CALIFORNIA STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS

CIVIL ENGINEERING EXAMINATION

February 1972

PART A

Time Allowed - Four Hours

This examination consists of two parts of four hours each (Part A and
Part B). Each part will be scored on the basis of 50 points. The total
possible score for the entire examination is 100 points.

This booklet contains the problems for Part A. Problem Al and A2 plus
two additional problems of your choice are required for a total possible
score of 50 points.

You may make appropriate assumptions where they are called for, or if you
deem a problem statement to be incomplete, or if you believe a problem is
in error. If an assumption is necessary, you should provide sufficient
explanation so that the examiner can judge your reasons therefor. Assump-
tions must generally follow the logic and requirements of the problem
statement.

Your work is an engineering report. Computations should be neat and
orderly. You should show sufficient calculations and basic development so
that the examiner can judge your method of approach, and can follow the
steps in your solution.

Slide rule computations are generally acceptable, unless the given data
indicates that a higher degree of accuracy is required.

All of your work must be included in your workbook, and it must be turned
in to the proctor before you leave the examination room at the end of each
period. No work will be accepted, or scored, that is not turned in to the
proctor at the proper time.

At the end of each problem, note 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.

Problem A1 - Wt. 12.5   (Required)   Answer all parts.

SECTION 1

a   The Land Surveyors' Act provides an exemption for a registered civil engineer
insofar as the licensing requirement is waived. What is the obligation of a
civil engineer who practices land surveying with respect to the filing of a
Record of Survey map? Identify three conditions which would require such a
map.

b   What is meant by the term "basis of bearing"? Identify three methods that
may be used.

c   What is the role of a civil engineer when he is called into court on a land
surveying matter?

d   Identify at least four significant matters that must be covered in a Record
of Survey.

e   What is a "senior right"?

SECTION 2

A highway alignment contains a 700 ft. long vertical curve with approach
grades as indicated in the drawing below. The stations and elevations of
the points at the beginning of the curve, and at the intermediate point
"A" are shown on the drawing.

REQUIRED:

What is the grade of the tangent at the right end of the curve?
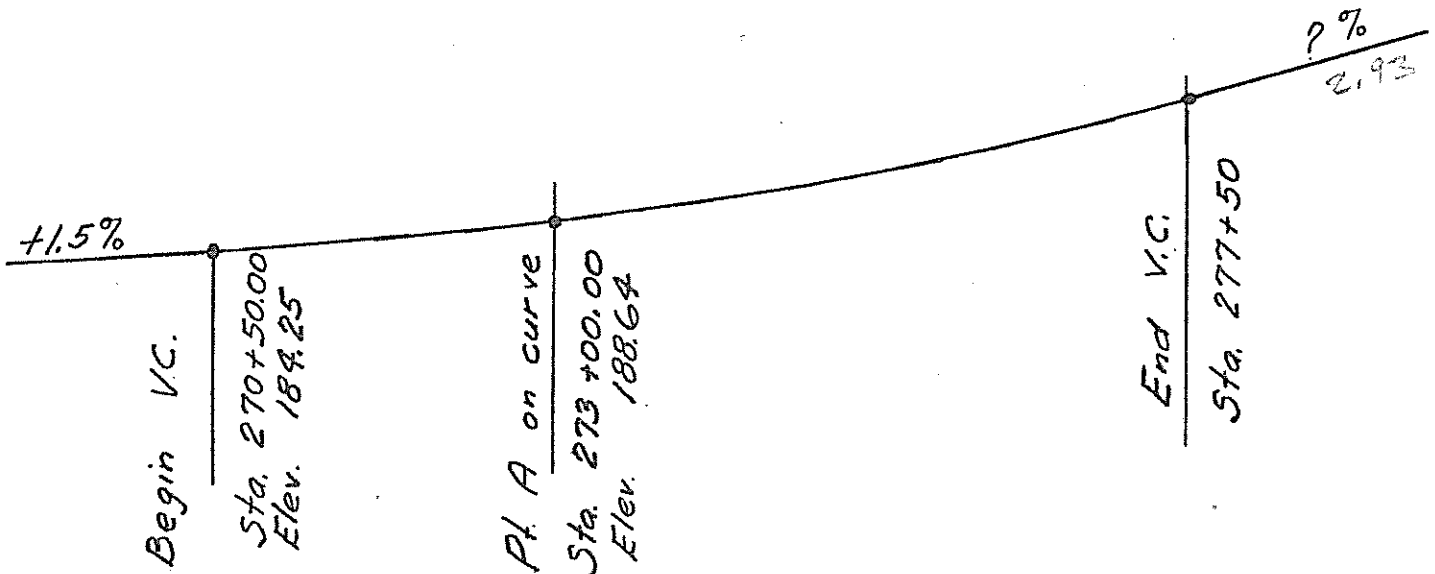

FIG. A1

CALIFORNIA STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS

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PART B

Time Allowed - Four Hours

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

You are to work any two problems for a total weight of 50 points. You may make appropriate assumptions where they are called for, or if you deem a problem statement to be incomplete, or if you believe a problem is in error. If an assumption is necessary, you should provide sufficient explanation so that the examiner can judge your reasons. Assumptions must generally follow the logic and requirements of the problem statements.

Your work is an engineering report. Computations should be neat and orderly, with sufficient calculations and basic development so that the examiner can judge your method of approach and can follow the steps in your solution. Slide rule computations are generally acceptable, unless the given data requires that a higher degree of accuracy is required.

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

You may keep this set of examination questions.

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Department of Consumer Affairs

Problem B2 - Wt. 25   Answer Both Sections

SECTION I

The drawing on the following page shows a plat of a certain land parcel. The bearings and distances shown are taken from a Record of Survey filed subsequent to the recording of HARRIS' deed.

The Northeast quarter of the section was deeded to JONES as recorded in Volume 5 of Official Records at page 72. Parcel "A" was deeded by JONES to HARRIS as recorded in Volume 17 of Official Records at page 13.

JONES wants now to sell the parcel marked "B" to BLACK.
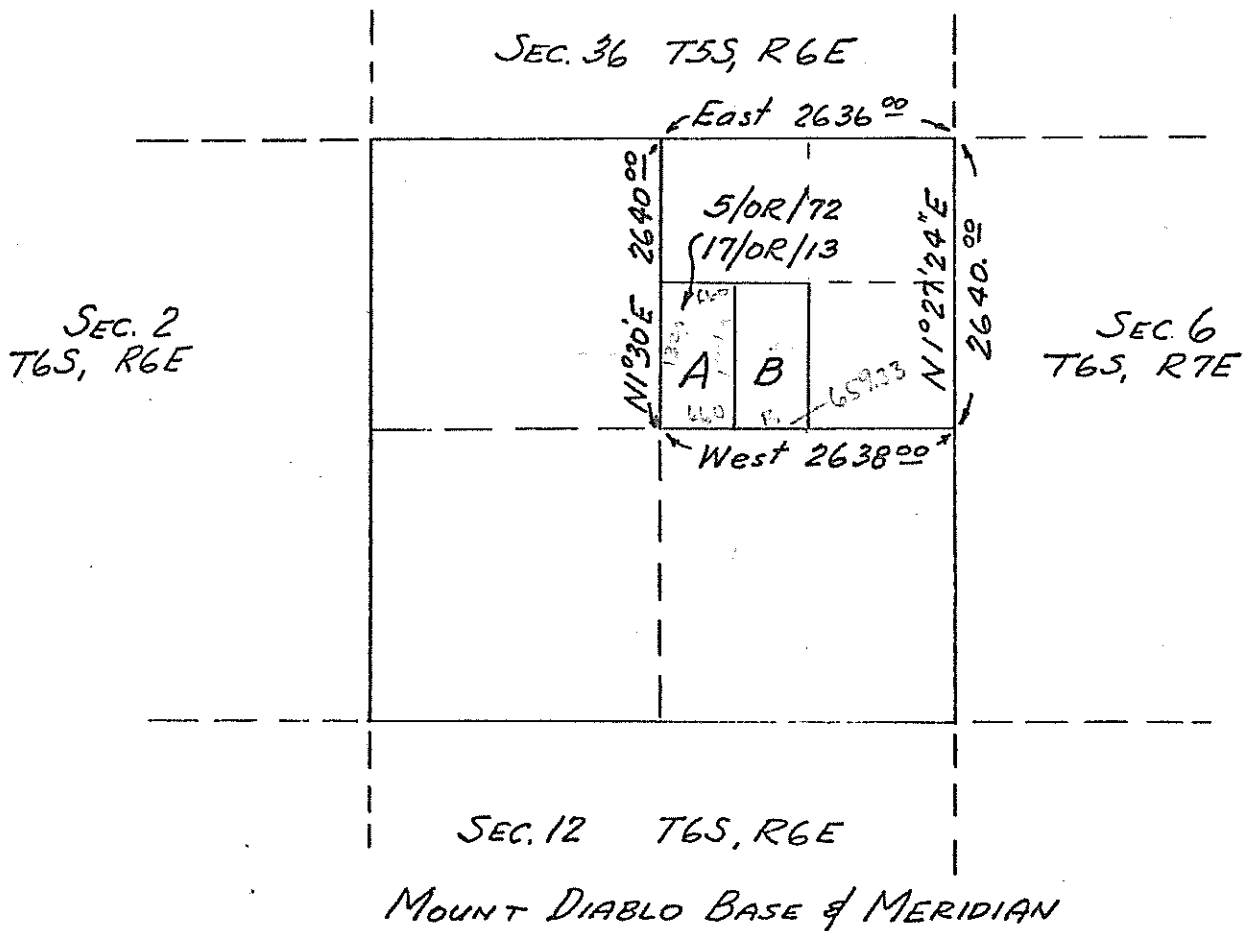
A portion of the HARRIS deed reads as follows:

". . . .Thence, South 2640 feet from said point of commencement
            to the center of said Section, being the true point
            of beginning of this description;
        Thence, East 660 feet along the half section line
        Thence, North 1320 feet
        Thence, West 660 feet
        Thence, South 1320 feet to the true point of beginning
        Containing 20 acres, more or less.

REQUIRED:

a   Identify the section, township, and range wherein parcels A and B are situated.

b   What is the point of commencement on the North line of the section called?

c   What is the bearing and length of the South line of parcel B?

d   "   "   "   "   "   "   " " East   "   "   "   B?

e   "   "   "   "   "   "   " " North "   "   "   B?

f   "   "   "   "   "   "   " " West   "   "   "   B?

g   What is the true acreage of parcel A?

h   "   "   "   "   "   " ⁄ "   B?

i   Write an acceptable description of parcel B without using bearings or distances.

j   Write a metes and bounds description of parcel B.

Problem B2 - Wt. 25 (Continued)

SEC. 36   T5S, R6E

East 2636.00

5/OR/72
(17/OR/13

Sec. 2
T6S, R6E

Sec. 6
T6S, R7E

2640.00'   N1°30'E   N1°27'24"E   2640.00

A   B

65923

West 2638.00

Sec. 12   T6S, R6E

Mount Diablo Base & Meridian

SECTION II

The following data is taken from a closed traverse containing four courses. The coordinates of point A are
N 1000.00
E 1000.00

Course	Bearing	Distance
AB	N82°30'E	100.00'
BC	S29°15'E	50.00'
CD	S24°15'W	70.32'

REQUIRED:

a   Draw a sketch of the traverse.

b   What is the bearing and length of course DA?

c   What are the coordinates of point C?

1. The term "plane surveying" is used with respect to

   A   precise location of horizontal control points TRIANGULATION TRAVERSE

   B   work which covers limited areas of the earth, and which disregards the earth's curvature

   C   work conducted through the use of an alidade and a plane table

   D   work which locates ground points for aerial photography· Photogra...

   E   work wherein distances and horizontal angles are projected onto the surface of the spheroid which represents the mean sea level of the earth   Geodetic. P.3

2. The Gunter's chain is

   A   used for precise measurement of distances

   B   one eightieth of a mile   80 c.. mile,

   C   a graduated ribbon of steel 100 feet long

   D   used for stadia surveys

   E   exactly 300 links in length

3. A double rodded line of levels means a line run

   A   in only one direction using two rods

   B   twice in the same direction using one rod

   C   using two turning points for each set up of the instrument

   D   in both directions using only one rod

   E   with two targets on a Philadelphia rod

4) The angle between the geographic meridian and the magnetic needle at any point is known as the

    A   deviation

    B   variation

    (C)   declination

    D   deflection

    E   azimuth

5) To determine the acreage of a rectangle 10 chains by 20 chains the simplest way is

    A   (10 chs. x 66 ft.) x (20 chs x 66 ft.)
        ÷ 43,560 sq. ft.

$$\frac{chs \times chs}{10} = acres$$
10 sq.ch. acres

    B   area by planimeter

    (C)   10 chs. x 20 chs. ÷ 10   10 sq. chains = 1 acre = 1 ch 1 2 3 4 5 6 7 8 9 10 10ch x 20ch

    (D)   660 ft. x 1320 ft. ÷ 43560

    E   660 ft. x 1320 ft. x $\frac{1\ ac}{43560\ sq. ft.}$ = 20 ac,

6) A map may show lines which represent the points of equal declination of the magnetic compass. Such lines are known as

    A   magnetic north lines

    B   oersted lines

    C   magconic lines

    (D)   isogonic lines

    E   gauss lines

(7) You have the square footage of 50 different sized parcels of land to be converted into their individual acreage. You have a desk calculator. Which would be the quickest and easiest method?

A   not use a desk calculator, use a slide rule

B   divide each area by 5280

C   multiply each area by $\dfrac{1}{43560}$

D   divide each area by 21780 square feet and multiply by 2

E   multiply the area of each figure by 43560

(8) A map showing contours of equal precipitation is called a

A   contour map - equal elev.

B   hydrologic map

C   isohyetal map

D   cadastral map - property boundary etc

E   Thiessen network

(9) A hectare is

A   a measure of land area   1 hectare = $10,000 m^2$ = 2.471 acres

B   used to support a plumb bob

C   an instrument used in map plotting

D   used by Kelsh operators

E   used to measure electrical output

10 A miner's inch is a unit of measure of

A   flowing water

B   shaft diameter

C   volume for rare metals

D   the depth of a well

E   barometric pressure

11 A "self-reading" rod eliminates the need for

A   subtracting rod readings

B   a rodman

C   a level

D   benchmarks

E   balancing back-sights and fore-sights

12 Measured slope distances are readily reduced to horizontal distances and differences in elevation by a

A   Rhodes Arc

B   Kelsh Plotter

C   self-reading rod

D   alidade

E   geodimeter

13) The "Compass Rule" is used to

    A   balance a traverse

    B   adjust a transit

    C   plot aerial surveys

    D   plot open traverses

    E   plot route surveys

14) A rhumb line appears as a straight line that crosses all meridians at a constant angle. The projection which shows the rhumb line as a line of constant true bearing is the

    A   Lambert Conformal Conic

    B   Zenithal

    C   Gnomonic

    D)   Mercator

    E   Stereographic

15) One would need an Ephemeris when

    A)   making solar calculations

    B   slope staking

    C   using a Rhodes Arc

    D   adjusting a transit

    E   standardizing a surveyor's chain

16 A party chief knows the horizontal distance from his transit to a point to be set on a hillside. If he sets a 15° vertical angle on the vertical motion of the transit he can set the point directly. Which of the following would not determine the slope distance?

A   horizontal distance divided by the cosine of 15°00'

B   horizontal distance multiplied by one plus the external secant of 15°00'

C   horizontal distance divided by the sine of 15°00'

D   horizontal distance multiplied by the secant of 15°00'

E   horizontal distance multiplied by $\dfrac{1}{\text{cosine } 15°00'}$

$$\cos 15° = \frac{100'}{X}$$

$$X = \frac{100'}{\cos 15°}$$

$$SECANT = \frac{1}{\cos}$$
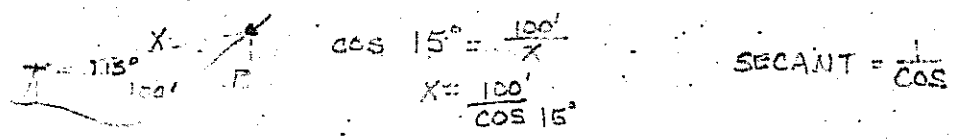
17 In California Grid Zone I you are located at North Latitude 40°51', at an elevation of 9,500 feet. The scale factor is 0.999895. The elevation factor is 0.999546. If you measure 1000.00 feet, this distance, corrected for scale factor and elevation, is

A   1000.00 feet

B   1000.56 feet

C   1000.28 feet

D   999.72 feet

E   999.44 feet

$$S.F. \times E.F. = GRID \ FACTOR$$
$$= 0.9994 \times 1,000 = 999.44$$

18 A traverse run by a surveyor along the bank of a stream is known as a

A   proprietor line

B   witness line

C   meander line

D   thread line

E   rhumb line

(19) Vertical curves may be placed at a sag or at a summit. The two most commonly used are

    A   tangent and cotangent

    (B)   equal tangent and unequal tangent

    C   sine and cosine

    D   cosine and secant

    E   cosine and tangent

(20) The four points of the compass - North, East, South and West - are also known as

    A   ordinal directions

    (B)   cardinal directions

    C   metes and bounds directions

    D   bases of bearings

    E   true azimuths

(21) The term "escrow" refers to

    A   a conveyance to a grantee in fee simple

    B   a conveyance to a grantee using a deed of trust

    C   an inheritance

    D   a fractional lot reduced in area by an encumbrance

    (E)   a grant deposited with a third party which will be delivered upon the completion of a condition

22) An excess or deficiency in the length of a block may be

    A   proportioned equally to the block affected, and the two adjacent
        blocks on either side

    B   proportioned into all the blocks contained within the subdivision

    C   assigned entirely into the last lot on the west side of the block

    (D) prorated among the lots within the block affected

    E   distributed according to the desires of the property owner

23) When a land surveyor uses the term "approximate" in connection with a
distance he usually means

    (A) an uncertainty of dimensions of lesser degree than "about"

    (B) an uncertainty of dimensions of greater degree than "more or less"

    C   a dimension that is as certain as can be measured

    --D a total lack of knowledge of the true distance

    E   the distances contain either a discrepancy or an error of
        measurement

24) In a triangulation net which is used for primary ground control

    A   large angles are desirable because they strengthen the figure

    B   small angles are undesirable because they increase the error of closure

    C   deflection angles are measured at least six times direct to the right
        and six times to the left inverted

    D   small angles are undesirable because they weaken the strenth of the
        figure

    E   small angles are desirable because they strengthen the figure and
        reduce the errors of closure

(25) The term "culmination" is applied to

  ✓ (A) the sun when it crosses the meridian of place

  B the sun when it crosses the ecliptic

  C the sun when it crosses the hour angle

  D Polaris in its most Westerly position

  E Polaris in its most Southerly position

(26) The term "equation of time" is used as a measure of the time interval between

  ✓ (A) mean solar time and apparent solar time

  B mean solar time and sidereal time

  C Pacific Standard Time and Greenwich Time

  D apparent solar time and sidereal time

  E Pacific Standard Time and local apparent time

(27) A sidereal day is the time required for

  A Polaris to move from upper transit to lower culmination

  B the sun to move from lower transit to upper transit

  C the sun to move one complete revolution around the ecliptic

  ✓ (D) one apparent revolution of the vernal equinox

  E the sun to move from the Eastern horizon to the Western horizon

(28) When running ordinary differential levels you may unbalance the lengths of foresights and backsights. When the unbalance becomes substantial, the potential for error increases. The error is most likely to be that due to

   A   parallax

   B   uneven graduations on the self-reading rod

   C   the level bubble not at the exact center of the bubble tube at the time the reading is taken

   D   the cross hair ring being rotated in the reticule

   √ (E)   the effect induced by refraction and the curvature of the earth

(29) The latitude of this place can be closely approximated by

   ✗ (A)   observing the sun at 12:00 Standard Time and measuring the angle from the center to the horizon

   B   observing the sun at sunrise and at sunset and taking the average of the two readings

   C   measuring the angle between Polaris at western elongation and zenith

   √ D   measuring the angle from the horizon to Polaris at upper and lower culmination and taking an average value

   E   measuring the angle from the horizon to the center of the sun at 12:00 noon Daylight Time

(30) The elevation of a turning point can be obtained by

   A   adding the HI to the BM elevation

   B   adding the BS to the BM elevation

   C   subtracting the BS from the HI

   √ (D)   subtracting the FS from the HI

   E   subtracting the FS from the BS

31 It is good practice to equalize the length of foresights and backsights
when taking differential levels in order to minimize, or eliminate, the
error induced by

    A   the axis of the bubble tube being not parallel to the line of sight

    B   the horizontal cross hair being slightly rotated in the reticule

    C   the line of sight not being perpendicular to the vertical axis

    D   the axis of the bubble tube not being perpendicular to the vertical axis

    E   parallax

32 When an instrument operates with a retrograde vernier, the least count of the
vernier is

    A   the lowest reading that can be read on the vernier

    B   equal to the number of main scale graduations divided by the
corresponding number of vernier graduations

    C   equal to the difference between the number of main scale graduations
and the number of vernier graduations

    D   a variable depending upon the length of the main scale graduations

    E   equal to the value obtained by dividing the length of the smallest
main scale division by the number of vernier divisions

33 A mechanical instrument that can be used to either enlarge or reduce the scale
of a map is called a

    A   polar planimeter

    B   pantagraph

    C   beam compass

    D   distomat

    E   gradienter

34) Which of the following relationships is correct?

   A   1 mil = 1000 degrees

   B   1 degree = 1000 mils

   C   1 degree = 0.9 grads

   D   1 grad = 12 mils

   E   2π radians = 1 degree

35) A steel tape which is 100 feet long may be compared to the standard which is done at

   A   20 pounds pull at 50° F with tape supported throughout its length

   B   20 pounds pull at 68° F with tape supported at two ends

   C   10 pounds pull at 68° F with tape supported at two ends

   D   10 pounds pull at 68° F with tape supported throughout its length

   E   5 pounds pull at 68° F with tape supported at both ends, and at mid point

36) The Lambert map projection method is referred to as "conformal". This means that

   A   all measured bearings are true bearings

   B   all directions, or azimuths, taken from one central point will show true direction

   C   all land parcels can be measured in true area without distortion

   D   all land parcels will be distorted in area in proportion to the distance away from the projection center

   E   land parcels will appear in their correct shape

(37) A characteristic of the compass rule which is used for balancing a survey is that the correction to be applied to the departure of one of the courses bears the relation to the total correction in departure as the

✓ A   length of the course is to the total length of all courses in the traverse

   B   length of the course is to arithmetical sum of all the departures

   C   length of the course is to the arithmetical sum of all the latitudes

   D   square of the length of the course is to the sum of the squares of all the lengths of all the courses

   E   bearing of the course to the number of degrees contained within the closed traverse figure

(38) The stadia formula contains a factor $(f + c)$ which is

   A   slightly variable according to the temperatures and humidity conditions surrounding the instrument

✓ B   a fixed value for a particular instrument

   C   equal to the stadia interval factor

   D   equal to the distance from rod to the focal point of the lens system

   E   usually equal to a unitless value of 100 for most instruments

(39) The meridian through Greenwich, when compared to Pacific Standard Time, would be

   A   7 hours behind Pacific Standard Time

   B   7 hours ahead of Pacific Standard Time

✓ C   120° of longitude apart

   D   equidistant from the International Date Line

   E   located in the Atlantic Standard Time Zone

(40) A circular curve as used for highways will have a degree of curve which is

    A   equal to the angle subtended by an arc of 100 feet

    B   equal to 360° divided by the central angle Δ

    C   equal to the deflection angle from the PC to the first station located on the curve.

    D   equal to the central angle in radians divided by the length of the curve

    E   equal to the angle subtended by a 100-foot-long chord

(41) A slope stake is set

    A   on center line at profile grade

    B   at the intersection of natural grade with profile grade

    C   at the intersection of the side slope and natural grade

    D   at the intersection of the side slope and the profile grade

    E   at the center position in a standard three level section

(42) The correct intent is expressed by which of the following?

    A   a plat of record is an aid to be used in the location of property

    B   a plat of record takes precedence over any other available evidence

    C   a plat of record will prevail over an instrument of service in which property lines are described

    D   monuments which can be ascertained can be superseded by correct measurements in the field

    E   a deed which contains the description of a property line will control the lengths and bearings

43) The difference in the hour angle between the true sun and the mean sun is called the

    A   hour angle

    B   sidereal hour angle

    C   right ascension

    D   longitude

    E   equation of time

44) A vertical curve which passes over a crest of a hill will have a plus and a minus grade tangent. If the algebraic difference between the two grades is evaluated it

    A   will determine the length of the curve

    B   is equal to the rate of change in the grade per station

    C   will be a function of the square of the tangent offsets from the same two tangents

    D   will always have a minus (-) value

    E   will be equal to the total grade change

45) A map projection method which utilizes a cylinder as the surface of projection is called the

    A   Mercator

    B   Lambert Conformal

    C   orthographic

    D   pantagraphic

    E   gnomonic

(46) A land parcel may be described by stating the respective lengths of each of the sides, and the corresponding bearings. Such a description would be identified as

   A   coordinates

   B   the Public Land Survey method

   C   lots and blocks

   D   metes and bounds

   E   the Prismoidal method

(47) A field party measured a base line between two points established on the ground. A series of observations was made of the same distance, and record made of each. From the record data it is true that the

   A   probable error of the whole series taken together will probably approach zero because of compensating factors

   B   probable error of one measurement will be a maximum

   C   probable error of one of the readings will be zero

   D   most probably correct value will be the mode

   E   probable error of the mean will be a function of the square root of the sum of the squares of the residuals

(48) In the surveys for the public lands of the United States the closing corners along a township line

   A   are used to establish the true location of standard section corners within the township

   B   were established by recent surveys to control the ultimate subdivisions of the township

   C   can be accepted as the true location of the standard section corners

   D   are positioned on the ground by double proportionate measurement

   E   will control the direction of the North-South section line in an East-West direction

49) A tangent can be prolonged through the procedure of double centering when using a transit. The error that is eliminated by this procedure is caused by

  A   vertical cross hair not in a vertical plane

  B   the horizontal plate bubble being out of adjustment

  C   the line of sight not being parallel to the axis of the bubble tube

  D   the line of sight not being perpendicular to the horizontal axis

  E   parallax in the reticule

50) The solution of the three point problem is a demonstration of the land surveying procedure known as

  A   subdivision

  B   resection

  C   intersection

  D   meandering

  E   Simpson's Rule

51) A survey crew working in the desert uses a steel tape that is consistently exposed to temperatures that exceed the usual standard. It is likely that an error will be introduced into the measurements that is

  A   instrumental

  B   personal

  C   compensating

  D   standard

  E   systematic

52) In order to determine the true altitude of the sun it is necessary to

A — subtract the corrections for refraction and parallax from the apparent altitude

B add the corrections for refraction and parallax to the apparent altitude

✓ C subtract the refraction correction and add the parallax correction to the apparent altitude

D add the refraction correction and subtract the parallax correction from the apparent altitude

E subtract only the parallax angle from the apparent measured altitude

53) Smith has conveyed to Jones a grant described as follows: "The West 30 feet of Lot 6, Green Hills Tract, to be used for road purposes." This means that Smith has

A dedicated a road to public use

B reserved a road easement

C granted a revocable permit to pass

D conveyed title in fee

E conveyed a right of way

54) Celestial coordinates used to locate heavenly bodies such as stars are identified as

A latitude and longitude

B sidereal hour angle and right ascension

C equation of time and hour angle

D hour circle and right ascension

✓ E declination and right ascension

55) A circular curve of arc length L is subtended by a central angle which is equal to

    A 2π radians

    B   360° minus the deflection per foot of length

    C   the deflection angle between the tangents to the curve

    D   one-half the deflection angle between the tangents to the curve

    E $2\pi\ R/L$

56) When viewing an aerial photograph the nadir point

    A   is halfway between the isocenter and principal point

    B   is identical with the zenith of the exposure station

    C   is the vanishing point of the vertical object images

    D   is located at the intersection of the two lines formed when the two opposite sets of fiducial marks are connected

    E   corresponds to the principal point in a tilted photograph

57) When working with vertical photographs the relief displacement will be a function of

    A   flying height, focal length, elevation of the point, and the radial distance on the photo

    B   flying height, focal length, and radial distance

    C   flying height, elevation of point, and radial distance

    D   flying height and focal length

    E   flying height and elevation of the point

(58) A basis of bearing for a given survey may not be

    A   taken from a previous survey

    B   assumed

    C   magnetic North

    D   taken from two found monuments

    E   taken from a deed which identifies the true point of beginning

(59) Which of the following formulas will identify the latitude of one of the courses of a closed traverse? Assume L = length of course, B = bearing of course, a = latitude of course, d = departure of course.

    A $\cos B = \dfrac{d}{L}$

    B $\cos B = \dfrac{a}{L}$

    C $\cos B = \dfrac{L}{a}$

    D $\sin B = \dfrac{a}{L}$

    E $\sin B = \dfrac{L}{a}$

(60) When a sudden change in the channel of a stream removes a large quantity of soil from the land of one and causes the material to be annexed to that of another without transfer of ownership, the term applied is

    A   dereliction

    B   accretion

    C   avulsion

    D   eminent domain

    E   reliction

61 The center of a standard section of land is

A the point of intersection of two straight lines -- one run from
the NE Sec. corner to the SW Sec. corner, and the other from the
NW Sec. corner to the SE Sec. corner

B a point located 40 chains South and 40 chains West of the NE
Sec. corner

C a point located 40 chains North and 40 chains East of the SW Sec. corner

D the point of intersection of a straight line run from the North
one quarter corner and the South one quarter corner, and the straight
line run from the East one quarter corner to the West one quarter
corner

E a point identified by the intersection of the meridian line and the
range line

62 The standard model for a township in the United States public land survey
system covers an area of

A 640 acres

B 40 acres

C 6 square miles

D 36 square miles

E 360 square miles

63 The boundaries of the public lands, when approved and accepted, are

A unchangeable

B changeable

C parallel to the meridian lines

D parallel to the range lines

E straight lines between section corners

(64) When following procedures for relative orientation of stereopairs, the
rotational motions are made about the

    A   isocenter

    B   nadir point

    C   focal point

    D   nodal point

    E.   principal point

(65) Which of the following is equal to a micron?

    A . 1/10000 millimeter

    B   1/25,400 inch

    C   1/10,000 meter

    D   1/52,800 inch

    E   .1/100,000 meter

(66) A map which represents the terrestrial relief of a geographical area would
be identified as

    A   topographic

    B   cartographic

    C   orthographic

    D   photographic

    E   an uncontrolled mosaic

67. The horizontal distance between two adjacent contours

   A   represents the contour interval

   B   is directly proportional to the slope of the ground

√ C   is inversely proportional to the slope of the ground

   D   is equal to the ground slope

   E   is usually shown by hachures

68. In the procedure known as transit-stadia surveying the rod intercept

   A   is equal to the stadia constant

   B   is equal to the horizontal distance from the transit

   C   is equal to the vertical distance from the transit

√ D   is equal to the length read on the rod scale between the two stadia cross hairs

   E   is equal to the stadia interval factor

69. A stadia reading will most accurately be reflected in the correct calculation when the

   A   rod is parallel to the line of sight

√ B   rod is held plumb

   C   rod is held perpendicular to the line of sight

   D   rod is "waved"

   E   rod is raised for red

(70) The azimuth of a line

A   is equal numerically to the bearing of the line

B   is always some value between 360° and 0°

C   compares to the bearing of the line in that it is 90° smaller, or 90° larger

D   compares to the bearing of the line in that it is 180° smaller, or 180° larger

E   is measured from the backsight

(71) Evidence which suffices for proof of a fact until rebutted by other evidence is called

A   indispensable evidence

B   extrinsic evidence

C   direct evidence

D   prime facie evidence

E   circumstantial evidence

(72) The monument which marks the theoretical center of a standard public land survey section would

A   be set by a U.S. Deputy Mineral Surveyor

B   be set by the U.S. Geological Survey

C   be set by the U.S. Coast & Geodetic Survey (former title)

D   probably be lost or obliterated because of the passage of time

E   never be found as it was never set

73 A curve constructed to the railway definition

A   is actually a series of connected chords made successively shorter so that they collectively approximate a true circular arc

B   is actually equivalent to a 10 chord spiral

C   is a part of a true circular arc defined by a degree of curve D and a 100-foot chord

D   actually follows the mathematical path of a parabola

E   actually follows the mathematical path of a catenary

74 A metes and bounds description starts from a point of beginning which is

A   referenced to a standard section corner

B   selected for ease of identification in the field

C   given higher priority as a control point than any other points described

D   never contained within the land parcel description

E   tied to a standard one-quarter corner

75 The angle measured from a horizontal plane and the natural slope assumed by a loosely placed embankment material is called the

A   dip

B   angle of incidence

C   strike

D   angle of refraction

E   angle of repose

END OF PART A
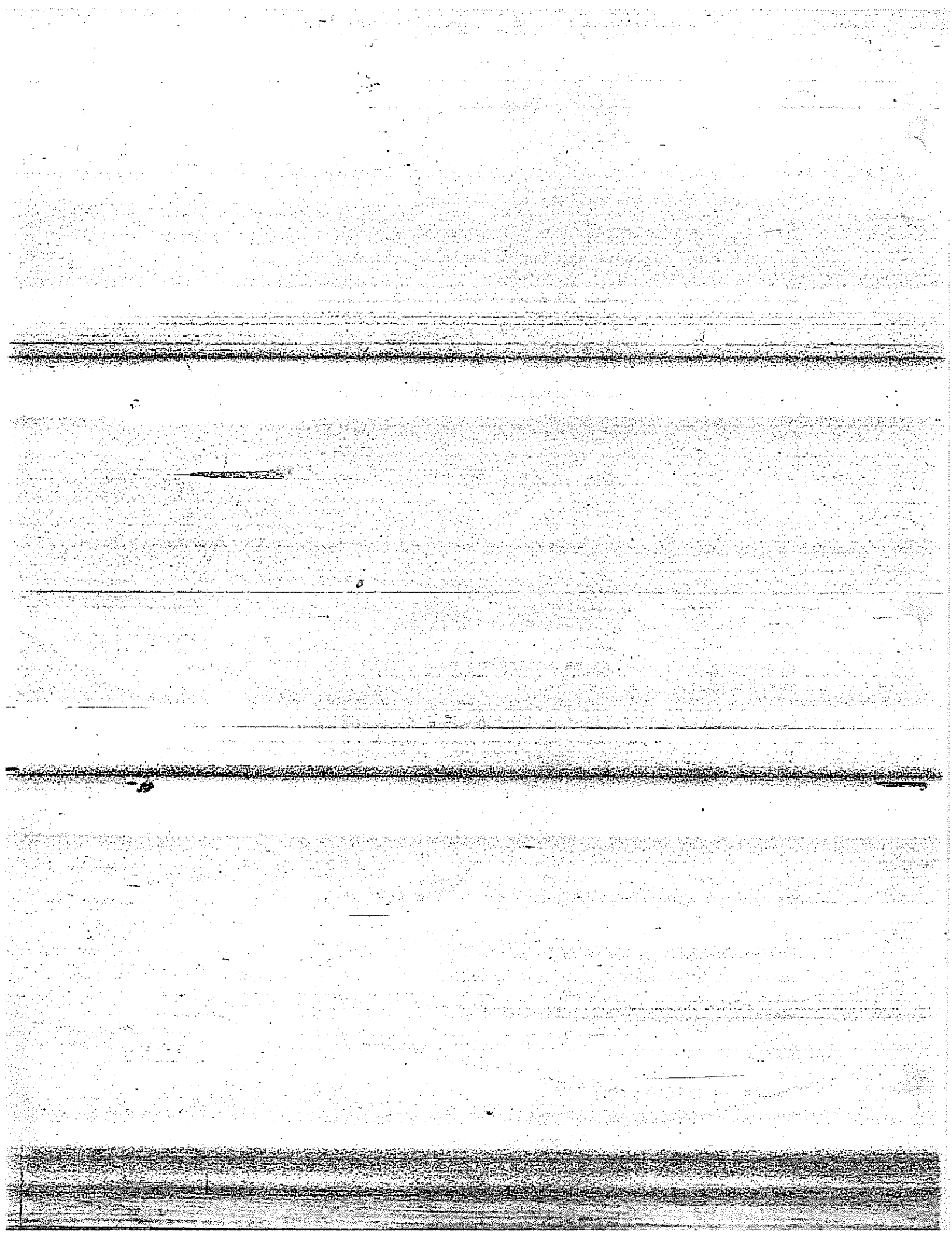
Problem B1 - Wt. 2

A line AB is in Zone III of the California Coordinate System and is East of the
Central Meridian. The theta angle at A is 1° 05' 10", and the geodetic bearing
of line AB is N 58° 57' 24" W. What is the grid bearing of line AB?

Problem B2 - Wt. 3

Prepare a land description for the cross-hatched area indicated in the following plat.
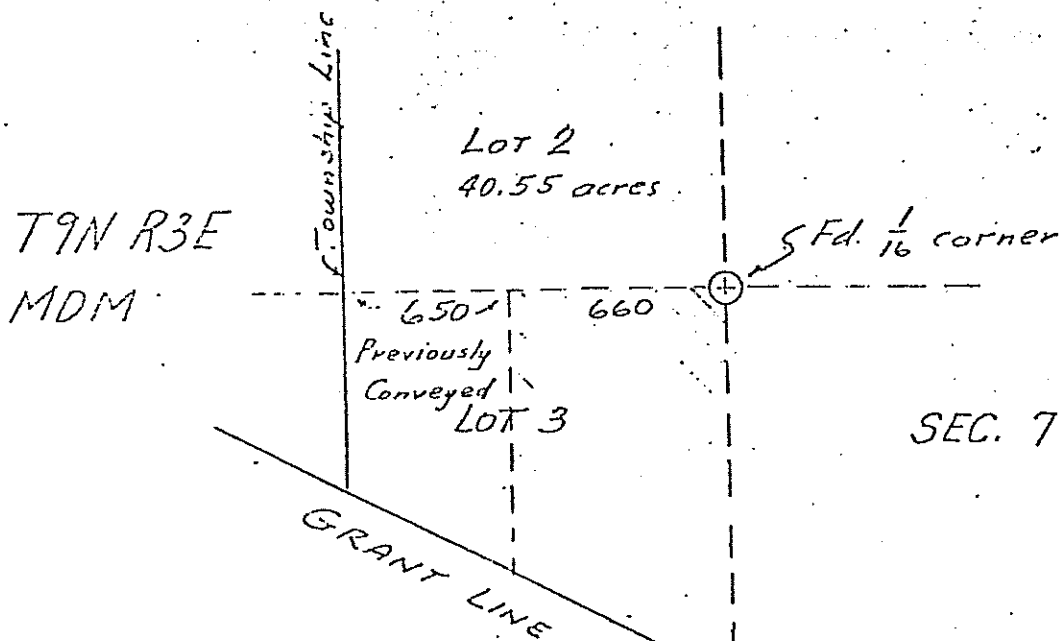
Problem B3 - Wt. 3

In the progress of a field survey it is impossible to measure the radius of an existing curb return directly so you measure the <u>chord</u> and the <u>middle ordinate</u>. Show by formula how you would compute the radius.
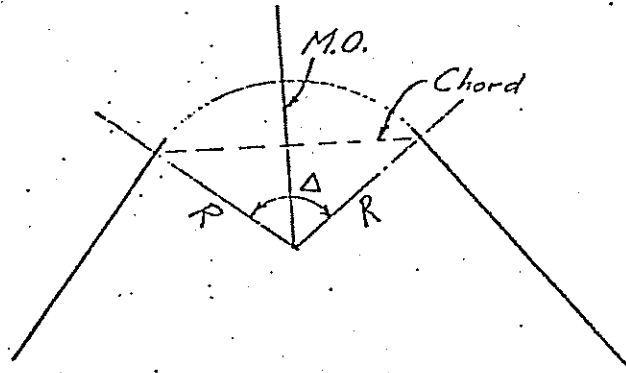
$$LC = 2 R \sin \frac{\Delta}{2}$$
$$M = R(1 - \cos \frac{\Delta}{2})$$

$$R = \frac{LC}{2 \sin \frac{\Delta}{2}}$$

$$R = \frac{M}{(1 - \cos \frac{\Delta}{2})}$$

Problem B4 - Wt. 3

The sun rises on June 22 at a certain point in the Northern Hemisphere at azimuth 61° 19'. What is the latitude of the place. Slide rule accuracy will be sufficient for this problem.

NOTE: The maximum declination of the sun is 23° 27'.

Problem B5 - Wt. 3

A six-sided figure with sides of about 200 feet has an error of closure of 3'N. and 10'E. Without placement of the error in a specific course, or a systematic adjustment into the various courses, is it possible to obtain a precise DMD area for the figure? Explain.

Problem B6 - Wt. 3

It is required that a curve be laid out by tangent offsets. Calculate the distance "y" along the tangent, and the tangent offset distance "x".

Sin 10° = 0.1736
Cos 10° = 0.9848
Tan 10° = 0.1763
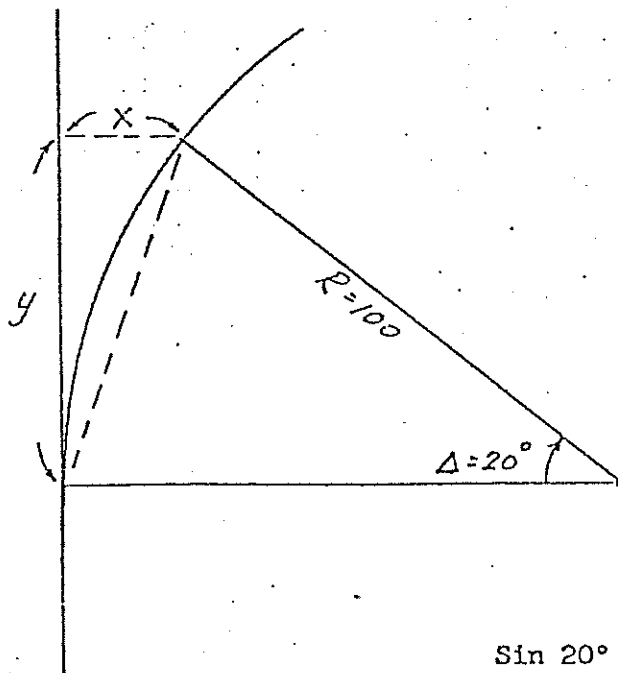
Sin 20° = 0.3420
Cos 20° = 0.9397
Tan 20° = 0.3640

Problem B7 - Wt. 3

A planimeter having a zero circle of 217.50 sq. in. is used with the anchor inside the figure, with a negative reading of 11.40 sq. in. The figure is to a scale of 1 inch to 40 feet. What is the area of the figure?

Problem B8 - Wt. 3

The figure shows a part of a circular curve with certain given components. Derive the formula for radius in terms of the other shown quantities.
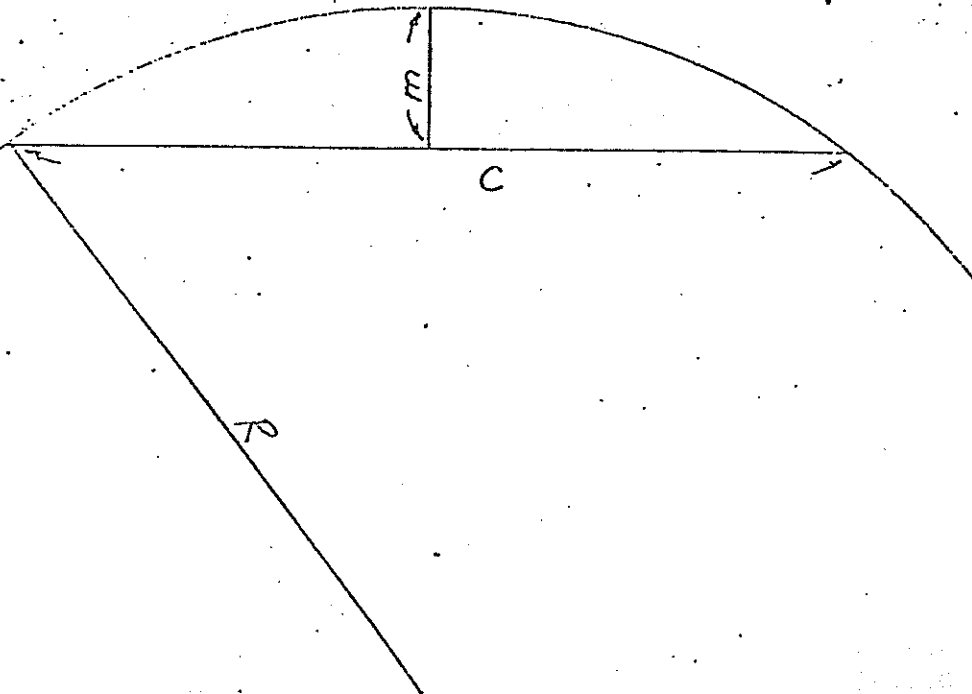
Problem B9 - Wt. 3

What are the (a) advantages, and (b) disadvantages of observing Polaris at culmination?

Problem B10 - Wt. 3

Recent developments and adaptations of electronic distance measuring devices make it possible to improve and speed up staking procedures without using a tape.

a   Describe two developments or modifications that have made this possible.

b   If the manufacturer claims an accuracy of $\pm$ 1 cm for his equipment, comment on what it could be used for in subdivision staking if the claim proves to be valid.

Problem B11 - Wt. 3

Describe a "plano-parallel", and identify two instruments in which it is used.

Problem B12 - Wt. 4

Develop the equation for the total area contained between the arc of the curve and the two tangents (area shown shaded). Your final equation should contain only the terms, T, R, and L.
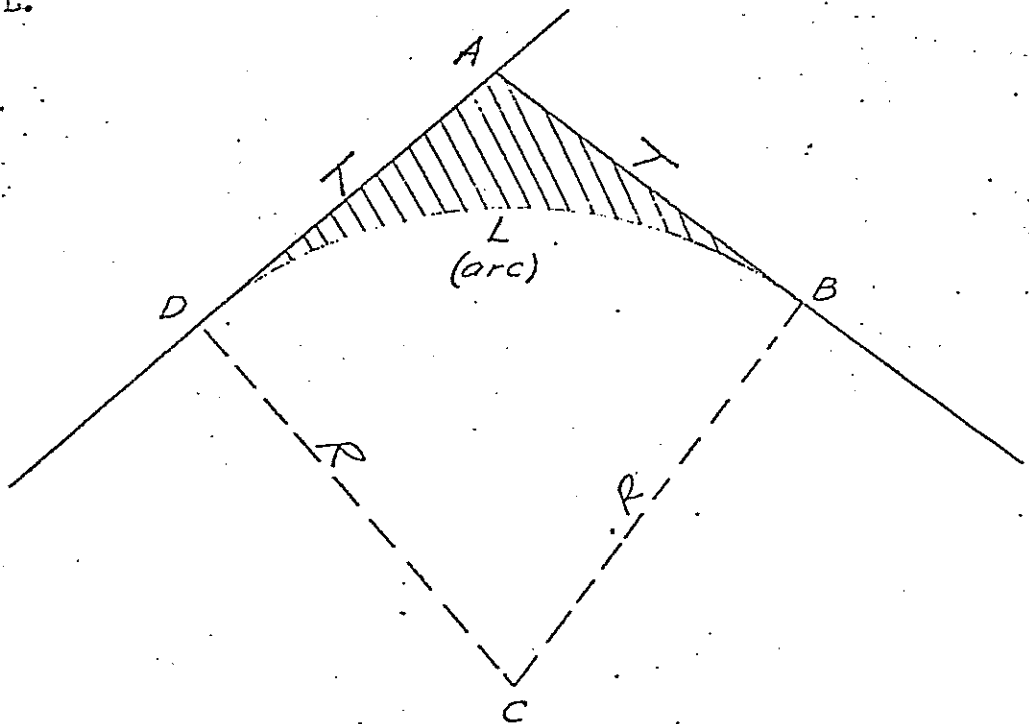
Problem B13 – Wt. 4

Explain the process of double proportionate measurement. When is it used? How is it accomplished?

Problem B14 – Wt. 4

In the process of surveying a lot in an old subdivision you measure between two original monuments and find that the distance you measured does not agree with the record distance by one foot. Give reasons for prorating. Give reasons for not prorating.

Problem B15 - Wt. 4

In the United States there are two primary projections which are used as the basis for the various state systems of plane coordinates.

What is the name of each of the two projections used?

Which system is used in California?

How many zones are in effect in the California system?

Describe the term "mapping angle" as used in each of the two state plane coordinate systems. What does it mean?

Problem B16 - Wt. 4

The grid dimensions of a square parcel of land are 1000.00 feet on a side. The grid scale factor is .999982 and the sea level factor is .999564. What is the ground area of this parcel? (Give answer in acres to the nearest .001 acre.)

Problem B17 - Wt. 4

a   In your own words name 5 basic entities that will define a Geodetic Datum.

b   What are the entities that define The North American Datum of 1927?

NOTE: Numerical values are not required.

Problem B18 - Wt. 4

Define each of the following photogrammetric terms:

a   aberration

b   ground nadir

c   X-tilt

d   principal line

e   swing

f   trilateration

g   fiducial axes

h   depression angle

Problem B19 - Wt. 5

A closed traverse was run around a parcel of land. Each line has been measured with an accuracy comparable to the angular accuracy. The interior angles were turned.

a   What method of adjustment should be used?

b   List in detail the steps you would go through to perform the adjustment.

Problem B20 - Wt. 5 . (Answer all parts)

a   On any map, deed, or other instrument, how does the reference to coordinates based on the California Coordinate System affect the title to real property?

b   Any map based on the California Coordinate System must show connections to at least two known stations. What are the requirements for these stations?

c   The Legislature divided California into grid zones which follow county boundaries rather than mathematical rules. What was the purpose of this action?

d   In each grid zone, sea level distances are equal to ground distances at all points along two lines of exact scale which are called_____.
At all other points, either a negative or a positive correction must be applied. Explain, or use a sketch, to show where, in each zone, the correction would be negative or positive.

Problem B21 - Wt. 6   (Answer all parts)

a   The two principal classes of resurvey of the United States Public Domain
     in California are the dependent resurvey and the independent resurvey.
     Explain the characteristics of each.

b   As far as the public domain in California is concerned, what is the
     difference between bona-fide rights of claimants and senior rights of
     possession?

c   Give an example of California title which enjoys a right of possession
     senior to the United States Public Domain.

d   Suppose that a tract of public domain land has been occupied in good
     faith, but a resurvey indicates that the lines of occupation are not
     in agreement with the boundaries of the resurveyed subdivision. Keeping
     in mind the manner prescribed in the current "Manual of Instructions for
     Survey of the Public Lands" for protecting bona-fide rights, how could
     this condition be remedied?

Problem B22 - Wt. 4

You are occupying a position on a mountain at which the elevation by topographic
map is 1471 feet, and sighting a point at elevation 1381 by the same map. The
sight distance by electronic measurement is 2325 feet. Ignore curvature and
refraction for this problem.

a   What is the vertical angle?

b   What is the horizontal distance?

c   Assuming the contour interval is 5 feet and the map and positions are correct
     within half a contour interval, what is the maximum amount for the
     horizontal distance?

Problem B23 – Wt. 4

Tidal Bench Mark data is published by the U.S. Coast and Geodetic Survey to aid local surveyors throughout California. Below is an excerpt from the material given for one of their stations located on the open sea coast at Crescent City. Using this data, and assuming that the coast is in a natural condition, tell how you would survey in the field, and indicate on a map, the waterward extent of your client's property. The client has riparian rights and adjoins state sovereign submerged lands, and his property is in the immediate vicinity of the tide station. From nearby bench marks, relate the boundary to sea level datum.

Mean Higher High Water	6.90 feet
Mean High Water	6.30 "
Mean Tide Line	3.75 "
Mean Low Water	1.20 "
Mean Lower Low Water	0.00 "

0.00 Feet Sea Level Datum = 1.23 Mean Lower Low Water

Problem B24 – Wt. 12   Work All Sections

Section A   Wt. 2

What is the difference between the equivalent focal length and the calibrated focal length of a precision mapping camera?

Section B   Wt. 4

If the calibrated focal length of an aerial camera is 6.000", what focal length stereo plotter would you use to bring the image to focus at 30" on the plotter?

Section C   Wt. 4

Determine the elevations of points a, b and c from the following information:

Flying height		4000'	
Air base		2000'	
Focal length		152.4	mm
Parallax	a	8	mm
	b	79	mm
	c	91	mm

Section D   Wt. 2

Define relative orientation and absolute orientation in a stereo plotter.

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

The general instructions are shown on the cover page of your workbook. Please read them.

When you have completed Part C arrange the problems in your workbook in proper sequence, and check your workbook to see that it is complete. No work will be accepted that is not turned in to the proctor at the close of the examination period.

You are to work the problems that are given in the examination booklet. You may make appropriate assumptions where they are asked for, or if a problem is incomplete, or if a problem is obviously in error. If an assumption is necessary, you should provide sufficient explanation so that the examiner can judge the reasons therefor. Assumptions must generally follow the logic and the requirements of the problem statement.

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

You may use a self-contained mechanical calculator in this part of the examination. This means a hand operated type, or a battery operated type. Proctors are instructed to prohibit the use of any machine which requires a plug-in type power source.

You may keep this set of examination questions.

You are required to work Problems C1, C2, and C3, plus a choice of one.

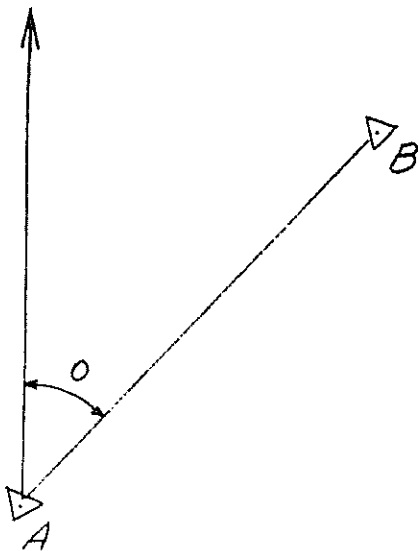Problem C1 - Wt. 12.5   (Answer all parts)

a   What is a closing corner, and why is it used?

b   What is a one-quarter corner, and why is it used?

c   Under what conditions may a standard section corner be moved?

d   What is a grant deed?

e   What is meant by the term - fee simple?

f   What is a conveyance?

g   Where are deeds recorded?

h   What is the primary purpose of a deed? Identify at least five essential
     parts to a deed.

i   Distinguish between a lost corner and a witness corner.

Note: Corners refer to those identified in the system of United States Public Land
         Surveys.

Problem 2 - Wt. 12.5 Answer all parts

a How many zones make up the California Coordinate System? How are they identified?

b What is the basis of projection for the California Coordinate System?

c Does the scale factor in the California Coordinate System change according to change in latitude, or in longitude? Explain.

d Explain the relationship between grid North and geodetic North.

e How many standard parallels are included in each grid zone in the California Coordinate System? What is the reasoning for this selection?

f In a given California Coordinate System Zone, at what location is the scale exact?

g Name one other projection system that is used in the United States other than as identified in (b) above.

h In the sketch below what were the field observed values for angle "O" and distance A-B? (ignore curvature and refraction, and assume level terrain)

Geodetic North


```
* Mapping Angle = +1° 03' 41"
  Elevation A-B = 6,200'
  Grid Distance A-B = 8,900.21
  Grid Bearing A-B - N 40° 58' 28" E
* Central Meridian = 122° 00'
* Grid Scale Factor = 0.9999158
  Longitude Point A = 120° 19' 00"

* from projection tables
```

Problem C3 - Wt. 12.5   Answer all parts.

a   The term $\rho = \sqrt{\dfrac{\sum v^2}{n-1}}$ is used to represent the standard error or standard deviation. What is the significance of the standard error? How would it be used or applied?

$\sum v^2 =$ sum of squares of the residuals   n = number of observations

b   If several measurements are taken between the same two points on a base line, a representative, most probable value may be taken to be the mean of the measurements. Does the mean value represent a least squares adjustment of the measured values? Explain.

c   What is your understanding for a "weighted arithmetic mean"?

d   What is meant by the index error of a transit?

e   Define the term "probable error" of an observation.

f   Each of the following ten factors may be a source of a taping error to a surveyor. Each of the factors can be related to a source (personal, instrumental, natural, etc.) and to a classification (accidental, systematic blunder, etc.). Identify the source and classification of error as related to each of the following:

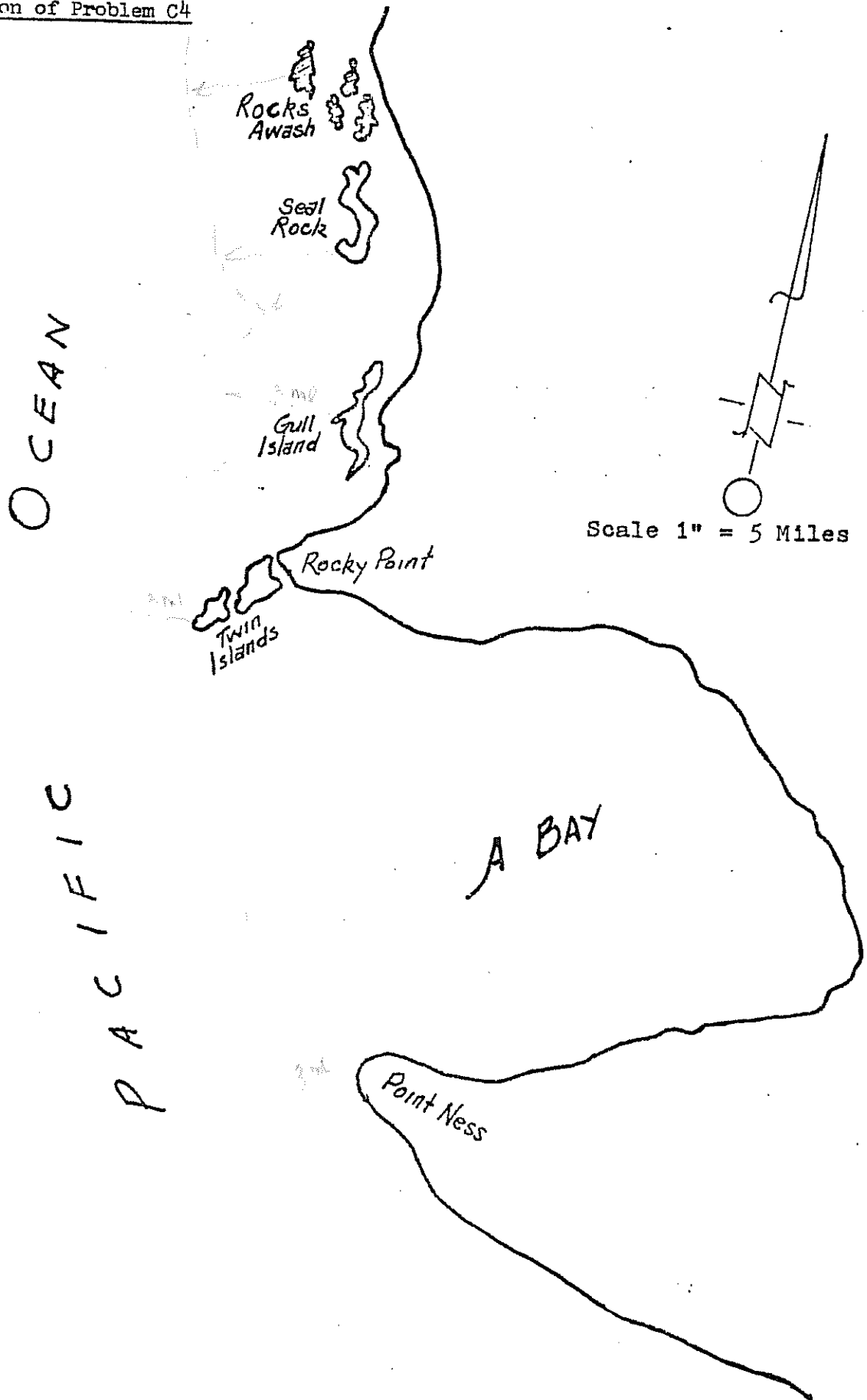|	
tension	tape on slope (not level)
temperature	marking
sag	plumbing
length of tape	dropped chaining pin
alignment	interpolation

Problem C4 - Wt. 12.5

The map shown on the following page shows a part of the California coast where
the land mass adjoins the Pacific Ocean.

REQUIRED:

a   Reproduce the map in your workbook and indicate the sea boundary of the
territorial waters of California. Indicate by a dashed line, and explain
the reasons for this particular selection.

b   Explain the ordinary basis for determining the sea boundary, and how it
is established along the West Coast of the United States.

c   If you were given a commission which required that you establish the
sea boundary, describe one method by which you might proceed.

Continuation of Problem C4

Rocks
Awash

Seal
Rock

OCEAN

Gull
Island

Rocky Point

Twin
Islands

Scale 1" = 5 Miles

PACIFIC

A BAY

Point Ness

Problem C5 - Wt. 12.5

A second order traverse was run between U.S.C. & G.S. control points "PINE" and "ROCK". The equipment used included a one second theodolite and a light wave measuring device with an accuracy claimed by the manufacturer of 0.04 ft. ± 4 ppm. The angles were balanced and distances reduced to grid.

Preliminary California Coordinates prior to adjustment are as follows:

			N	E
"PINE"			363,992.10	1,985,147.83
	N85°06'30"E	2542.40		
A			364,208.90	1,987,680.97
	S89°22'15"E	3418.18		
B			364,171.37	1,991,098.94
	S81°31'50"E	4229.39		
"ROCK"		(Calculated)	363,548.46	1,995,282.21
	Published Values		⟨363,548.18	1,995,282.33⟩

REQUIRED:

a   Adjust the coordinates by:

   1. the compass rule, and
   2. the transit rule

   Do not calculate the bearings and distances from the adjusted coordinates.

b   Identify three sources of error that might affect the angular accuracy.

c   Identify three sources of error that might affect the distance.

d   What range of error would you expect for any one angle? For any one distance? Identify any applicable assumptions with respect to the methods of measurement.

e   Which of the two adjustment methods is the more logical?

f   Would better results be obtained from a least squares adjustment? Explain.

L S

LAND SURVEYOR - 1972

Part D - Weight 50

D

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

The general instructions are shown on the cover page of your workbook.
Please read them.

When you have completed your work for Part D arrange the problems in
your workbook in proper sequence, and check your workbook to see that
it is complete. No work will be accepted that is not turned in to
the proctor at the close of the examination period.

You are to work the problems that are given in the examination booklet.
You may make appropriate assumptions where they are asked for, or if a
problem is incomplete, or is obviously in error. If an assumption is
necessary, you should provide sufficient explanation so that the
examiner can judge the reasons therefor. Assumptions must generally
follow the logic and the requirements of the problem.

At the end of each problem, list any reference book, diagram, or tables
which you have used. Give book title, edition and page number.
You may use a self-contained mechanical calculator in this part of the
examination. This means a hand operated type, or a battery operated
type. Proctors are instructed to prohibit the use of any machine which
requires a plug-in type power source.

You may keep this set of examination questions.

Choose any 50 points.

Problem D1 - Wt. 25   (Answer all parts)

a   The Land Surveyor's Act requires a record of survey to be filed in the event of "a material discrepancy with the record." What is the meaning of this provision in the law?

b   Modern surveying equipment and techniques (i.e. geodimeter, T-2, etc.) may provide accuracy in traverse surveys which may not be possible with conventional transit-tape methods. Do you think that discrepancies disclosed through the use of high accuracy techniques should be classified as a material discrepancy even though survey results obtained by lesser techniques are within the prescribed tolerances? Explain.

c   Should a record of survey be filed if in the foregoing (b) the fact is determined that no material discrepancy exists?

d   In the pursuit of a particular survey an existing monument may be called "off" to be consistent with record courses. A surveyor may change his measured course between two accepted monuments to be consistent with the called "for" course between the two monuments. Discuss these matters with respect to material discrepancy and extending future surveys.

The drawing below includes several preliminary measurements which have been made for the layout of an industrial plant installation.

A large conduit will be installed on a series of precast concrete saddles which will be located at approximately 10 ft. centers. The conduit will transport industrial compressibles, and it measures 60" OD, and 58.8" ID.

Shortly after the preliminary measurements were made several small pipe lines were installed on the site, and below the grade of the 60" conduit. These small pipe lines were located at random, and their present position now precludes an exactly even spacing of 10 ft. for the precast saddles. The saddle spacing can approximate 10 ft. with due allowance to clear the small pipe lines wherever they occur.

A hurry-up call indicates that the saddles will arrive at the site tomorrow morning, and will be lifted directly from the transport and placed in final position on the grout bed in one continuous operation. Upon arrival at the site of the work you find that the instrumentman has set up a transit at station 0 + 00 with HI = 621.42 ft.

REQUIRED:

How would you proceed to set the location of each of the saddles? Develop your method by showing the calculations for plan layout and elevation. Develop a procedure that will give a logical development of the installation, and which will assure that each saddle is located and positioned to its proper elevation.

PLAN
No Scale
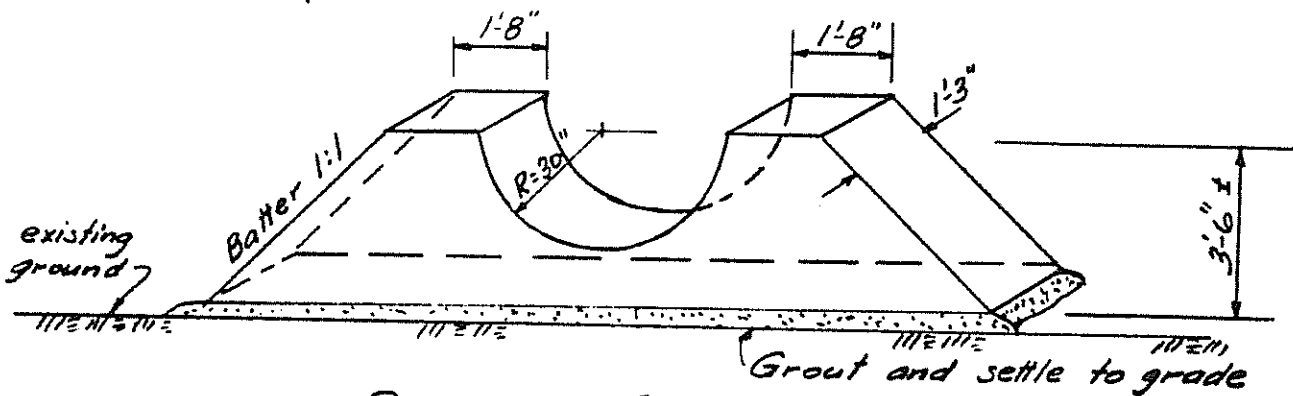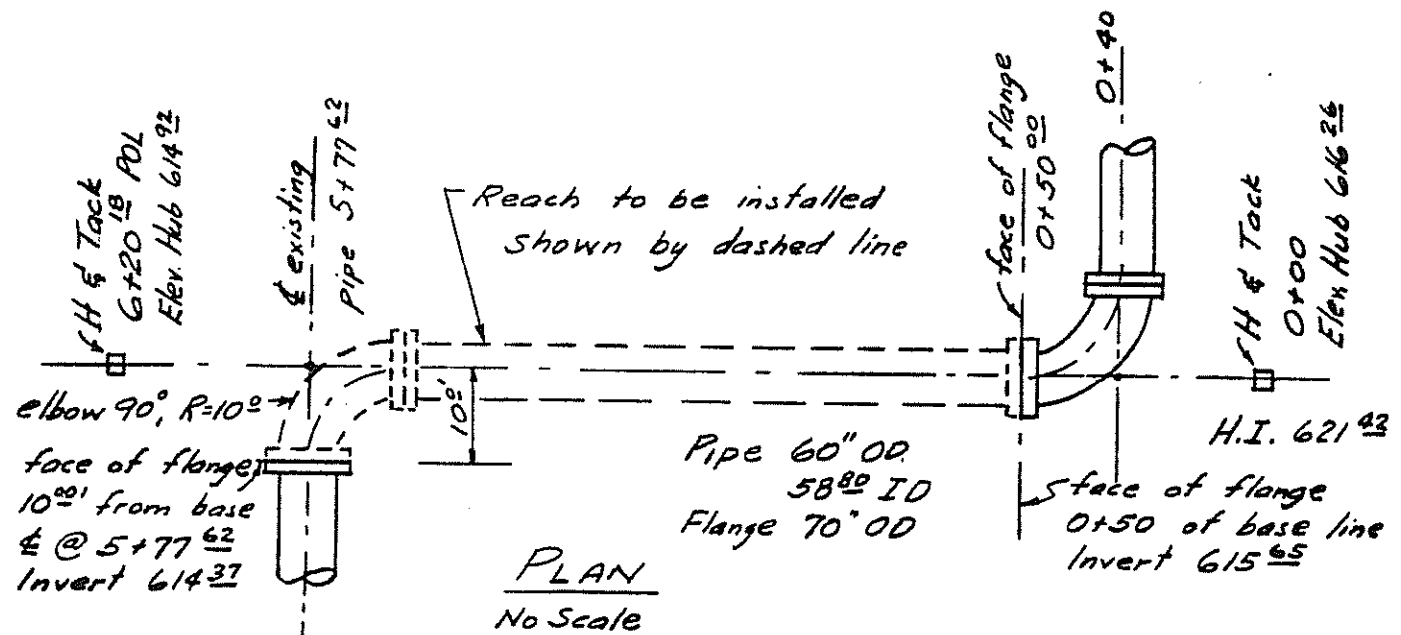
PRECAST CONCRETE SADDLE
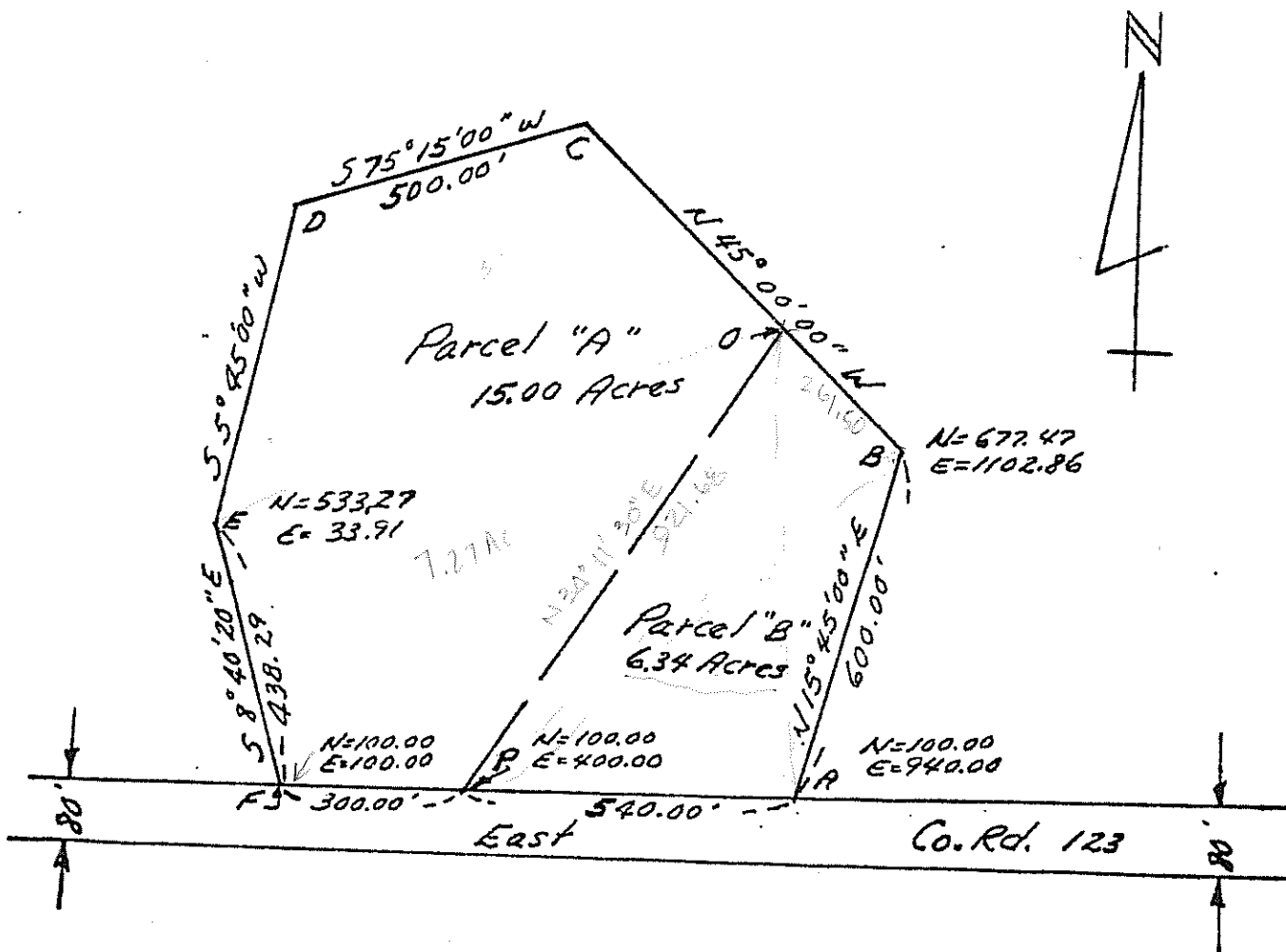No Scale

FIG. D2

Problem D3 - Wt. 25

The plat drawn below shows two land parcels which adjoin a county road. All the known information is shown.

REQUIRED:

    a   Compute the following distances:

BC	OC
DE	OP
OB	

   b   Compute the bearing from O to P.

Problem D4 - Wt. 12.5

The plat shown below shows fractional Section 20. The meridian and range are not identified. The distances shown in chains are the record distances. The bearings and distances given in feet are the results of your survey.

REQUIRED:

Compute the courses for the SW 1/4 of Section 20. Explain briefly the steps in the procedure you have followed in your solution.
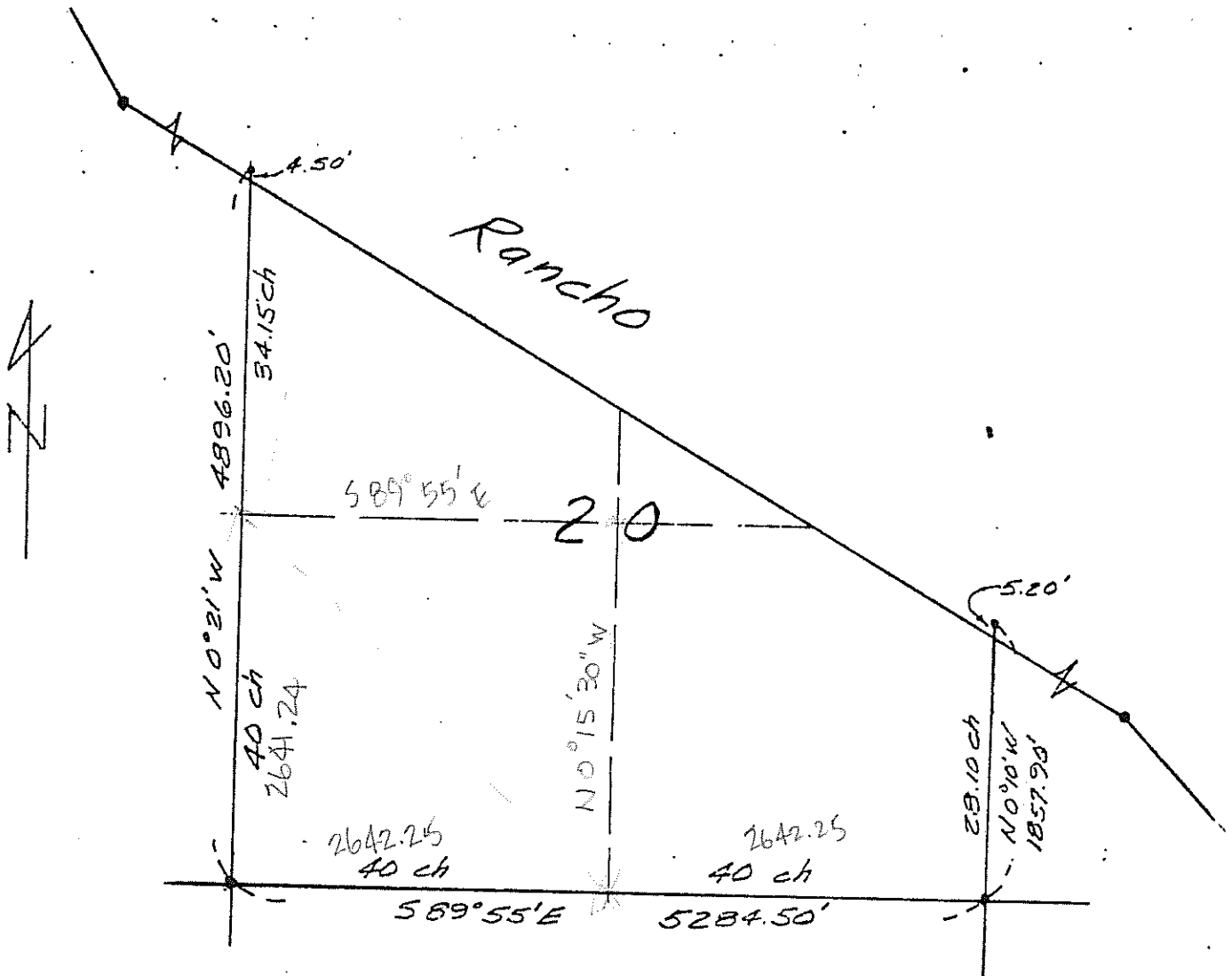
● Denotes Fd. orig. cor.

Problem D5 - Wt. 12.5

The plat below shows a parcel for which Corner #1 must be reestablished. All measurements must be made on River View Drive since the area around Corners #2 - 5, and most of the land area within the parcel, has been developed with buildings of various types.

REQUIRED:

a   Compute the bearings and distances needed to set Corner #1.

b   Describe the field procedures to be followed to set the corner.