × 98 + 1 · 517.20 + 1.00 = 518.20'

PART C - WT. 3
1965 L.S. Exam

PREPARE A SKETCH AND DIMENSION THE SOUTH HALF OF SECTION 10.

DRAW TO SCALE 1" = 200'



REFERENCE

ART. 206 - SUBDIVISION OF FRACTIONAL SECTIONS, PG 212 MANUAL OF SURVEYING INSTRUCTIONS 1947, BUR. OF LAND MANAGEMENT

3) Sin .5' = cc1454444
85c' Sin.5' = 1.24'
2570 Sin.5' = 3.74'

$B'C' = B'B + BC + CC' = 5285.0$

$\phi = \text{Tan}^{-1} \frac{1720}{5285.0} = .32544738$

$\phi = 18°01'38.''81$
$\text{Cos}\phi = .950908 38$

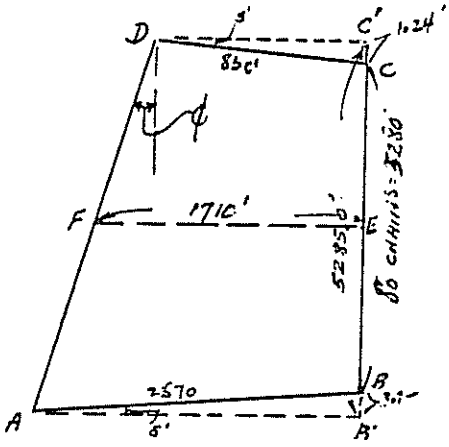
$AD = \frac{5285}{\cos\phi} = 5557.84'$

$AF = \frac{AD}{2} = 2778.9'$

4) Since scale required is too large for dimensions

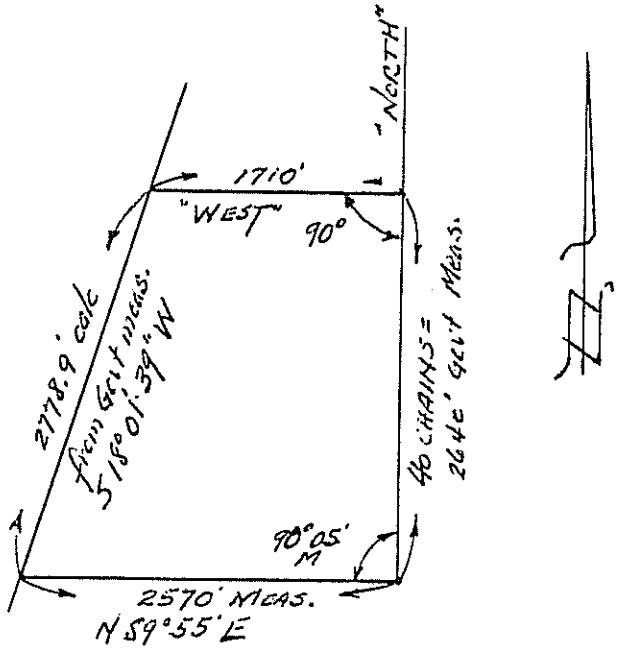
Let 1" = 1000'

Then



1) Assume BC NORTH
Then AB is N89°55'E
& CD is N89°55'W &
∴ EF = WEST BEARING

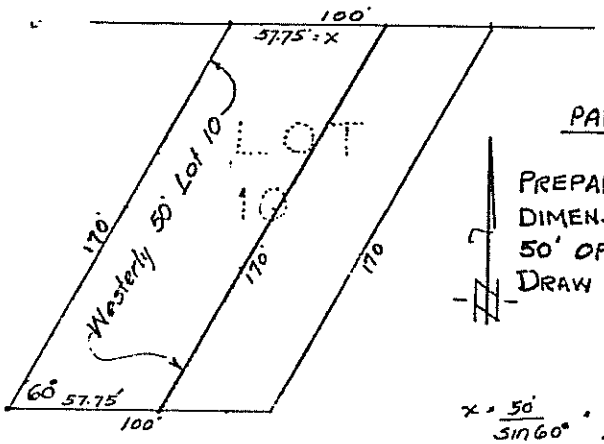
2) The N line of S ½ OF SECT. should be 40 CH. N of B to pt. E, & on a mean bearing between N & S lines of SECTION so that it would run DUE WEST TO PT F for 26 CHAINS according to Government Measure or 1710' (The mean of measured values).



Note: The answers given are not offered as the only solutions, nor the answers required by the Registration Board. They are suggested methods only. Next issue will contain the solution to a 25 point problem from the 1964 LS exam and other solutions from the 1965 ex. Due to photographic reduction in the printing process only a relative scale can be retained.-Ed

LS EXAM
8-26-65

PROBLEM D1 - WT. 15 (REQUIRED)



PART A - WT. 3

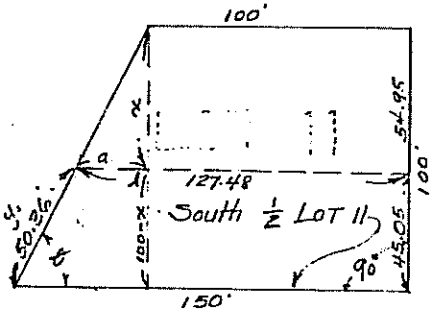
PREPARE A SKETCH, AND DIMENSION THE WESTERLY 50' OF LOT 10. DRAW TO SCALE 1" = 50'

$x = \frac{50'}{\sin 60°} = \frac{50}{.866} = 57.75'$

REF: ARTICLES 15-10 & 15-40 EVIDENCE & PROCEDURES FOR BOUNDARY SURVEY, BROWN & ELDRIDGE

PART B - WT. 3

PREPARE A SKETCH, AND SHOW DIMENSIONS OF THE SOUTH HALF OF LOT 11. DRAW TO SCALE 1" = 50'



$y^2 = (100-x)^2 + (50-a)^2$

$y^2 = (45.05)^2 + (22.52)^2$

$y = 50.36'$

REF:- SECTIONS 458 & 473, ON SURVEYING & BOUNDARIES, CLARK

A_1 = AREA LOT 11 = $\frac{100}{2}(250) = 12{,}500$

$\frac{A_1}{2} = 6250 \square' = \frac{x}{2}(100+100+a)$

$\cot\theta = \frac{50}{100} = \frac{1}{2} = \frac{a}{x}$

$a = \frac{x}{2}$

$6250 = \frac{x}{2}(200+a) = \frac{x}{2}(200+\frac{x}{2})$

$x^2 + 400x - 25000 = 0$

$x = \frac{-400 \pm 509.90}{2}$

$\therefore x = 54.95' \quad a = 27.48'$

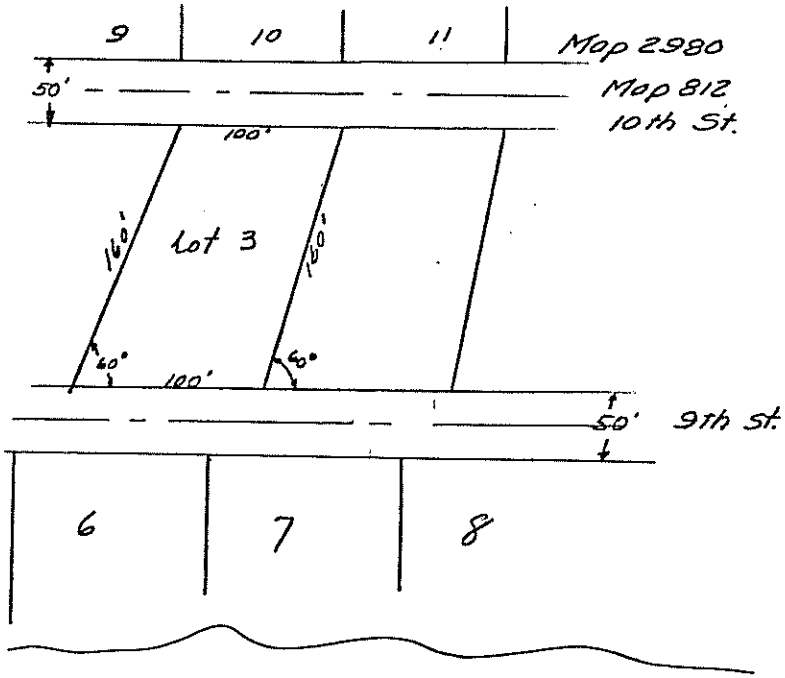
$100 - x = 45.05'$

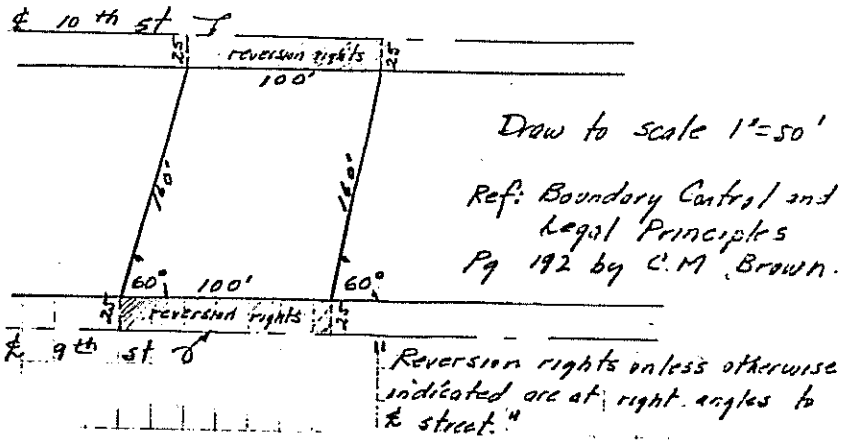
(cont'd on Left)

L.S. Exam 1965 Afternoon

Part E - wt. 3

Prepare a sketch of lot 3, and show all of the underlying fee rights. (reversion rights)





Draw to scale 1"=50'

Ref: Boundary Control and Legal Principles Pg 192 by C.M. Brown.

"Reversion rights unless otherwise indicated are at right angles to ℄ street."

46. When Polaris is at its lowest observable position, it is said to be at _____, and, when it is at its most eastward position, it is said to be at _____.

47. The angular distance which is measured along the celestial equator between the vernal equinox and the hour circle through a given body is called the _____. right ascension

48. Measuring west from a principal meridian to the second guide meridian, you would have to measure _____ miles.

49. The apparent path followed by the sun during a calendar year is called the _____. ecliptic

50. Write the value of 1 radian in terms of the number of degrees in a circle and such other symbols as are usually used. 57.2 deg. $\frac{360°}{2\pi}$
57.17 44.8

51. The meridian through Greenwich is at 0 ° longitude, and the International Date Line is generally at 180° longitude.

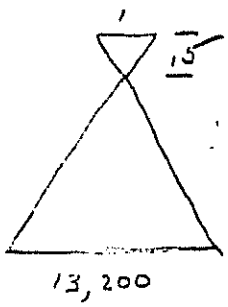
52. In a regular township, what is the number of the section that may have fractional lots along both the North and West sides? 6

53. How many grid zones are there in California? 7 Seven

54. The Zodiac contains twelve stellar constellations, all of which are approximately along the celestial equator. Name four of the constellations of the Zodiac. Orion,

55. What are the format dimensions of the film negatives that are usually used for aerial mapping purposes? Give numerical value and units. 9"x9"
9" x 9"

56. What is the flight altitude of an aerial photograph taken with a 6-inch focal length lens camera at a scale of 1:13,200?



$\frac{26,400}{.5\overline{)13,2000}}$
10
32
30
20

$\frac{1}{13,200} \times \frac{.5}{x}$

6,600

1200

$\frac{1}{.5} = \frac{13,200}{x}$

$x = 6600'$

153.56 / 2.54 = 6.04

1" = 2.54 cm
1" = 25.4 mm

153.56 / 25.4

57. An aerial camera has a focal length of 153.56 mm. What is this length in inches? 6.04 inches

58. The azimuth from Station A to Station B is 337°18'20.676". What is the azimuth from Station B to Station A if the convergence of their meridians is 18.235 seconds of arc? 337° 18' 02.441"

59. Convert 143°05'15" to grads. $\frac{360}{400} = \frac{143°05'15"}{x}$ or $\frac{360}{400} = \frac{143.0875}{x}$

60. The swing motion of a projector of a Kelsh plotter, if applied, will cause the conjugate principal point, or any other projected point, to trace a path the loci of which describes a _____.

END OF PART A

CALIFORNIA BOARD OF REGISTRATION FOR CIVIL AND PROFESSIONAL ENGINEERS

1965 LAND SURVEYOR EXAMINATION

August 25, 1965

LS

PART B

B

Closed Book

Time Allowed - Four Hours

This booklet contains the problems for Part B of this examination.

Follow the instructions that are given on the cover page of the workbook which you have already received.

All of the work which is to be graded must be included in your workbook. No work will be considered that is not completely included at the close of the examination.

If the meaning of a problem is not clear to you, or if it appears to be incomplete, note such assumptions as you think necessary and proceed with the solution.

No books, notes, or reference material may be used in this part of the examination. Slide rules and minor drafting aids, such as triangles, scales, french curves, and compasses are permitted.

You may keep this set of examination questions.

Work any combination of problems for a total of 50 points.

B1 - 3
B2 - 4
B4 - 3
B5 - 3
B10 3 10

B13 - 4
B16 - 4
B17 - 3 10

B18 - 3 10
B19 - 4
B20 - 4 20
B21 - 6
B24 - 6

Problem B1 - Wt. 3

Calculate the area, the perimeter, and the sum of the exterior angles of following: (cot 54° = .72654, cot 30° = 1.7321)

(a) a pentagon with sides of 10'

(b) a hexagon with sides of 9'

Problem B2 - Wt. 3

Prove that the following equation is an identity:

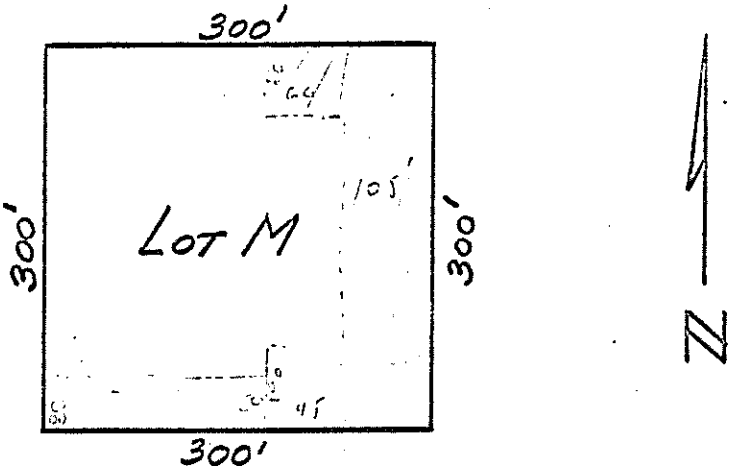
$$\sec^2\theta + \cos^2\theta = \tan^2\theta \sin^2\theta + 2$$

Problem B3 - Wt. 4

Draw and dimension in your workbook the parcel of land described as:

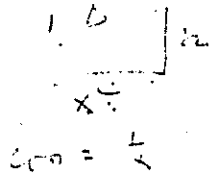
> Lot M, except the East 105 feet, also except the North 60 feet of the East 165 feet, also except the South 100 feet of the East 150 feet, also except the South 80 feet.

Use Scale 1" = 100'



Problem B4 - Wt. 3

The cosine of an angle is equal to x, what is the value of the tangent of the angle. Your answer should only include terms of x and such constants as are appropriate.



$a^2 + x^2 = 1$

$a^2 = 1 - x^2$

$a = \sqrt{1-x^2}$

$\tan = \frac{\sqrt{1-x^2}}{x}$

Problem B5 - Wt. 3

Solve the following equations by the use of determinants. Show all the required steps in your solution, and show full equations for x, y, and z.

$$z + y + 2z = 0$$
$$3x - 2y + 2z = -8$$
$$2x + 2y + 3z = 3$$

No credit will be allowed for any other solution procedure.

Problem B6 - Wt. 2

A steel tape which is 0.30" wide and 0.02" thick is standardized at exactly 100.00' at a tension of 20#. If the tension is increased to 40#, what will be the length of the tape? Assume constant temperature. E = 30,000,000 psi

Give answer in feet. PL = EAK

Problem B7 - Wt. 4

The Land Surveyors' Act makes certain provisions for Record of Survey Maps.

1. What margins are to be provided on the Record of Survey Map?
   (a) on the left edge 1 1/4
   (b) on the right edge 1/2
   (c) at the top 1/2
   (d) at the bottom 1/2
2. What materials may be used for the original sheets of the Record of Survey Map? linen & vellum
3. What is the time limit established for the filing of a Record of Survey Map? This time limit is assumed to extend after the points or lines have been established.

Problem B8 - Wt. 4

What is parallax? Discuss briefly what it is, or what causes it; what it does, and how it may be corrected. Limit your discussion to telescopes and related optical devices rather than to photogrammetric procedures.

Problem B9 - Wt. 3

Draw an appropriate map symbol for each of the following:

(a) bridge over a waterway
(b) ford across a waterway
(c) triangulation station
(d) power line
(e) depressed area
(f) bench mark showing elevation

Problem B10 - Wt. 3

A land surveyor must be concerned with errors of many types. Give a definition of each of the following types of errors:

(a) accidental
(b) systematic
(c) discrepancies
(d) compensating
(e) mistake
(f) natural

Problem B11 - Wt. 3

Describe an isogonic chart. What is it, what does it show, and how is it used?

What is an agonic line?

Problem B12 - Wt. 4

Circular curves are designated by the arc definition or by the chord definition. Show by an appropriate labeled sketch all of the essentials to demonstrate the meaning, and the differences between these two definitions. State the formula for the degree of curve (D) for each condition, and include a definition for D in your discussion in terms of the other known data.

Problem B13 - Wt. 4

Sketch in your workbook to an approximate scale of 1" = 30 miles the following:

(a) Principal meridian
(b) Base line
(c) 1st Guide meridian East
(d) 2nd Guide meridian West
(e) 2nd Standard Parallel North
(f) the distances between adjacent Guide meridian
(g) the distances between adjacent Standard Parallels

Indicate convergence where applicable.

Problem B14 - Wt. 4

The base line for a triangulation net was measured with a 300-foot steel tape. The measured distance was 2474.92 feet. Later it was discovered that the actual length of the tape was 300.07 feet. What is the true length of the base line? What type of error is produced by this condition?

Problem B15 - Wt. 5

Explain the difference between sidereal day and solar day. What is the vernal equinox? What is the winter solstice? Are these absolutely fixed points? What is right ascension?

Problem B16 - Wt. 3

A transit has a vernier where 30 spaces on the vernier are equal to 29 spaces on the graduated circle, and one space on the circle is 15'. What is the least count of the vernier? Name two general types of verniers that are in general use.

Problem B17 - Wt. 3

A survey line was originally run by solar compass in 1871. The magnetic bearing, at that time, was S 87° 29°E, and the magnetic declination was 5°13'E. If the magnetic declination now is 1°17'W, what is the magnetic bearing of the line today?

Problem B18 - Wt. 3

What is "Invar"? What is it used for in land survey work, and why is it used?

Problem B19 - Wt. 4

Solve the following equations graphically, and identify the points of intersection by the coordinates with origin at O:

$$4x^2 + 9y^2 = 36$$

$$2x - 3y = -6$$

Explain in words what type of figure is represented by each of the two equations.

Problem B20 - Wt. 4

The following notes were recorded for slope stakes set at Station 8 + 00 and 9 + 00. Use the average end area method, and compute the volume of material between the two stations in cubic yards.

Side slopes are 2:1, $\frac{W}{2}$ = 24 feet

Cuts are identified as +, and fills are -

8 + 00	+ 6.0	+ 2.0	+ 5.0	
	36.0	0.0	34.0	
9 + 00	+ 8.5	+ 3.1	+ 6.2	+ 7.0
	41.0	10.0	0.0	38.0

Problem B21 - Wt. 6

The Transit Rule and the Compass Rule are frequently used in land survey work. State in words the essence of each, describe what they are used for, why they are necessary, and which of the two rules you would prefer to use, and why.

Problem B22 - Wt. 5

An aerial photograph is taken of a city with high buildings. Explain how the nadir point can be approximately located.

Problem B23 - Wt. 5

A simple double-convex lens has a focal length of 2 inches. An object is placed 5.5 inches in front of the lens. By the method of ray tracing, make a graphical solution for the location of the image in relation to the object and the lens. Give the image distance and the magnification.

Problem B24 - Wt. 6 (Weight each part = 3)

Given the following conditions: The 1:6000 scale of a vertical aerial photograph applies to a valley floor; the focal length of the lens used is 8 inches; the image of the top of a hill appears on the photograph 3.98 inches from the principal point; the height of the hill is 150 feet above the floor of the surrounding valley. What is the amount and direction of relief displacement with rspect

(a) to the valley floor
(b) to sea level, assuming that the valley floor is 250 feet below sea level

END OF PART B

CALIFORNIA BOARD OF REGISTRATION FOR CIVIL AND PROFESSIONAL ENGINEERS

1965 LAND SURVEYOR EXAMINATION

August 26, 1965

LS

PART C

C

Open Book

Time Allowed - Four Hours

This booklet contains the problems for Part C of this examination.

Follow the instructions that are given on the cover page of the workbook which you have already received.

All of the work which is to be graded must be included in your workbook. No work will be considered that is not completely included at the close of the examination.

If the meaning of a problem is not clear to you, or if it appears to be incomplete, note such assumptions as you think necessary and proceed with the solution.

At the end of each problem, list any reference books, diagrams, or tables which you have used. Give book title, edition, and page number.

You may keep this set of examination questions.

Mechanically operated calculators may be used in this part of the examination. Calculators permitted include only those that are operated by a hand crank. Electrically powered calculators and computers are prohibited. Proctors are instructed to prohibit the use of electrically powered machines.

Problem C1 - Wt. 10 (Required)

Subject: Exceptions to rules.

Many rules used by land surveyors have exceptions. For example - this rule pertaining to possession rights:

Rule: If all of the requirements of the adverse right statutes and common law adverse right rules are complied with, a fee title to land can be obtained.

Exception: Adverse rights cannot ripen into a fee as against land held by the government in trust for the people.

For each of the following rules, list the important exceptions. In your answer, exclude all considerations of possession, that is, adverse rights, agreed boundaries, estoppel, etc. Answer all parts.

Rule 1 - Wt. 1

The center of a section of land on a resurvey is determined by connecting opposite one-quarter corners.

Rule 2 - Wt. 1

If an original section corner monument called for by the original U. S. patent (by reference to the township plat and notes) is found undisturbed, its position will determine the correct location for the section corner.

Rule 3 - Wt. 1

Meander lines (sectionalized lands) do not represent property lines.

Rule 4 - Wt. 1

A lost interior section corner to a township (not on a township line) is relocated by double proportionate measurement.

Rule 5 - Wt. 1

One-quarter corners of sections were originally set half way between section corners.

Rule 6 - Wt. 1

Correction lines (standard parallels in sectionalized lands) are located 24 miles apart.

Rule 7 - Wt. 1

Original monuments set to mark the corners of lots of a subdivision (subdivided in accordance with state laws) represent the ownership rights of the purchaser whether measurement errors exist or not.

Problem C1 contd

Rule 8 - Wt. 1

Accretions belong to the adjoining upland owner.

Rule 9 - Wt. 1

The reading on a planimeter whose arm is set to obtain a result in square inches is multiplied by the scale factor (that is, the scale factor is 100 x 100 for a 100 foot to an inch plat) to obtain the area traversed once by the pointer of the planimeter. (Note: You are to assume that the planimeter was run in the correct direction and the setting of the planimeter was zero at the start.)

Rule 10 - Wt. 1

Contour lines never cross one another.

Problem C2 - Wt. 10 (Required)

Subject: Precision; Grid and Astronomic Bearings. Answer all parts.

Part A - Wt. 4

You are to lay out a rectangular field 200 feet by 500 feet within the nearest 10 square feet. (1) Determine the maximum error (linear) permissible for each side, assuming that the error ratio is the same for all sides. (2) What is the error ratio?

Part B - Wt. 2

The central meridian is 2,000,000X and the California Grid Coordinates of point G is less than 2,000,000X. The difference in longitude between the central meridian and point G is 0° 30' 01". The constants of the zone are C = 2,000,000 R_b = 32,271,267.72 Y_o = 424,696.79 ℓ = .5495176; latitude Central Meridian = 116° 15'. The known geodetic bearing of line G to H is West. What is the grid bearing of line G to H?

Part C - Wt. 2

Are geodetic and astronomic north the same at a given point? Give reasons.

Part D - Wt. 2

Point H of Part B is 0° 20' in longitude from point G. (1) What would be the approximate geodetic bearing from H to G?

Problem C3 - Wt. 10 (Required)

Subject: Instructions to Associates

You are to specify to your chairman the error tolerance that you will permit in order to obtain an accuracy of 1/15,000 for each of the following items when setting a point 2,000' from a given monument. Available equipment includes a 100-foot, 2# tape, plumb bobs (uneven country), and a transit. Grading will be based on your general approach, and will follow the philosophy that insufficient accuracy indicates incompetent instructions, and that excessive accuracy indicates bad judgment.

Show your answer in your workbook, with each part clearly identified, and include any computations that you make to arrive at your answer.

Each part is prepared in the form of your instructions as the principal land surveyor to those who work under your direction. Work all parts.

Part A - Wt. 2.0

You are to apply a 20# pull, and you may not vary more than _____# from the 20#.

Part B - Wt. 0.5

You are to record the temperature of the tape with an error of not more than _____°F.

Part C - Wt. 1.0

For any given tape length, you are to be within _____ feet of a straight line.

Part D - Wt. 2.0

If you slope chain, you must read your vertical angle within _____° _____' when you read less than 5°; within _____° _____' when your vertical angle reads between 5° and 10°; and within _____° _____' when you read from 10° to 15°.

Part E - Wt. 2.0

You may not have an error of more than _____ feet due to plumb bob swing when setting points (assume only 20 full tape lengths are used).

7

Part F - Wt. 2.5

Assuming that you use only full tape lengths and assuming that there are no other errors than those listed above, the probable accuracy of your chained line will be _____.

NOTE: Choose any 2 from Problems 4, 5, 6, or 7

Problem C4 - Wt. 10 (Optional)

Subject: Lenses and Light

The bearing of a line must be transferred and prolonged beyond an obstruction, as shown in Figure C4.

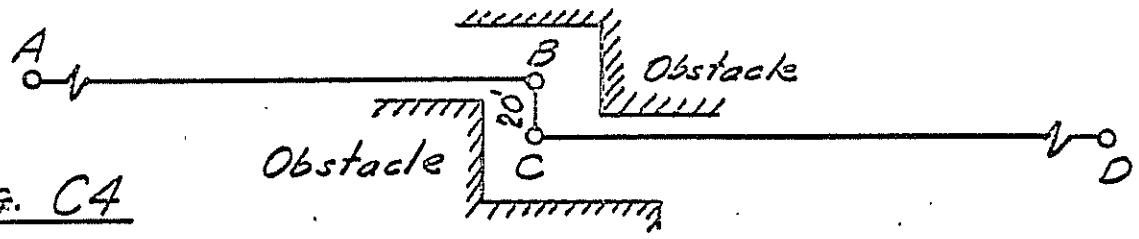


FIG. C4

A decision was made to use two Wild T2 theodolites, one set at B and one at C. The angles at B and C are to be determined using the principle of collimation. At B, you sight on A, turn towards C and look at the cross hairs of the transit. At C, you look at the cross hairs of the transit at B and turn to D.

Part A - Wt. 2

What must be the focus of the transits at B and C when looking at one another?

Part B - Wt. 7

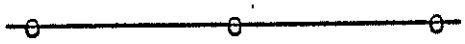
The angles are turned three times with these results:

	B	C	Sum
1.	270° 01' 22"	90° 05' 12"	360° 06' 34"
2.	270° 01' 57"	90° 04' 38"	360° 06' 35"
3.	270° 00' 44"	90° 05' 48"	360° 06' 32"

Explain the principle of light ray transfer that enables the sum of angles B and C to be almost constant, yet the angle at B or C may vary significantly.

Part C - Wt. 1

How can you see the cross hairs of another instrument?



NOTE: Choose any 2 from Problems 4, 5, 6, or 7

Problem C5 - Wt. 10 (Optional)

Subject: Boundary Determination

A monument has been discovered that you believe to be the correct corner of the parcel which you are surveying. Explain what evidence or types of evidence you can use to prove whether the corner is in fact the one you seek.

Problem C6 - Wt. 10 (Optional)

Subject: Mean High Tide and Lake Land

Wt.		
6	(a)	Explain the essential factors that cause variations of the elevation of mean high tide level along the California Coast line (not in bays or inlets).
1	(b)	Explain how many years are required to determine an average mean high tide.
3	(c)	Explain why a lake at 10,000 feet elevation is not parallel with mean sea level.

Problem C7 - Wt. 10 (Optional)

Two control monuments called A and B had been premarked so that their identifications were clearly positive on a pair of overlapping aerial photographs. The California Plane Coordinates of the monuments and their photogrammetric coordinates (as determined by a first-order universal instrument) are as follows:

	Calif. Coord. (feet)		Photogr. Coord. (mm)	
	X	Y	X	Y
Mon. A	1,579,485.63	318,323.57	411.64	405.38
Mon. B	1,580,270.69	318,431.91	564.12	457.21

REQUIRED:

Determine the California Plane Coordinates of a premarked property corner where the photogrammetric coordinates in the same model are

X = 522.55 mm
Y = 626.95 mm

(Slide rule accuracy is permissible for this problem.)

END OF PART C

CALIFORNIA BOARD OF REGISTRATION FOR CIVIL AND PROFESSIONAL ENGINEERS

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PART D

D

Open Book

Time Allowed - Four Hours

This booklet contains the problems for Part D of this examination.

Follow the instructions that are given on the cover page of the workbook which you have already received.

All of the work which is to be graded must be included in your workbook. No work will be considered that is not completely included at the close of the examination.

If the meaning of a problem is not clear to you, or if it appears to be incomplete, note such assumptions as you think necessary and proceed with the solution.

At the end of each problem, list any reference books, diagrams, or tables which you have used. Give book title, edition, and page number.

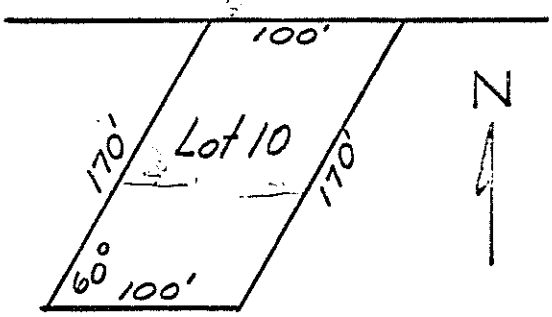
Mechanically operated, hand-crank type, calculators are permitted. Electrically powered calculators and computers of any type are prohibited.

You may keep this set of examination questions.

Problem D1 - Wt. 15 (Required)

Part A - Wt. 3

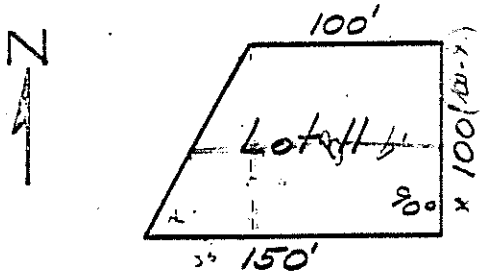
Prepare a sketch, and dimension the Westerly 50' of Lot 10.



Draw to scale 1" = 50'

Part B - Wt. 3

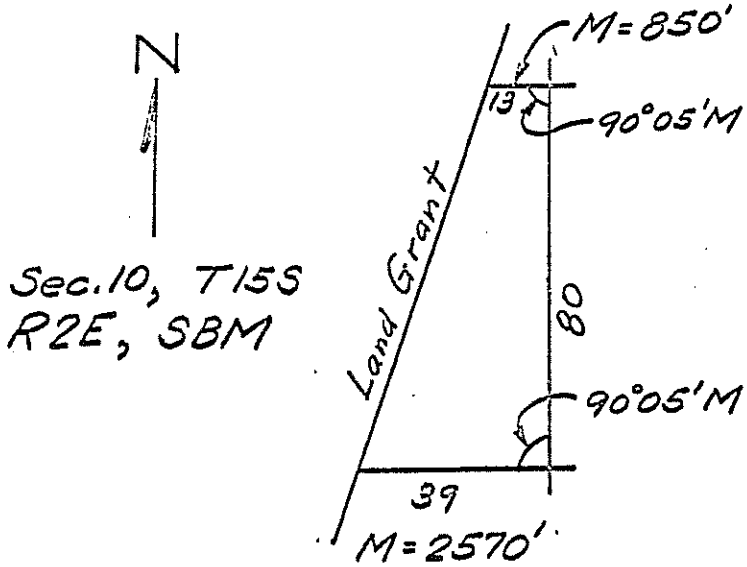
Prepare a sketch, and show the dimensions of the South half of Lot 11.



Draw to scale 1" = 50'

Part C - Wt. 3

Prepare a sketch, and dimension the South half of Section 10.



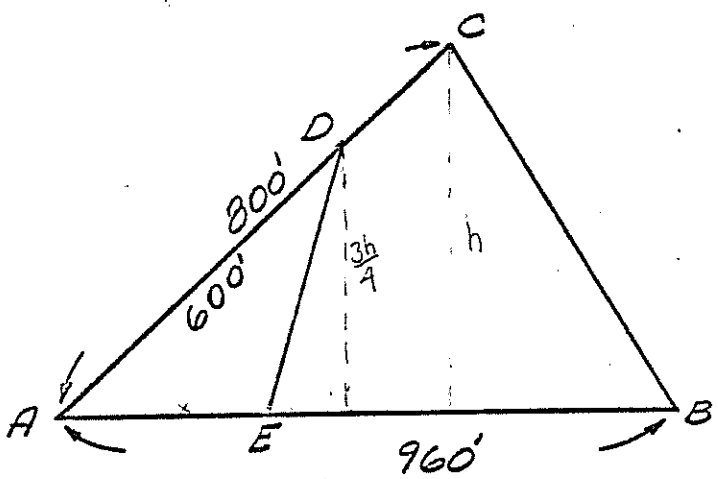
Draw to scale 1" = 200'

Problem D1 contd on next page

Problem D1 contd

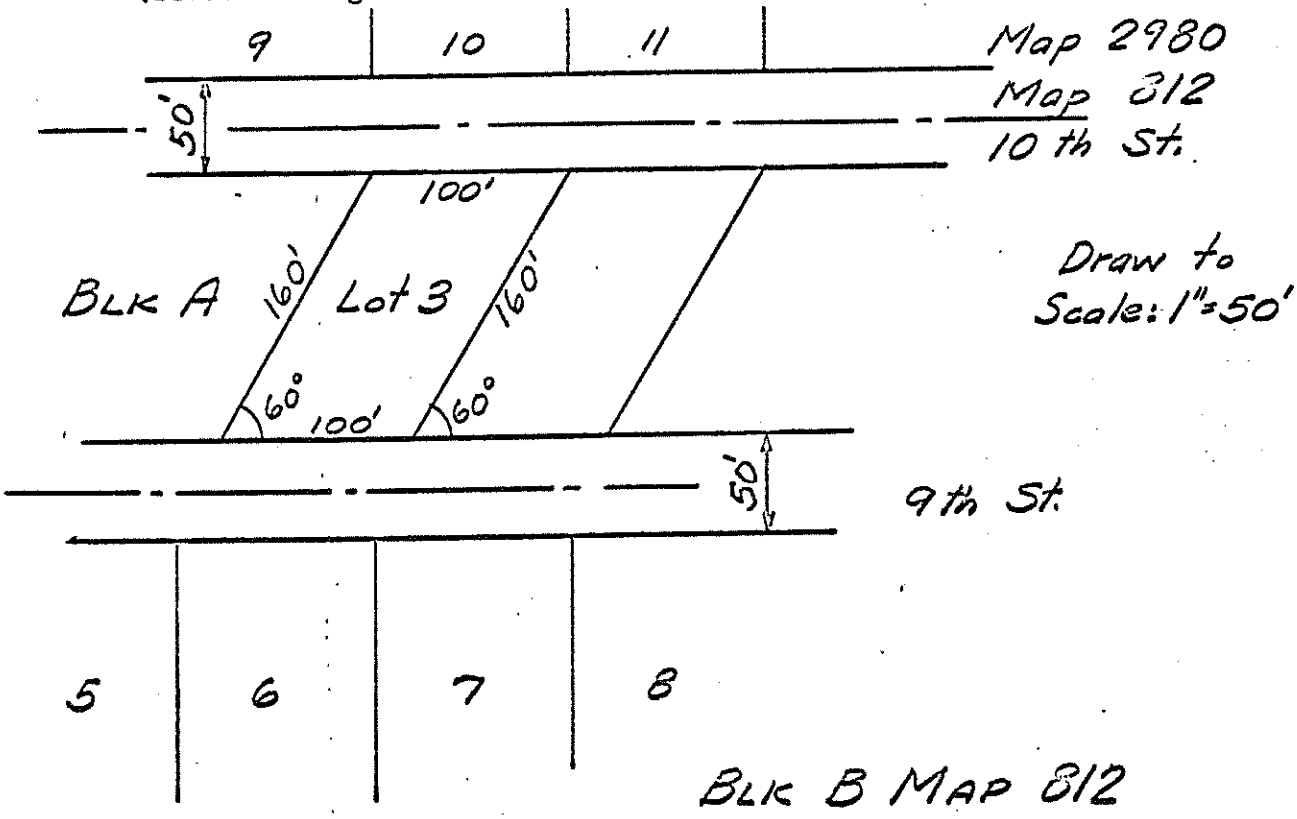
Part D - Wt. 3

The area of ADE is one fourth the area of ABC. From the information given in the sketch, determine the length of AE.



Part E - Wt. 3

Prepare a sketch of Lot 3, and show all of the underlying fee rights (reversion rights).



NOTE: Choose either Problem D2 or D3 for 10 points

Problem D2 - Wt. 10

Part A - Wt. 6

Arrange the following level readings into an accepted note form. This form shall also include and show your reduction of the notes.

A first order level and a yard rod were used. The bench mark (#164) elevation was 187.311 feet. The foresight readings at setup #1 was on the bench mark.
(3 wire level, constant = 0.3)

	Readings F S	Readings B S	
	2.875	2.381	
Setup #1	2.125	2.210	
	1.374	2.040	
	3.961	2.113	
Setup #2	3.121	1.850	on BM #165
	2.281	1.587	
Return	2.221	3.909	
Setup #3	1.952	2.998	
	1.683	2.087	
	2.881	3.169	
Setup #4	2.471	2.610	on BM #164
	2.060	2.251	

3.169
2.610
559

2.610
2.251
359

Part B - Wt. 2

Was there a mistake made in one of the readings? If so, which one, and how much?

Part C - Wt. 2

Assuming that the equipment used was accurate enough to obtain first order results, and that there were no mistakes made in the readings, do the notes indicate that first order procedure was followed? Give reasons.

NOTE: Choose either Problem D2 or D3 for 10 points.

Problem D3 - Wt. 10

The following calibration data applies to an aerial camera:

Calibrated focal length = 153.26 mm

Radius *	20	40	60	80	100	120	130	140
Distortion *	+.003	+.005	+.005	+.001	-.0045	-.0035	0.0	+.009

*Values in mm

Photography taken with this camera is to be used in a 5-diameter direct projection stereoplotter to produce a neat model with dimensions B x 2B (where B is the air base distance equivalent to 90 mm at contact scale).

REQUIRED:

Determine the expected vertical deformation at the center of the neat model in relation to the corners.

NOTE: Choose Problem D4 or D5 for 25 points

Problem D4 - Wt. 25

Sectionalized Land Problem

The following field notes were recorded on a resurvey:

		Found original SW corner of Section 2, T13S, R3E, SBM. At this point, I make a solar observation, and run
East	2640'	Nothing found. Continuing
East	5280'	Nothing found. Set 2x2 hub called "A". Continuing
East	7929.9'	Found original Section 1, South 1/4 corner 5 feet South. Returning to point "A", I run
South	2639.8'	Found original 1/4 corner 5.0' West. Returning to point "A", I run
North	2652.1'	Found original 1/4 corner 10.3' East. Continuing
North	5362.4'	Found original monument set for the NE corner of Section 2 located 10.3' East. From the monument, I run
East	396.7'	Found original section corner of Section 35 located 12.1' South. Returning to the found monument (set for NE corner Section 2), I run
West	2256.5'	Found South 1/4 corner Section 35 located 1.8' North. Continuing
West	2640'	Nothing found. Continuing
West	4899.9'	Found original monument for SW corner of Section 35 located 5.2' South. Continuing
West	5280'	Nothing found. Set 2x2 hub (point B). Continuing
West	7542.5'	Found original monument for the South 1/4 corner of Section 34 located 17.2 feet North. Returning to point "B", I run
South	2758.8'	Nothing found. Continuing
South	5362.4'	where the SW corner of Section 2 lies 10.3' West.

Part A - Wt. 13

A client has employed you to set all of the 1/4 corners, and all of the section corners of Section 2, according to his ownership description, (his title reads Section 2, T13S, R2E, SBM).

Prepare a list of the coordinates of all of these corners (also show computations where necessary) in the position that you would locate them. Assume that the SW corner of Section 2 has coordinates of 1000 North and 1000 East.

Figure D4 shows the original township plat.

Problem D4 contd on next page

Problem D4, Part A contd

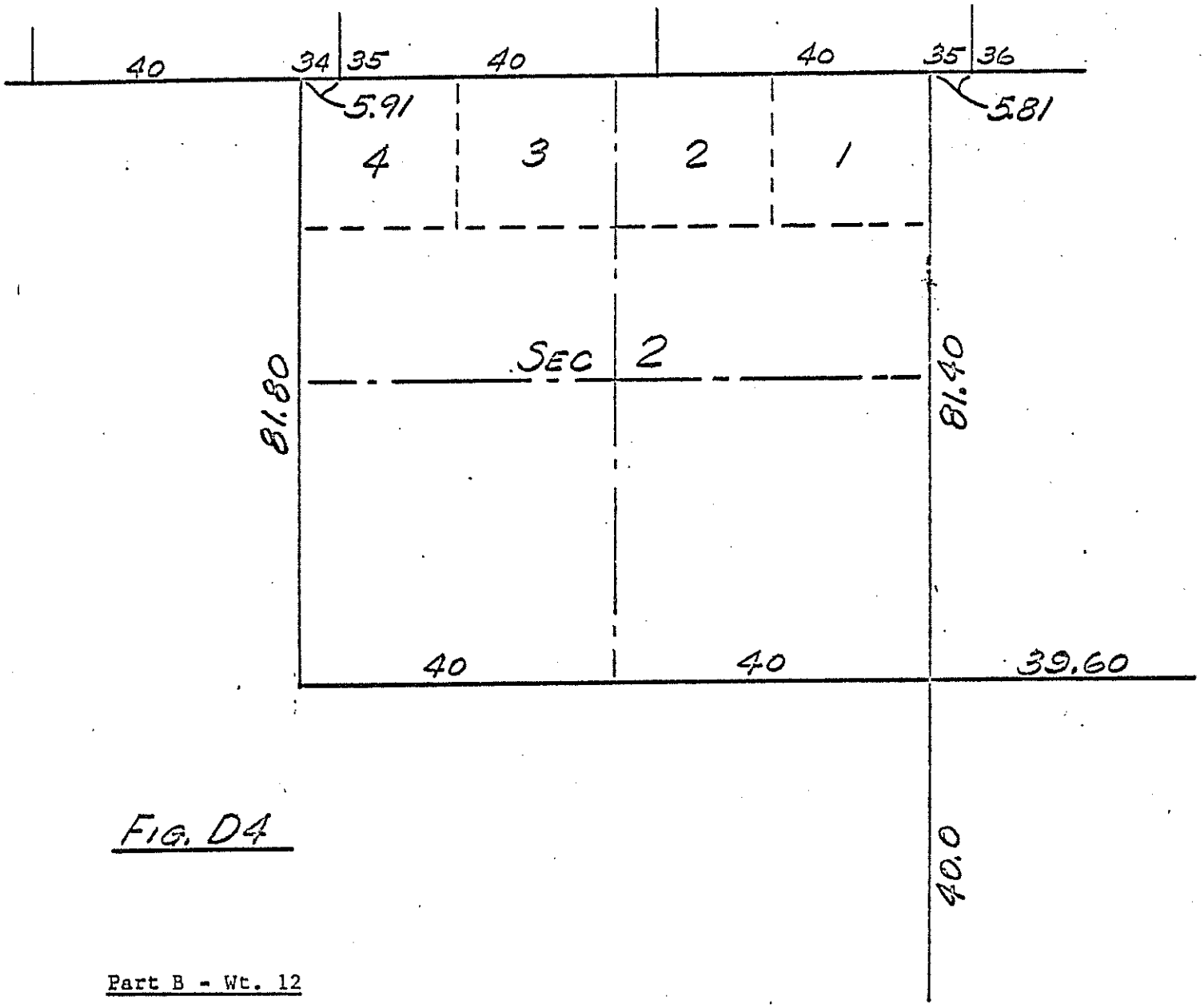


FIG. D4

Part B - Wt. 12

Describe in detail what you would do in preparation for a field survey as described above. Limit your discussion to the preliminary and preparatory work up to, but not including, the field survey, and the searching for monuments in the field.

What would you do to finish the job after the field work has been completed?

NOTE: Choose Problem D4 or D5 for 25 points

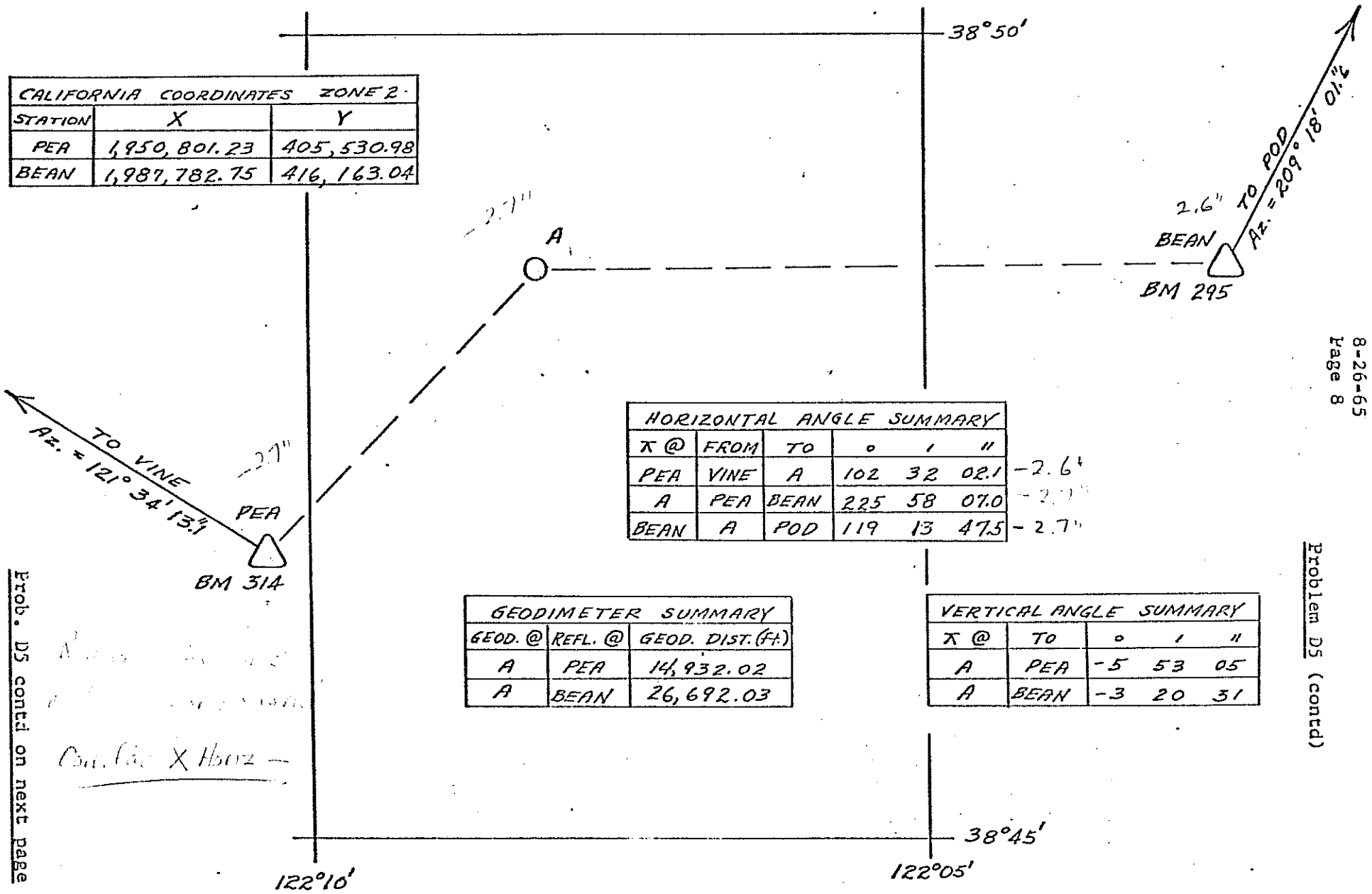
Problem D5 - Wt. 25

Control Station "A" was established by 2nd order traverse procedures between two monuments called Pea and Beam. Instruments used were a Model 4D Geodimeter and a Wild T-2 Theodolite. Field data is summerized on Figure D5.

REQUIRED:

Determine the traverse closure and the preliminary position of Station "A" on the California Coordinate System, Zone 2.

Problem D5 contd on next page



CALIFORNIA COORDINATES ZONE 2		
STATION	X	Y
PEA	1,950,801.23	405,530.98
BEAN	1,987,782.75	416,163.04

HORIZONTAL ANGLE SUMMARY						
∠ @	FROM	TO	°	′	″	
PEA	VINE	A	102	32	02.1	-2.6
A	PEA	BEAN	225	58	07.0	-2.7
BEAN	A	POD	119	13	47.5	-2.7

GEODIMETER SUMMARY		
GEOD. @	REFL. @	GEOD. DIST. (FT.)
A	PEA	14,932.02
A	BEAN	26,692.03

VERTICAL ANGLE SUMMARY				
∠ @	TO	°	′	″
A	PEA	-5	53	05
A	BEAN	-3	20	31

Cor. Ck. X Horiz —

Prob. D5 contd on next page

Problem D5 (contd)

Lambert Projection for California II

Table I (Cont'd)

Problem D5 (contd)

Lat.	R feet	Y' y value on central meridian feet	Tabular difference for 1 sec. of lat.	Scale in units of 7th place of logs	Scale expressed as a ratio
38° 41'	25,942,004.70	370,252.95	101.15933	-264.7	0.9999391
42	25,935,935.14	376,322.51	101.15967	-273.3	0.9999371
43	25,929,865.56	382,392.09	101.15967	-281.5	0.9999352
44	25,923,795.98	388,461.67	101.15967	-289.4	0.9999334
45	25,917,726.40	394,531.25	101.16000	-296.9	0.9999316
38° 46'	25,911,656.80	400,600.85	101.16000	-304.1	0.9999300
47	25,905,587.20	406,670.45	101.16017	-310.8	0.9999284
48.	25,899,517.59	412,740.06	101.16033	-317.3	0.9999269
49	25,893,447.97	418,809.68	101.16050	-323.3	0.9999256
50	25,887,378.34	424,879.31	101.16067	-329.0	0.9999242

Lambert Projection for California II

Table II (Cont'd)

1" of Long. = 0"63046797 of Θ

Long.	Θ	Long.	Θ	Long.	Θ
120° 46'	+0° 46' 39"2778	121° 21'	+0° 24' 35"2951	121° 56'	+0° 02' 31"3123
47	+0 46 01.4497	22	+0 23 57.4670	57	+0 01 53.4842
48	+0 45 23.6216	23	+0 23 19.6389	58	+0 01 15.6562
49	+0 44 45.7936	24	+0 22 41.8108	59	+0 00 37.8281
50	+0 44 07.9655	25	+0 22 03.9827	122° 00'	0 00 00.0000
120° 51'	+0 43 30.1374	121° 26'	+0 21 26.1547	122° 01'	-0 00 37.8281
52	+0 42 52.3093	27	+0 20 48.3266	02	-0 01 15.6562
53	+0 42 14.4813	28	+0 20 10.4985	03	-0 01 53.4842
54	+0 41 36.6532	29	+0 19 32.6704	04	-0 02 31.3123
55	+0 40 58.8251	30	+0 18 54.8424	05	-0 03 09.1404
120° 56'	+0 40 20.9970	121° 31'	+0 18 17.0143	122° 06'	-0 03 46.9685
57	+0 39 43.1689	32	+0 17 39.1862	07	-0 04 24.7965
58	+0 39 05.3409	33	+0 17 01.3581	08	-0 05 02.6246
59	+0 38 27.5128	34	+0 16 23.5300	09	-0 05 40.4527
121° 00'	+0 37 49.6847	35	+0 15 45.7020	10	-0 06 18.2808

END OF PART D