86

MAP READING

NOTES ON ANSWERING QUESTIONS

REVISED 1939

22.11.39

PREFACE.

When using a map for the first time, especially when it is issued for examination purposes, examine it for the following important information.

1. What locality it deals with.
2. Its scale. Is it in miles, yards, or metres. What is the R.F.
3. Its orientation, and the local magnetic variation (North Point)
4. The conventional signs it employs. Note any that are unfamiliar.
5. The contour system and interval. Is it in feet or metres. Or does it employ, form lines, hachures, layers, or spot heights
6. The date of issue or revision. An old map will not give up to date information unless it has been revised. This is especially important with Canadian Maps where the colouring and conventional signs in regard to roads has changed several times during the past 10 years.
7. By whom and how it was made.
8. The system of reference and grid employed. Is it in metres or yards.

The names and numbers of adjoining sheets.

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INDEX.

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NOTES ON ANSWERING QUESTIONS IN MAP READING.

1. Dont Use Faulty Tools. You must provide yourself with a GOOD protractor, pair of dividers, magnifying glass, perfectly straight ruller showing 10ths, 12ths & centimeters, a parallel ruler or pair of set squares, coloured pencils, a pencil sharpener, and a romer for scale 1 inch to 1 mile.

2. Read the instructions at the top of your paper carefully. Also those on your Exam Book. Do not answer more questions than the instructions call for. You MUST answer the questions in ink not pencil, unless the instructions in the exam paper say that pencil may be used to answer a given question.

3. To get marks you must show all your working either in Exam Book or on the map. Use left hand page of Exam Book for rough working in pencil and right hand page for answer in ink. If all working is shown, and you are right in principle but make a slip in arithmetic, etc. you are nearly always given some marks.

4. You may not be an artist, but you can be neat, and neatness counts, but don't waste time in being too elaborate. Especially practice speed combined with neatness in constructing scales. Make conventional signs no larger than they would be on a field sketch. Don't use coloured pencils if paper states "Make a Pencil sketch". Use black lead pencil only.

5. Allow yourself about 15 minutes to read the questions, see exactly what is asked in the question, and underline the important words. Be sure and answer exactly what the question calls for and put in no irrevelant details. Most Army Map-reading questions are framed as a tactical situation or a short, short story, don't let this disturb you, pick out what concerns map reading and concentrate on that.

6. As you read the question, locate the places referred to, and mark them with coloured pencil. Using a different colour for each question is a good plan.

7. Decide which questions you are most sure you can answer and which will take the least time. Answer those first. Leave difficult or long questions to the last, and then do as much of them as your remaining time will permit. Above all leave a map enlargement until last as it always requires much time.

8. Questions may be answered in any order, but you must be sure to put the number of the question in the margin. NEVER copy the question into your book. Rough working should also bear the number of the question.

9. Remember that your answer must not be just YES or NO even though you have worked it out on your left hand page. You must give the complete answer to the question, as plainly and briefly as possible. Thus in describing an area, use headings such as:-- General statement; main features; minor features; artificial features i.e. roads, railways, buildings, etc.

10. Remember that the person marking your paper has many others to mark, so don't annoy him by illegible writing, long rambling answers, and careless rough work.

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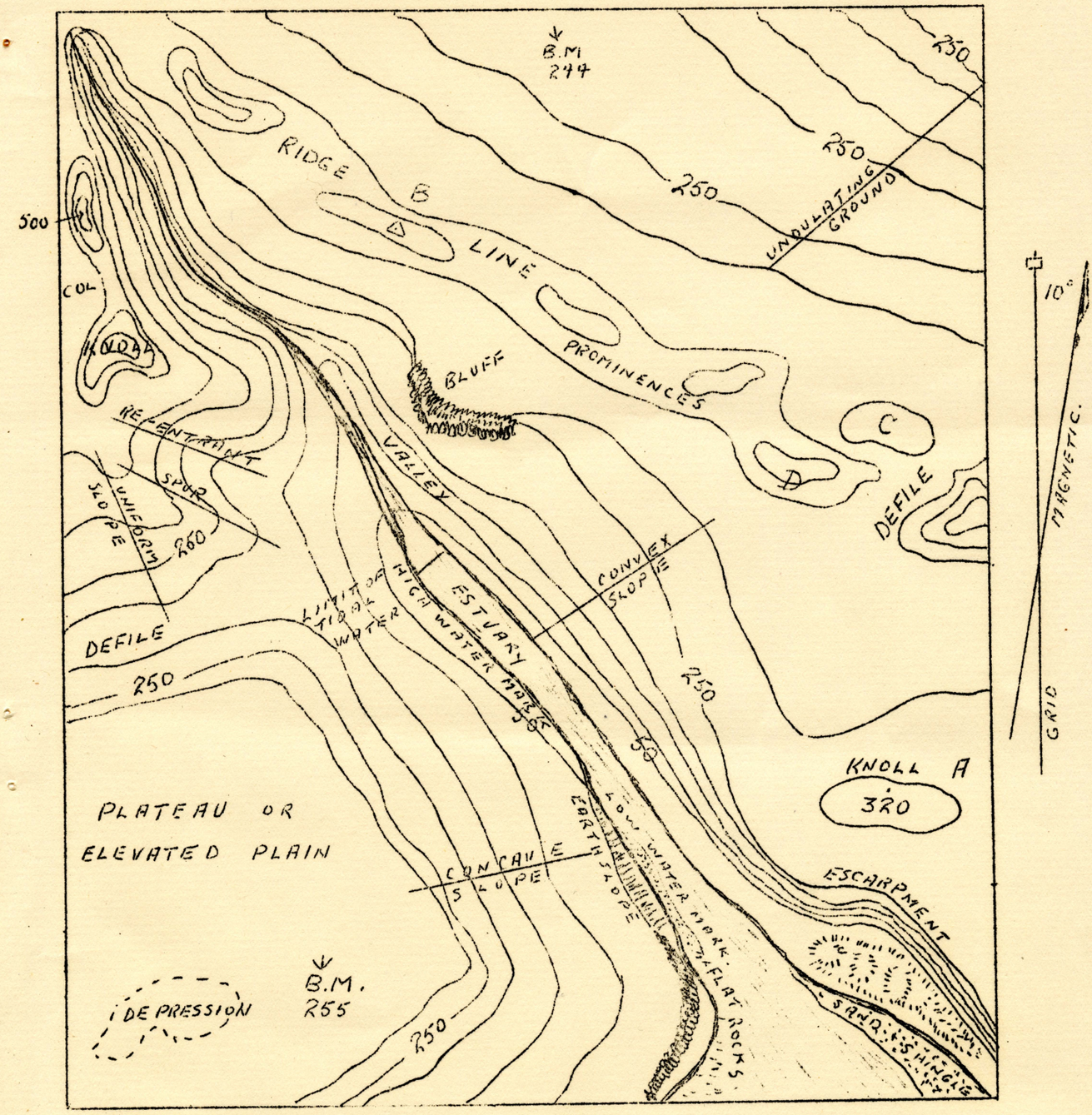
SKETCH I.
RELIEF



SCALE R.F. 1 : 18000

YDS 500 4 3 2 1 0 500 1000 1500 2000 2500 YARDS

MAJOR FEATURES PLATEAU, VALLEY, RIDGE, UNDULATING GROUND.

MINOR UNDER FEATURES. SPURS, RE-ENTRANTS, BLUFFS, COLS, KNOLLS. ETC

HINTS ON ANSWERING QUESTIONS INVOLVING CONVENTIONAL SIGNS.

OBJECT OF SIGNS. Conventional signs are used to depict on the map the various features found on the ground, i.e. NATURAL FEATURES such as hills, rivers, woods, marshes etc. and ARTIFICIAL FEATURES such as roads, railways, canals, buildings etc.

ALL candidates must be familiar with the signs used for FIELD SKETCHES and for showing troops on the map. (See Plates V &VI MMR 1929) If asked to draw a sketch THOSE are the signs you must use.

For 1st, Class Cert. of Education students must study thoroughlythe signs used with the 1 inch to 1 mile British Ordnance survey map)See Plate 11a MMR 1929)
Note. Plate 11a was issued as Amendment No.1 to the M.M.R in 1935. It may be some time before maps using the new signs are issued for examination purposes. The old signs must therefore also be studied.

For Military Examinations set in Canada. In addition to the above the signs used on Canadian maps must be studied. Most of those used will be found below any 1 inch to 1 mile Canadian Military map which has not been printed especially for examination purposes.

The reference used in these notes regarding Canadian maps are to Kingston sheet, 1 inch to 1 mile and 2 inches to 1 mile.

In drawing a sketch PAY ATTENTION TO FINISH (See p.98 MMR/

STUDY THE FOLLOWING PAGES IN CONJUNCTION WITH THE VARIOUS PLATES IN THE MANUAL, OR IN NOTES ON MAP READING (which is merely an extract from the manual)

NATURAL FEATURES.

RELIEF i.e. The shape or configuration of the ground.
ON ORDNANCE SURVEY or CANADIAN MAPS.

HILLS, VALLEYS etc. RELIEF is shown by continuous brown lines called CONTOURS.
DEFINITION OF A CONTOUR. "an imaginary line on the surface of the ground at the same height above mean sea level (MSL) throughout". It is accurately surveyed with instruments. Hill tops are shown by encircling or ring contours. If they are small it is sometimes difficult to arrive at their height unless a careful study of the other contours is made. Example C and D in Sketch 1, C is 350 feet, D is 450 Feet above MSL.

Valleys can usually be readily identified because they form the course of a stream or river.

SUBMARINE CONTOURS are known as the 5 fathom line, 10 fm. line etc. (there are 6 ft. to 1 fathom) and indicate the approximate shape under water. They are obtained by taking soundings with a lead line.

Note how contours cross a river. This is often the only clue to the direction of flow.
Note carefully how they connect with cliffs or bluffs, i.e. if a cliff is 75 feet the 50 ft. contour would not tie in with the top of it, but slightly below the top.

LEARN THOROUGHLY THE DEFINITIONS of TOPOGRAPHICAL FORMS (Chap.11 MMR)

SLOPES. Note that for CONCAVE SLOPES the contours are close together at the top; for CONVEX SLOPES they are close together at the bottom; for UNIFORM SLOPES they are evenly spaced; while for PRECIPITOUS SLOPES they run so close togther that they can hardly be identified. In GRADUAL SLOPES. they are far apart.

N.B. On some maps relief is shown by HACHURES or shading by short strokes Example: The sand hills in Sketch 1. This system does not accurately depict relief, it merely indicates the shape of hils etc.

Air maps and some others show relief by LAYERING i e. layers of different colours. They are usually contoured at every 500 or 1000 ft and the colours run from dark brown for the greatest heights to dark green for the deepest valleys.

They enable a quick picture of the general shape of the relief to be seen, but are expensive to make and cannot show features which may be several hundred feet in height and therefore very important from a military point of view.

Sometimes a contoured map is shaded on hill features to make them stand out, this is called SHADING and must not be confused with HACHURing which it somewhat resembles.

RELIEF CAN THEREFORE BE DEPICTED BY:-

1. CONTOURS.
2. FORM LINES (to be explained later)
3. HACHURES.
4. LAYERING.
5. SHADING.
6. SPOT HEIGHTS (to be explained later)

HEIGHT. The heights shwn on a map are those above MEAN SEA LEVEL. This is aften forgottn in describing a piece of country . For example the map may show a hill as being 3000 ft. above MSL but actually in relation to the ground you are describing it may be only 100 ft in height, so be careful to state "3000 ft avove MSL but only 100 ft above the surrounding country". Otherwise you do not give a true picture of the ground.

SPOT HEIGHTS. Besdies contours the exact heights of hill tops, valleys, surface of rivers and lakes, cross roads etc. are indicated by a dot and small black figures; these points are called SPOT HEIGHTS. Do not confuse the figures with the slightly larger ones which indicate MILE STONES along a road. Example :A Sketch 1.

BENCH MARKS. When height is actually recorded on the side of a bridge or on a stone monument etc. it is indicated on the map by a broad arrow and the letters BM as well as the height. This is called a ↑BM BENCH MARK. Sometimes, owing to lack of space, the figures indicating the height are some distance from the arrow. Example: Railway bridge KINGSTON MILLS 4821.

TRIG. POINTS. The basis of survey of all accurate maps is a series of fixed points, the exact position of which is known, and the distance between each measured, either along the ground or by triangulation. These points are called TRIANGULATION or TRIGONOMETRICAL POINTS. (Trig. Points) On the ground they consist of a visible mark such as a cairn of stones, a flag, beacon, church steeple or other well defined object; and a permanent mark in metal or stone which may be buried underground. On a map they are shown by a triangle thus △ and if the height is known a spoy height inside it thus △264 Example B in Sketch 1. If the steeple of a church is used, British maps indicate the exact point by a dot inside the symbol for a church thus ⊙ . If the height is also given, it indicates the height of the object at its base not its top.

FOR FIELD SKETCHING OR SKETCHES IN EXAMINATIONS.

RELIEF is usually shown by broken (or pecked) lines instead of continuous ones, thus - - - - - - - - These are called FORM LINES. They show relief less - - 250 - - accurately than do contours.

RELIEF ON CHARTS.

Ground configuration on marine charts is usually indicated by FORM LINES, HACHURES, OR SPOT HEIGHTS, or a combination of these.

GENERAL.

In reading your map, first look for the water courses, this will give you an idea of the low ground and enable you to pick out the hills etc.

In drawing a river remember that the contours on BOTH sides must be of equal height. Also remember that rivers do not run up hill i.e. up spurs, they run down re-entrants.

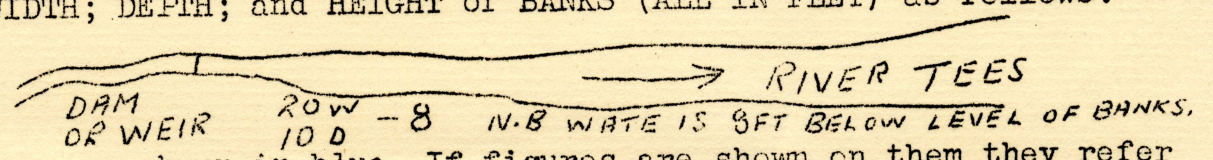
If the question does not specifically state "show by means of CONTOURS", always show relief in a sketch by FORM LINES, because you are merely sketching them in by eye and not as the result of instrumental observation.

RIVERS. Rivers are indicated on a map by blue lines. A thin blue line indicates a stream (On Canadian maps) a river under 30 ft wide). If however it is marked "Riv." call it a RIVER not a STREAM. This occurs on some maps.

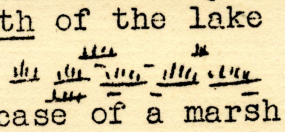
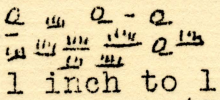
Larger rivers have two lines and are coloured bright blue above, and lighter blue below, TIDAL LIMITS. Where a river empties into the sea and is affected by tide, its mouth is called an ESTUARY.

A stream or river which is dry at some seasons of the year is shown by a pecked or broken blue line.

In a sketch always show the direction of flow by an arrow and indicate the WIDTH; DEPTH; and HEIGHT of BANKS (ALL IN FEET) as follows:-

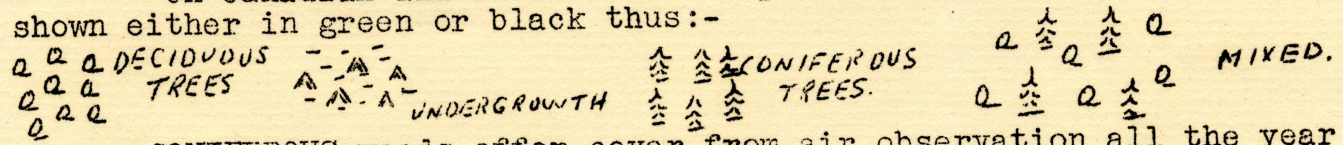


LAKES. Lakes are shwon in blue. If figures are shown on them they refer to the height of the surface above MSL not to the depth of the lake

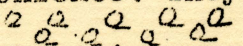
MARSHES. Are shwon either in blue or in black thus:- 
On Canadian maps note the difference in the case of a marsh which is sometimes covered with water. Also note MUSKEGS or swampy ground in a wood or undergrowth. 

On the latest 1 inch to 1 mile Ordnance Survey maps, woods are shown as a patch of deep green (See Plate 11a MMR).

On Canadian and earlier Ord. maps the nature of the trees is shown either in green or black thus:-

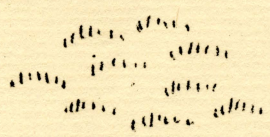


CONIFEROUS woods offer cover from air observation all the year round. DECIDUOUS trees drop their leaves in autumn, they offer good cover only in summer.

ORCHARDS. These are really artificial features and are grouped here merely for convenience. They denoted by the trees being evenly spaced. 
If a wood or orchard is surrounded by a continuous line it indicates a fence.

PARKS. Also artificial features. Public parks are shown in pale green. Private parks are shaded in black and have one or two individual trees shown.

HEATHS. The signs for a heath are often confused with those for a MARSH. Note the difference


HEATH


MARSH.

IN FIELD SKETCHING AND MAP ENLARGEMENT.

Do not exaggerate the signs. This is a common fault. In Field Sketches the nature of tree is written in addition to the sign thus:- OAK, FRUIT, PINE etc., also the nature of cover i.e.DENSE or OPEN. As shelter from tanks, indicate the diameter of trunks and spacing between trees in feet thus:- 5d, 10s. In the case of fields indicate the cover available e.g. WHEAT 4ft high. Note the spacial sign for wire fence:-

ARTIFICIAL FEATURES.

ROADS. On the Ordnance Survey Maps.
1st. Class MAIN roads i.e. metalled or paved over 18ft in width are coloured reddish brown between thick black lines and have the letter "A" and a number against them.

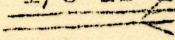
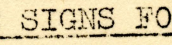
2nd. Class roads over 14ft wide are light brown between thick black lines, with the letter "B" and a number.

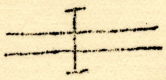
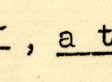
Other metalled roads 14ft wide are light brown between thin black lines and have no letter or number.

Roads with less than 14ft of metalling. Tarred. Pale brown but only half the width of the others. Untarred.Uncoloured and only half the width of the others.

Minor and private roads. Extremely narrow and uncoloured.

NOTE. Unfenced roads are shown by broken (or pecked) lines.
On older maps INDIFFERENT metalled roads were shown in broken coloured, i.e. alternate pale brown and white.
FOOTPATHS are shown by a dotted line .....

GRADIENTS. The gradient or steepness of a hill, if greater than a rise of 1ft in 5ft i.e. 1/5 is indicated thus:  over 1/7 and under 1/5 thus:- 
DONT MISTAKE THESE SIGNS FOR ROAD BLOCKS.

TOLL BARS & GATES. A toll bar is shown thus  , a toll gate 

IN ALL QUESTIONS REGARDING ROADS, CONSIDER THE FOLLOWING.

1. CLASS OF ROAD. (see also p. 78 MMR 1929) Name, if any.
2. WIDTH, PAVED, METALLED, FENCED or UNFENCED.
3. Where does it lead to. Usually shown at margins of map.
4. What is its general nature. LEVEL, HILLY, STRAIGHT or WINDING.
5. What is its maximum GRADIENT, and where is it situated.
6. Are there any LEVEL CROSSINGS, BRIDGES, CUTTINGS, or EMBANKMENTS.
7. Through which TOWNS or VILLAGES does it pass.

On CANADIAN maps: The signs for roads have changed several times during the past 10 years. Always note the signs shown in the bottom left hand corner of the map.

At present the classification is :-
PAVED over 18ft, RED. Under 18ft. BROKEN RED. IMPROVED over 18ft. BROWN. Under 18ft. Broken brown. DIRT. Uncoloured. WAGON. Two dotted lines. FOOTPATH. One dotted line

In earlier editions any nature of road might be fenced (shown by lines) or unfenced (shown by broken lines), but this distinction is not made on the latest maps.

IN FIELD SKETCHES.

If you have no colours write METALLED or UNMETALLED and show the class of road A1, B3 etc, (see page 78 MMR).

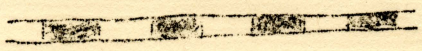
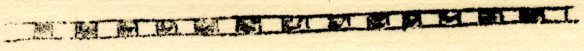
At each end of the road show the distance to the nearest town e.g. PLYMOUTH 4 miles.

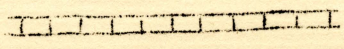
Indicate FENCED or UNFENCED by continuous or broken lines N.B. a road mat be fenced on one side and unfenced on the other.

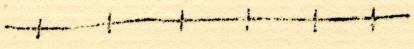
GENERAL.

In sketches or map enlargement DO NOT enlarge a road in width because it is already larger in proportion than the scale of the map calls for. Keep the width about the same as on the original map.

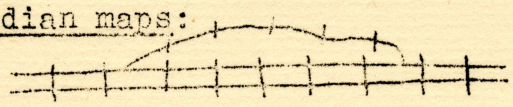
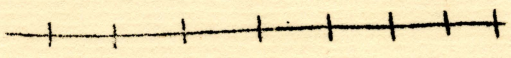
RAILWAYS. On Ordnance Survey maps: Note the difference between DOUBLE and SINGLE lines NORMAL GAUGE.

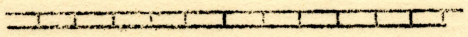
DOUBLE  SINGLE 

NARROW GAUGE  (formerly MINERAL)

TRAMWAYS  (formerly NARROW GAUGE & TRAMWAYS)

On Canadian maps:

DOUBLE  SINGLE. 

STREET RAILWAY 

FIELD SKETCHES.

As for Canadian maps but the words SINGLE, DOUBLE, NARROW, BROAD or STANDARD GAUGE must be written against the sign.

The distance to the nearest town off each end of the sketch should also be shown.

Sta. should be written against the sign for a station.

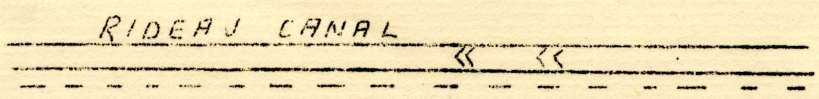
GENERAL.

In considering questions on railways, consider the following:-

1. Name of the railway.
2. Nature. Is it a single, double, or street. Is it standard, broad or narrow gauge. Is it a mineral line or tramway?
3. Between which towns does it run?
4. Are there any tunnels, cuttings, embankments, viaducts, level crossings, or bridges?
5. Has it a principle station or an ordinary station sometimes called a HALT. Is the station closed?

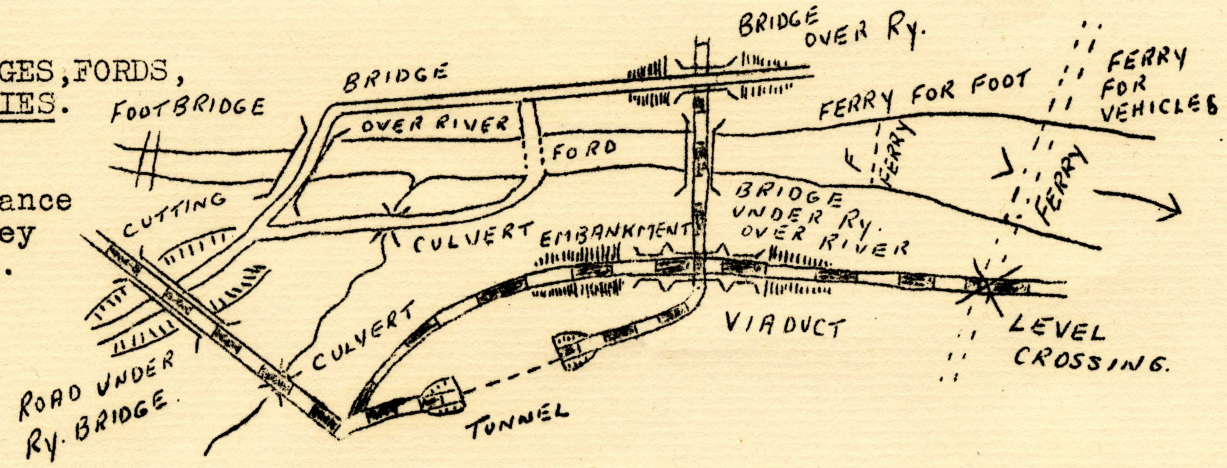
CANALS. Canals are usually marked CANAL but if not can generally be identified because they are straighter than rivers.

A dotted line indicating the TOWING PATH is nearly always shown alongside the canal. Note the sign for LOCKS, do not confuse it with the gradient sign.



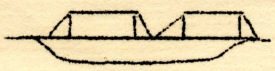
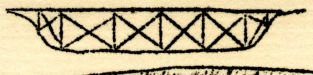
BRIDGES, FORDS, FERRIES.

On Ordnance Survey Maps.



Note the difference between a BRIDGE, a FOOTBRIDGE, and a VIADUCT, also note the sign for CULVERT, which is really a small bridge.

Picture to yourself how these look when seen from one side:

BRIDGE  or  or 

FOOTBRIDGE 

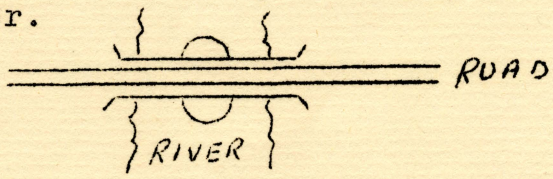
CULVERT

(ARCHED BRIDGE or VIADUCT 
(If this carries a canal instead of a road
(or railway it is called an AQUEDUCT.

Bridges must be either across rivers, or cuttings, or between contours of equal height, or else they must have embankments leading up to them if they have to cross a road or railway.
Therefore pay attention to this when making a sketch showing a bridge.

On Canadian maps:

Principle bridges have the nature of material with which they are constructed indicated by a letter thus:- W.Wooden, I. Iron or steel, M.Masonry i.e. stone, concrete or brick. Small bridges usually have no letter. Culverts usually have no letter.

A SWING BRIDGE is shown thus:- 

FIELD SKETCHES.

In Field Sketches the nature of material is written against the bridge thus:- STONE, IRON, etc.

TOWNS, VILLAGES. On Ordnance maps.

The size of the lettering indicates the approximate population and therefore the size of the town or village. This is very useful when considering billets.

Large scale maps show nearly every building of any size, but the 1 inch to 1 mile map can show only a few of them, so that the number of houses shown on the map does not give an indication of the size of the village etc.,on small scale maps.

POST OFFICES etc. A large town will naturally have Post, Telegraph, and Telephone offices so these signs are not usually shown against large towns. Note. In ENGLAND, telegraphs and telephones are operated by the General Post Office (G.P.O). In CANADA, by private companies.

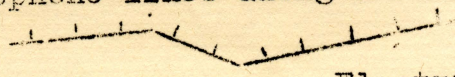
POST OFFICES etc (contd)

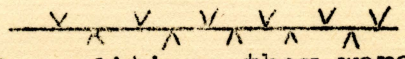
	NEW SIGN	OLD SIGN.
POST OFFICE with TELEGRAPH AND TELEPHONE.	P	PTt or T
POST OFFICE with TELEGRAPH.		T
POST OFFICE with TELEPHONE.		Pt
other POST OFFICES.	P	P
TELEGRAPH KIOSK.	T	
TELEPHONE CALL BOX.	t.c.b.	t.c.b.

N.B. The letter P or T does not indicate the position of the office on the map but merely shows that one exists in the town or village

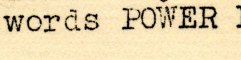
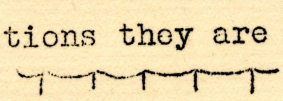
On CANADIAN maps.

The letter P indicates POST OFFICE, T Telephone exchange, T TELEGRAPH OFFICE.

Telegraph and telephone lines along a road are shown :-
across country:- 

POWER LINES. On Ord. Survey maps. Electrical transmission or POWER LINES are shown in BLACK thus: 

On Canadian Maps. In the earlier editions they were exactly similiar to telegraph or telephone lines, with the words POWER LINE written against them.

In later editions they are printed in RED  if on wooden poles and  if on steel pylons.

CHURCHES & CHAPELS. On Ordnance Survey maps.

CHURCH WITH TOWER 

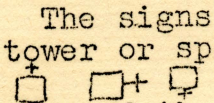
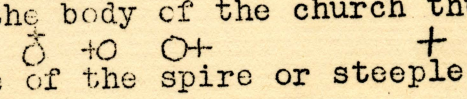
CHURCH WITH SPIRE OR STEEPLE. 

CHURCH WITHOUT SPIRE OR STEEPLE. 

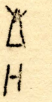
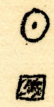
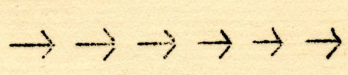
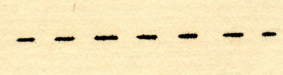
CHURCH WHICH IS ALSO A TRIG. POINT. 

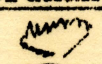
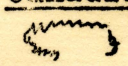
Note. On these maps the signs always lie north and south.

On Canadian Maps.

The signs are shown with the cross indicating the position of the tower or spire in relation to the body of the church thus:-  
The centre of the cross is the centre of the spire or steeple.

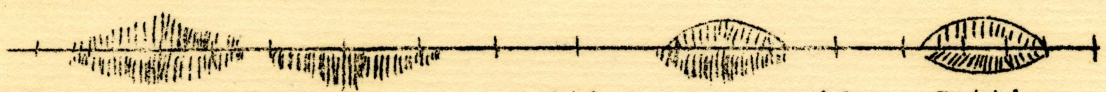
A CEMETERY is shown by a C. thus 

OTHER SIGNS.	Ordnance Survey.	Canadian.
WINDMILL		
WIND PUMP.....		
WIRELESS MAST.....		
UNDER 150 ft.		
OVER 150 ft.		
HOTEL.....	P H	 H
HOSPITAL.....	HOSP L	HOSPITAL
WATER PIPE LINE..... (IN BLUE)		
SCHOOL.....	Sch.	 S

	Ordnance Survey.	Canadian
QUARRY		
SAND PIT.....		
TUMULUS.....		
MILL or FACTORY.....		
SAW MILL.....		 S.M.
GRIST MILL.....		 G.M.
CHEESE FACTORY.....		 C.F.
FORGE or BLACKSMITH's SHOP....		 F.
GARAGE or SERVICE STATION.....		 G.
WATER TOWER or TANK.....		 W.T.

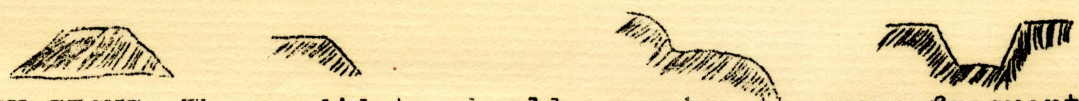
Ruins and ancient buildings etc (other than ROMAN) are shown in Old English printing. Roman ruins are shown thus:- ROMAN WALL.

CUTTINGS.DYKES, EMBANKMENTS. Seen on the map they look like this:-



Embankment. Bank on one side only. Cutting on one side bank on the other. Cutting.

Seen in section they look like this:-



MILITARY SIGNS. The candidate should memorize the more frequently used signs shown on Plate VI, MMR 1929, i.e. Cav.,Arty.,Inf.,guns, barbed wire, disposition of a Coy., etc.

For instance a question set in 1934, required that the map be marked in ink.

Cavalry crossing bridge at 612607
Guns moveing into wood 6559
Tanks on road by M of ELHAM 6261

Candidates should also be prepared to state the MILITARY value of the objects represented by the conventional signs on the map, thus:-

A church with tower is useful as an O.P. or an aiming point.
School or hall useful as a dressing station or for billets.
Bridges prepared for demolition to delay troops
Bridges, Cuttings, Febced roads or any feature which causes the normal frontage of troops to be diminished are termed defiles.
Rivers, Lakes or Streams afford water supply.
Woods afford cover from observation.
Marshes or Swampy ground are obstacles for tanks.
Contours. The shape of the ground affects:- Observation, field of fire, cover from observation or from fire, while the gradient or slope affects movement of guns, transport, and if very steep - troops etc,etc.

UNLESS YOU CAN CORRECTLY INTERPRET THE SIGNS ON A MAP YOU CANNOT EXPECT TO PASS IN MAP READING.

FINALLY.

If asked to draw signs DONT make them TOO LARGE, and make them NEATLY Use those on Plate V MMR 1939, unless told otherwise.

HINTS ON ENLARGING MAPS.

This is a fairly frequent type of question that might be asked. It is a long question and should be left till the last.

Practice against time (30 minutes is the most you can allow) is required to be successful in completing it.

Unually you are only asked to fill in certain things. DON'T waste time filling in things not asked for.

First check and double check the area you are to enlarge and mark its boundaries clearly on your map. Enlerging the wrong area is a frequent error. Many candidates in 1935 lost marks for this reason. Then construct the scale for the map . Remember, that since you are enlarging map, your scale will be larger than a scale of the original map. Don't forget R.F. and written description of scale. Enlarge length and breadth of original map to required size, thus if enlarging 1" map to 4 inches to 1 mile, enlarge length and breadth four times. Cover area on original map with suitable guide lines - squares and diagonals, and if map is gridded, make a paper romer to suit grid (remember grid may be in metres), you can use the romer for locating points more accurately than by eye alone. Sketch in detail lightly. Don't enlarge width of roads too much.

Check and line in.

Add North point or points, (this is often forgotten), and Mag.Var.

On top of sketch write :-

Enlargement of Sq.---------- 1 in. map Sheet No.-------.

Be neat but do not waste time on elaboration.

If asked to indicate spurs, re-entrants, convex slopes, do so plainly and do not omit to do so.

Here is the way marks were allotted in a question of this sort:-

(a) Framework, scale, and North Point.	5	Marks.
(b) Road detail.	5	"
(c) Contour detail.	5	"
(d) Conventional signs (Field Sketching)	5	"

METHOD OF ENLARGING A MAP.

The general idea of enlarging by eye is to copy the detail shown inside a small figure (square, triangle, etc.) on the map into simiiliar but larger figure on the fresh paper. In theory it does not matter what sort of figure is chosen, but in practice, the figure which is easiest to draw is naturally the best. Unually enlarging is done by "squares" because many maps are already squared, and require no further subdivision except by drawing in diagonals, as in the so-called Union Jack method. If diagonals are drawn in, other lines may be added by joining up the points at which the diagonals intersect each other. By drawing all these lines the map will be divided into small triagles. However the map is divided, and in practice it will be wise to keep to the grid squares and their diagonals, the fresh paper must be divided up in the same way, and the detail sketched in at its enlarged scale by eye.

EXAMPLE.

It is required to enlarge a gridded quarter inch map to one inch to the mile. The grid squares are 10,000 yards.

The ratio is, obviously, as 1 : 4.

Thus the sides of the grid on the enlargement should be 40,000 yards, as measured on the quarter inch grid.

Prick through from the quarter inch map to the paper on which the enlargement is to be made, the corners of a 40,000 yard (quarter inch) grid, and draw lines through the holes.

Add diagonals to both original and enlargement - copy detail by eye.

HINTS ON DESCRIBING ROUTES and AREAS.

DESCRIPTION OF A ROUTE.

Study the question carefully and see exactly what is required. You may be asked:-

1. To describe a route to someone who has no map. Q.3 March 1931.
2. To compare two routes in regard to their military value. Q.3. Oct. 1935 and Q.5 March 1936.
3. To write directions to enable someone to find his way. Q.4. March 1933. Q.4 March 1936.

YOUR ANSWER MUST BE CLEAR yet CONCISE. Therefore it is best to TABULATE as far as possible.

In the case of a simple description, divide it into:-

(a) GENERAL DESCRIPTION (b) DETAILED DESCRIPTION either by mile sections or natural sections, i.e. between intersecting roads or between villages.

SUGGESTED HEADINGS for GENERAL DESCRIPTION.

1. NAME OF ROAD (if any)
2. CLASS (main, secondary, or minor, or Class A1, A2, B3 etc, vide p 78 MMR.)
3. SURFACE and WIDTH (Paved, metalled, or dirt over...ft or under ... ft)
4. FENCED or UNFENCED.
5. NATURE (Straight, winding, hilly or level. Maximum gradient ...)
6. APPROXIMATE DIRECTION. (N., E., SSE., etc. from ..... to .....
7. APPROXIMATE LENGTH. (e.g. 2¾ miles)
8. GENERAL NATURE OF COUNTRY THROUGH WHICH IT PASSES (Enclosed, open, undulating, marshy, desert, etc.

SUGGESTED ADDITIONAL HEADINGS for DETAILED DESCRIPTION.

Between ..... and .....
Apply any of the above that are applicable and any or all of the following:-

1. INTERSECTING ROADS, RAILWAYS or STREAMS.
2. CUTTINGS or EMBANKMENTS.
3. BRIDGES (give details if known)
4. TOWNS, VILLAGES or HAMLETS through which route passes.
5. POST, TELEGRAPH & TELEPHONE facilities along route.
6. GARAGES, FORGES, INNS etc.
7. WOODS, COMMONS, PARKS.

In each case give the distance from starting point.

EXAMPLE.1 Describe the route between the road fork at LYDDEN 706639, and EYTHORNE crossroads 723671.

GENERAL DESCRIPTION.

Suggested Answer

Unamed secondary road with over 14ft metalling. Partly fenced & partly unfenced. Mostly straight with gentle down grade, except for first portion which is uphill. Leads N.E. from LYDDEN to EYTHORNE, approximate distance 2¾ miles. Road runs along crest of a spur with a long re-entrant on either side. Country is chiefly open, with park-land on the right hand side for the last mile and a half.

DETAILED DESCRIPTION.

1. Between LYDDEN and COLDRED STREET.
On leaving fork roads the route crosses double track line of SOUTHERN Ry. by a bridge over a cutting, then ascends a hill about ¼ mile long (maximum gradient 1/12). After 600 yards it curves slightly to the left at 5/8 miles it enters the hamlet of COLDRED STREET, turns sharply to the left for 200 yards, then sharply to the right.

A secondary road from the N.W. joins it at this point. Total distance ¾ miles.
For the first 300 yards the road is fenced on both sides. The right hand side is then unfenced to within about 150 yards of COLDRED STREET.

2.Between COLDRED STREET 711648 and COLDRED crossroads 715656.
At ¼ mile from road junction route crosses a single track mineral line by a bridge over a cutting, at 3/8 mile it passes through COLDRED and is crossed by a secondary road leading to HAZLING DANE. Road is fenced on the right and mostly unfenced on the left. It is straight and slightly down hill. Total distance 1 3/8 miles.

3. Between COLDRED 7165 and EYTHORNE crossroads 723761.
At ½ mile from crossroads, route is joined from the right by a private road from WALDERSHARE PARK 719663. The latter extends along the right hand side of the road for the whole distance. A secondary road from GOLGOTHA joins from the left. At these crossroads there are trees on either side of the road for several hundred yards. The road is straight gently down hill, and unfenced on the left side to within ½ mile of EYTHORNE. Total distance 2¾ miles. EYTHORNE village has a post office with telegraph.

If this question asked for the military information that would likely be of use to a military commander you would:-

Give the GENERAL DESCRIPTION as above. Also detail re:-

1. COVER FROM LAND or AIR OBSERVATION or AIR ATTACK.
2. DEFILES or points at which a march might be delayed.
   (such as bridges, narrow roads, cuttings, mountain passes)
3. BILLETING AREAS (Towns or large villages, large schools)
4. BIVOUAC AREAS (Commons, heaths or suitable fields)
5. WATERING, POST, TELEGRAPH & TELEPHONE FACILITIES.
6. PROXIMITY to RAILWAYS.
7. PLACES SUITABLE as O.P's such as hills, churches,etc.
8. GRADIENTS (Whther transport or guns could negotiate them).
9. HOSPITALS if any.

Example 2. With reference to the route in Example 1, give all the Military information that might be of use to a commander.

Suggested Answer.

1. GENERAL DETAILS OF ROAD. Secondary road, over 14ft of metalling, partly fenced, mostly straight with gentle down grade, leads N.E. from LYDDEN to EYTHORNE, along the crest of a spur with a long re-entrant on either side, through open country or parkland, for a total distance of 2¾ miles.
2. COVER. (a) From ground observation. First ¼ mile is uphill and from the bottom of a deep hollow. Road is concealed from all directions except from points very close to it. It then crosses a narrow plateau for about ½ mile and could be seen from the high ground to the West. For the remaining distance it is down hill and exposed to observation from the N.E. but concealed from other directions.
   (b) From air observation and attack. The road is straight for most of its length and therefore lends itself to attack by low flying planes. There are no woods along the road, but a belt of trees at COLDRED 715656 and at the crossroads WALDERSHARE PARK 719663 which might afford some cover. The road being largely unfenced would permit easy dispersal of a column.
3. DEFILES. The only points at which a march might be delayed are the bridges across the railway cuttings at LYDDEN fork roads 706639 and between COLDRED STREET and COLDRED at 712653.
4. BILLETING AREAS. The vicinity of EYTHORNE would be suitable for billets for a battalion.
5. BIVOUAC AREAS. WALDERSHARE PARK would make an excellent bivouac area.

6. WATER, POST, TELEGRAPH etc. Facilities for watering not known. No streams or ponds shown on map. EYTHORNE has post and telegraph. LYDDEN has post office.
7. RAILWAYS. Main line of SOUTHERN Ry runs through LYDDEN. Double track, several spur lines to colliery 7163. Enters tunnel near fork roads bridge 706641.
Mineral line to colliery 720649 crosses road between COLDRED STREET and COLDRED, could be used to bring up ammunition or guns. Joins EAST KENT Lt. Ry. at EYTHORNE.
8. O.P's. Could be established at any point along crest line of plateau (400 ft above MSL) overlooking ground to N.E. or overlooking valley to S.E. and S.W.
9. GRADIENTS. The only important hill is the one ascending from LYDDEN maximum gradient 1/12 and therefore presents no difficulty to guns or transport.
10. HOSPITALS. Churches at LYDDEN and EYTHORNE could be used as hospitals or dressing stations.

DESCRIPTION OF AN AREA.

This may be of two kinds:
a. Description of ground that can be seen from a certain spot.
b. Description of an area without any special view point.

Imaginary Example. Describe all that can be seen 15 degs. on either side of a line from the A in ASH to cross roads at 684235, for a radius of one mile.

1st Locate the A in ASH and the cross roads and join them with a line. Then with a compass set at distance for 1 mile scale of map, strike an arc extending 15° right and left of the line. Join the ends of the arc to A by lines. This gives you the area you are to describe.

2nd Study the spacing of the contours, if the slope is concave all the way and no woods etc. intervene, you will see almost everything in the area. If slope is convex, there will be a certain amount of ground that you will not see. To find this out you will have to draw sections through the doubtful points. Shade in the area that cannot be seen. Be sure a thing can be seen before you describe it. Don't forget to add 5 feet to the height of A to allow for the height of your eye. Allow about 20 ft. for buildings stating that you are assuming this to be the height.

Tabulate your answer thus:-

1. Ground slopes in gentle convex slope for ½ mile and then is level to cross roads 684235.
2. Area from 250 feet. contour to point half way between 200 and 150 ft, contours cannot be seen.
3. Mixed wood, 682235, obscures E. to W. secondary road on left in line. Cross roads can be seen, except in area noted in para. 2. A main road with over 14 ft. metalled, for fast traffic, runs N. and S. and is visible.
4. Village of ASH can be seen. Conspicuous points are, Church with tower, 684283, Wind pump, 682232, Manor ho. 681230. Village has Post Office, but exact location is not indicated on map.

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HINTS ON TIME AND ROUTE PROBLEMS.

This is one of the questions most frequently set. It has several variations and is sometimes combined with, marching by compass bearings, or description of route taken.

Usually it is required to find the shortest route, and the time expected to reach certain points, either by marching, motor cycle, or mechanical transport.

You may also be expected to take into consideration the gradient, e.g. where is steepest gradient? or, if M.T. cannot negotiate gradients steeper than 1/5 where is route suitable?

But the actual questions relative to time, condense down to two types:--

a. How long will it take to reach a certain point?
b. Where will you be at a certain time?

To do these it is advisable to construct a time scale, although they can be solved by simple proportion.

Usually the question states the rate of marching.
Thus:--Infantry marching at 3 miles per hour.
M. T. moving at average speed of 15 m.p.h. etc.

A column of troops marching under ordinary conditions, halts for 10 minutes before each clock hour, thus:--at 3 m.p.h. they do 1 mile in 20 minutes, and as they actually march for 50 minutes only, they do 2½ miles. Therefore if they started at 0900 hrs, at 1000 hrs. they would have marched 2½ miles and at 1100 hrs. 5 miles and so on. So the question sometimes states the time as 3 M.P.H. including halts; in others it says they march at the rate of 3 m.p.h. for 50 minutes and halt for 10 minutes, which gives the same result, i.e. 2½ miles per hour, in other words, if halts are included the rate is 3 but the progress is 2½

TIME SCALE.

If the map has a scale of miles, simply make two primaries, each to include the number of miles equal to one hour at the rate called for:--

e.g. Map 1 inch to 1 mile. Rate 3 m.p.h. including halts.
3 m.p.h. @1" per mile = 3 inches. Two primaries 3 x 2 = 6 in.
Scale 6" long. Left hand primary divided into 12 secondaries each of 5 minutes, numbered in 10's from 0 to 60 towards the left of scale, the extremeleft being marked MINUTES and the extreme right 1 HOUR.

Above the scale put:-
TIME SCALE for 3 miles per hour. SCALE 1" to 1 mile. R.F. 1/63360.
NOTE: If the road has the miles marked by figures i.e. 6. 7. 8. 9. etc., a scale is hardly necessary unless asked for.

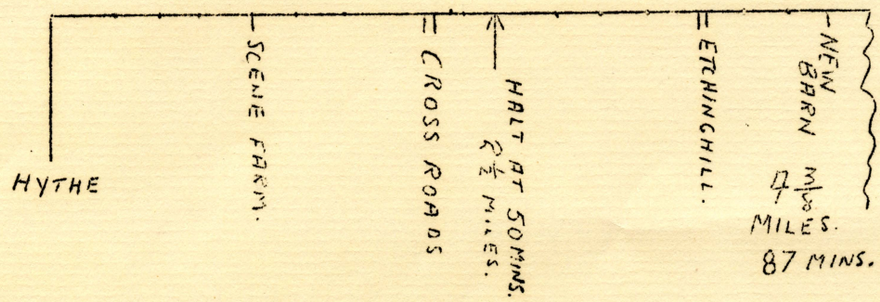
Now to answer questions of type (a).

Example: How long would it take troops marching at an average rate of 3 miles an hour, (including halts) to march from HYTHE STA. (6503) to NEWBARN (5958) via the cross roads in sq. 6155. If they start at 0900 hrs. when will they arrive?

Take a piece of paper with one perfectly straight edge, mark it with a pencil point to represent starting point HYTHE, then lay it along middle of road. Stick a pin in it at the first point that road bends, then revolve paper around pin until road bends again, remove pin and stick it in at this point, revolve paper again and so on until you have measured total distance. It is a good plan to mark any road intersections (or prominent objects along road) on your strip of paper as this facilitates checking.

If you now lay the paper strip along mile scale of map, you can get the distance travelled, and by laying it on time scale, the amount of time required to cover that distance.

Your strip of paper when finished will look something like this:-



Actual marching time is 87 minutes, to this must be added 10 minutes, for the halt at first hour, so time of arrival will be 87 plus 10, 97 or 1037 hrs. In these questions where you get odd minutes like 37 always say "between 1035 and 1040 hrs."

Note: The paper you use should be marked with your index number and attached to your Exam Book.

Now a question of type (b).

Taking the former example (i) Where will the usual hourly halt take Place? ii. Where will column be at 1035 hrs?

i. Take your paper strip, lay it against time scale, make a mark on it opposite 50 minutes, i.e. time to first halt. Now measure distance along road as previously diescribed, until you reach the 50 minute mark, on strip. The point on map opposite this mark is place to halt.
In this example it is "The bend in the road at 610599. Distance $2\frac{1}{2}$ miles".

ii. At 1025 hrs. column will actually have marched 75 min. i.e. 1025 - 10 = 1015, so mark your paper against scale for 75 mins. and proceed as in i.

In this example "Column will be at ETCHINGHILL cross-roads, 606576, at 1025 hrs. Distance 3 5/8 miles."

If you do not use a time scale, measure distance to required point, with pin and paper as above. Then work out how far you will travel in 1 minute and find answer by simple proportion.

3 miles per hour = 1760 yds in 20 mins. or 88 yds in 1 min. so in type (a) time for 4 miles 3 furlongs is :

$$\frac{(1760 \times 4) \text{ plus } (3 \times 220)}{88}$$

1760 × 4 = 7040 ; 220 × 3 = 660 ; 7040 + 660 = 7700

88)7700(87 minutes actual marching time.
704
660
616

In type (b) in 75 mins. troops will travel:-

$\frac{75 \times 88}{1760} = 3\frac{33}{44}$ miles, approx. 3 5/8.

Finally it should be noted that if march commenced at 0830 hrs. instead of 0900 hrs. the 10 minutes halt is still made at 0850 and 1950. Thus you have actual marching time of 87 minutes.

But: 0830 to 0850 equals 20 mins.
0900 to 0950 " 50 "
1000 to 1017 " 17 "
87 minutes.

Time of arrival would be 1017, i.e. between 1015 & 1020.

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HINTS ON QUESTIONS INVOLVING BEARINGS.

A VERY SHARP PENCIL AND A GOOD PROTRACTOR ARE ESSENTIAL WHEN DOING QUESTIONS OF THIS NATURE.

A bearing is the angle, measured clockwise, which a line to an object makes with either the TRUE, MAGNETIC or GRID NORTH line.

On a map TRUE north is indicated by:-

a. A line having an ornamental arrow head, or
b. The meridian lines of longitude, or,
c. A statement that the right hand edge of sheet is true north or that Grid North in the centre of sheet is so many degrees E. or W. of True North.

MAGNETIC North is indicated by a line having a plain arrow head right (East) or left (West) of the True of of the Grid North line.

The angle between these lines in the MAGNETIC VARIATION. It may be East or Wes, according to the inclination of the Mag. North line.

It differs according to locality, and on sea charts and small scale maps, may vary in several places on the same chart or map. (KINGSTON Ont. is an instance of this). It also increases or decreases annually, and a note regarding this is usually found on the map. THIS MUST BE TAKEN INTO CONSIDERATION WHEN ANSWERING QUESTIONS.

NEVER add or deduct the magnetic variation to a magnetic bearing. This has been done by some candidates in the past.

OR

GRID NORTH. Is indicated on British maps, by a plain line, and on Canadian maps sometimes by a plain line and sometimes by a line with a small square on top of it. All the vertical lines of a grid are parallel to grid north. It agrees with true north only at the point of origin of the grid.

OR

When using a gridded map all bearings to objects must be converted to grid bearings, unless specifically directed otherwise.

In examinations for 1st Class Certificates there is usually a grid north and magnetic north line printed in violet as well as a magnetic and true north line printed in black. The violet one is the one to be used in the examination.

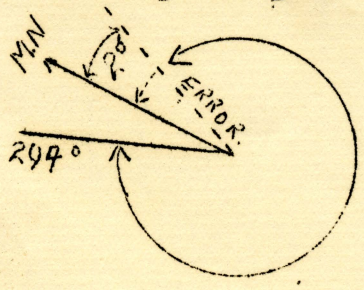
Bearings can be measured on the ground by a prismatic compass or other angle measuring instrument, and on the map by a protractor.

Remember that a compass bearing is always magnetic i.e. from magnetic north.

A compass may have an error of several degrees EAST or WEST which must be allowed for when reading bearings.

Thus:- Compass has an error of 2 degs. E.
Using this compass a bearing reads 294 degs. what is actual magnetic bearing?

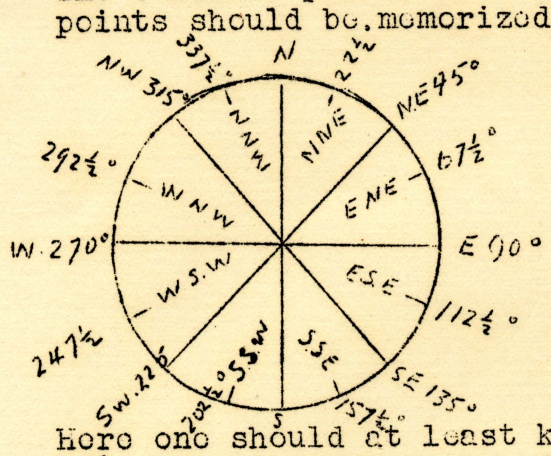
On the left hand page of your M.B. 39 it is always advisable to make a rough diagram in questions of this nature. e.g.



Error is East so we ADD the 2°.
294° plus 2° = 296°

If the error is WEST, it would be deducted from the compass reading, i.e. 294° - 2° = 292°

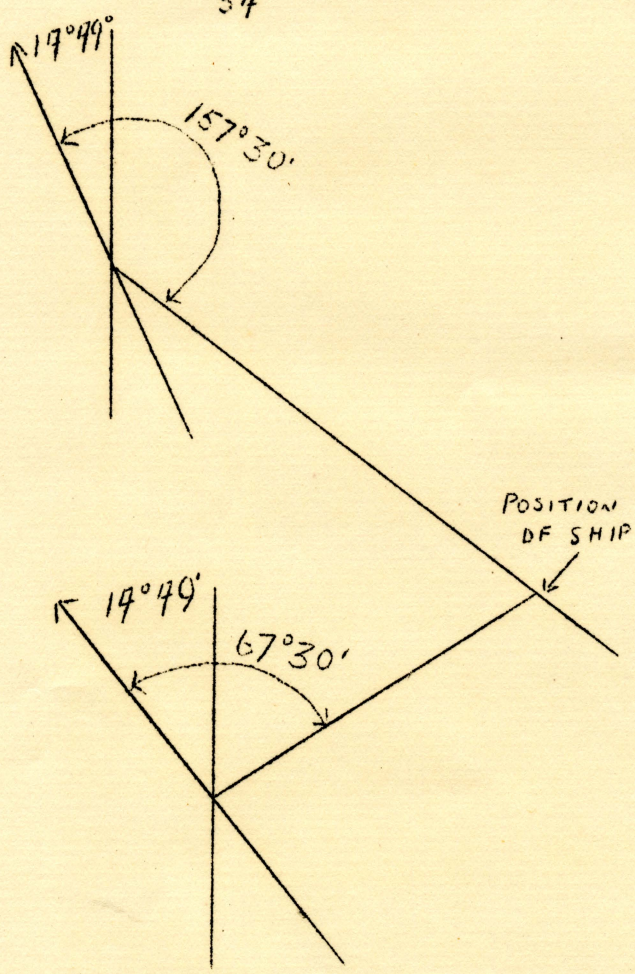
The cardinal points of a compass and the more important intermediate points should be memorized, also the number of degrees to each.



There are several reasons why this is necessary.

1. Questions have been set like this.
Give map reference to a ship reported to be SSE of the WARREN HALT. 687559, and ENE of Wind pump, 678547. Use grid north in making your calculations.

Here one should at least know that S is 180 degs. and that there are 22½ degs. in each intermediate point, so SSE is 180 degs. - 22½ degs. = 157½ degs. and ENE is 90 degs. minus 22½ degs. = 67½ degs. So compass bearings to ship are:- 157 ½ degs. and 67 ½ degs. The map gives the variation, from grid north, as 13 degs. 54 mins. W. in 1929 with annual increase of 11 mins., so in 1934 it would be 13 degrees 54 mins. plus 55 mins. equals 14 degs. 49 minutes.



Mag. Bearing	157°	30'
Variation	14	49
	142	41

Mag. Bearing	67°	30'
Variation	14	49
	42	41

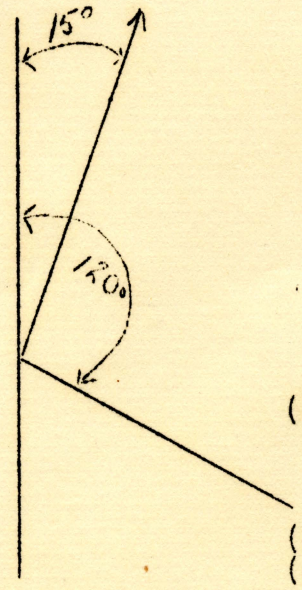
To get ship's position, draw a line on your map parallel to grid north, through WARREN HALT and through the wind pump, then with your protractor set off 142° 30' and 42°30' (which is the nearest you can estimate), the place where they intersect is the approx. position of ship. Then with your romer get a map reference.

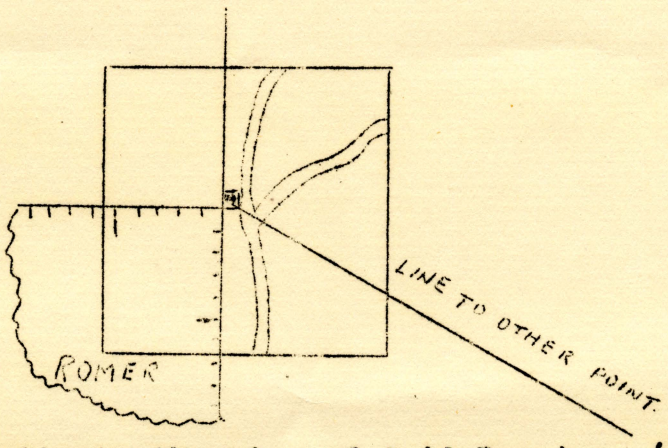
2. A knowledge of the points and their degrees enables one to picture the approximate position of an object before actually working it out, and is a useful check when using the protractor so that you will not use the wrong set of figures.

TO MEASURE GRID BEARINGS AND CONVERT TO COMPASS.

The previous example showed how to convert compass bearings to grid. To convert grid bearings to compass proceed as follows:-

a. Join the points by a thin pencil line.
b. Draw a grid N. line through the point from which bearing is taken. (Note) A simple way to ensure line is parallel is to use your romer. First get the map reference by your romer, then at the top and bottom of the square set off the Easting, draw a line through these points and you have your grid N. line.





(c) Estimate the size of Grid Bearing, (the above is approx. E.S.E. or 112½ degs.) so that you do not read wrong figures on protractor. It is actually 120 degs.
(d) With your protractor measure angle accurately.
(e) Draw a rough diagram and convert Grid to Compass bearing.

Suppose Mag. Variation was 15 degs. E. then compass bearing would be 120 degs. - 15 degs. = 105 degs.

SETTING YOUR MAP AND FINDING YOUR POSITION.

A map is said to be "Set" (a) When true north on the map agrees with North Point, or (b) when a line joining your position on the map and a prominent object on the map, points to the prominent object on the ground.

In the case of (A) find approx., N. by the sun or stars and turn map until north line points towards north, check by Method (B).
If you have a compass:--

1. Lay the hair line exactly covering Mag. North line on map.
2. Unclamp compass card and bring it to rest by alternately pressing and releasing check spring, (prismatic Compass) not necessary with liquid Compass.
3. Turn map around until hair line, Mag. north line on map and compass needle are all in line.

Always answer questions of this nature in this way, i.e. in the order it would actually be done. Don't write an essay about it.

TO FIND YOUR POSITION ON THE MAP.

There are several ways to do this:

1. Roughly, by relation to major natural features such as woods, hills,rivers, villages, roads, etc., then more exactly by such minor features as corners of woods, houses, bends in roads, intersections of fences, etc.

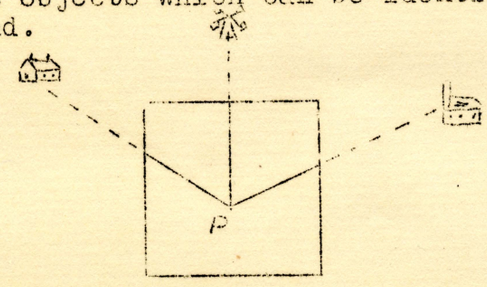
2. By resection, using a plane table and trough compass. The map is pinned to the table and set by the compass as above. Three lines or rays are then drawn back from three points on the map, which have be aligned with their corresponding features on the ground. The rays should intersect at a point which is the position required. If they do not intersect they will form a triangle, known as the triangle of error. This method is not one that the candidate for 1st Class Cert. need devote much time to.

3. By resection, using the prismatic compass, and one or more fixed points to which bearings are taken:
   (a) One ray method. Here your position must be near some well defined feature, such as a road, river, fence or wood. (See next page.)

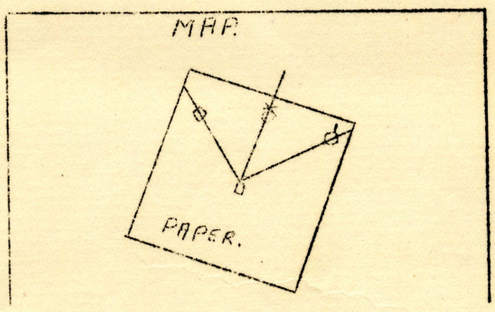
(b) By two or more bearings to prominent objects.
1. Identify on map two or preferably three prominent features on the ground.
2. Take compass bearings to them.
3. Convert to grid bearings.
4. Draw grid north lines through them.
5. With protractor set off back bearings and draw back rays.
6. Point of intersection of rays will be position.

4. Tracing paper method. This is the quickest and easiest. But to do it, a plane table, a board or other level surface is necessary, also a ruler and some thin paper.

1. Mark a point P on the thin paper.
2. Without moving paper draw rays through P to three prominent objects which can be identified on map and ground.



3. Lay this paper over your map and manipulate it, until the rays cover the three features on the map.
4. Stick a pin through P. the pin hole in map will be your position.



One Ray Method. Proceed as follows:-

1. Measure with your compass bearing to prominent object such as church, windmill etc.
2. Identify this object on map and draw grid north line through it.
3. Convert compass bearing to grid bearing.
4. With protractor set off back bearing from the object on the map, i.e. If grid bearing is less than 180 degs. you add 180 to it, and if more than 180 degs. you deduct 180 from it.

	Compass bearing	Mag. Var.	Grid bearing.	Back bearing
EXAMPLE	60 degs.	20° W.	40°	40° + 180 = 220°
	320 degs.	20° W.	300°	300° - 180 = 120°

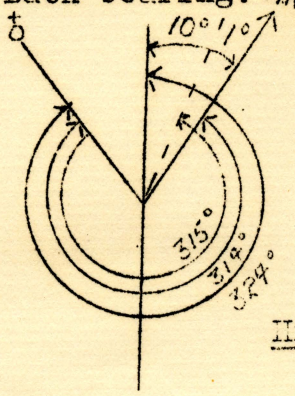
5. Draw a line from the object on the map through the required back bearing to the river, road or other feature by which you are standing.

6. Point of intersection is your position.

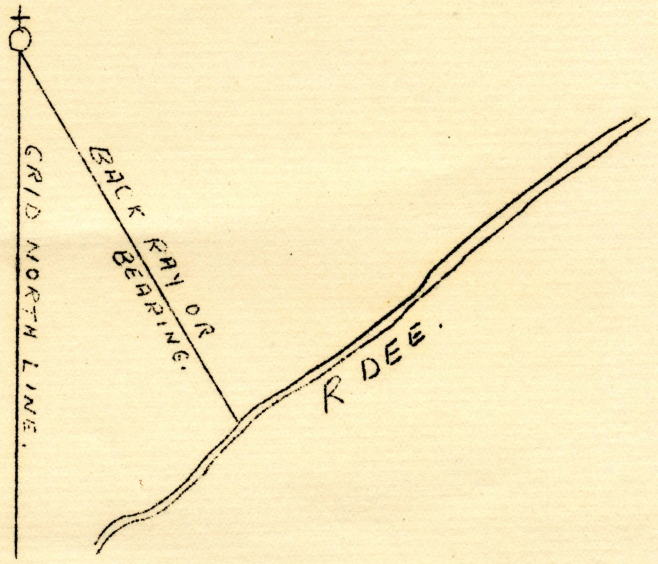
EXAMPLE. You are on the banks of the river DEE and take a compass bearing of 315 degs. to church at 456732. If mag. var.

is 10 degs. E. and your compass has an error of 1 deg. W. where is your position?

Compass Bearing	315°
Error	1°W.
Real bearing	314
Var. from grid N.	10°E.
Grid bearing.	324°
	180
Back bearing. M.N.	144



ROUGH DIAGRAM TO CHECK CALCULATION.

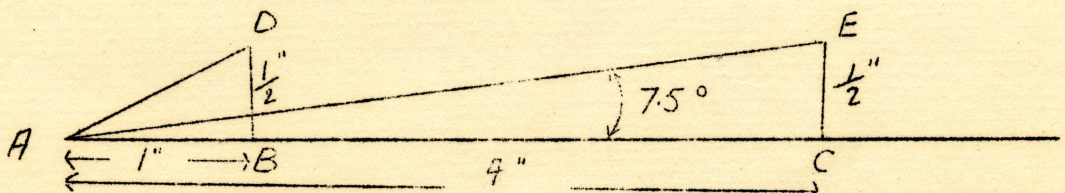


Hints on solving questions re gradient and visibility.

GRADIENT This is the degree of steepness of a slope.

It is usually expressed as a fraction, with 1 as the numerator; thus 1/30 represents a rise or fall of 1 foot in 30 feet.

On a map Height (or the VERTICAL INTERVAL V.I.) is got from contours, spot heights, or trig. points.
While Distance is the Plan (or HORIZONTAL EQUIVALENT H.E.) of the slopes. A GOOD PAIR OF DIVIDERS IS REALLY NECESSARY to get distance between contours.



In the above fig. it will be seen that if the height remains the same, the greater the distance the smaller the gradiant.

(a) $\frac{V.I.}{H.E.} = \frac{D\ B}{A\ B} = \frac{\frac{1}{2}"}{1"}$ or $\frac{.5}{1} = \frac{5}{10}$ or $\frac{1}{2}$

(b) $\frac{V.I.}{H.E.} = \frac{E.C}{A\ C} = \frac{\frac{1}{2}"}{4"}$ or $\frac{.5}{4} = \frac{5}{40}$ or $\frac{1}{8}$

IT MUST BE BORNE IN MIND THAT BOTH TERMS OF THE FRACTION MUST BE THE SAME UNIT OF MEASURE.

Thus V.I. - 50 feet. H.E. - 125 yards. BOTH must be in terms of FEET i.e. $\frac{50}{125x3} = \frac{50}{375} = \frac{10}{75} = \frac{1}{7.5}$

This is one of the most frequent causes of error.

Slopes may also be expressed in degrees.
A rough rule for slopes up to 20 degrees is to divide the H.E. into 60 thus:- 1/8 in degrees would equal:-

$$\frac{1 \times 60}{8} = 7.5 \text{ degrees.}$$

or, if the number of degrees is given, we can find the gradient by dividing the degrees by 60 in fraction form; thus $\frac{7.5}{60} = \frac{1}{8}$

To be more exact we should use 57.3 instead of 60, or better still the Tangent of the angle, but 60 is good enough for any questions likely to be set.

Conventional sign for gradient steeper than 1/7

These questions generally are given in connection with movement of transport. It is generally accepted that unless specially stated, transport cannot negotiate gradients steeper than 1/7 without assistance.

N.B. The point to look to in examining a route for transport is, where is the least space between contours, work out the gradient for this, and if it is less steep than 1/7 the route is suitable as far as gradient is concerned.

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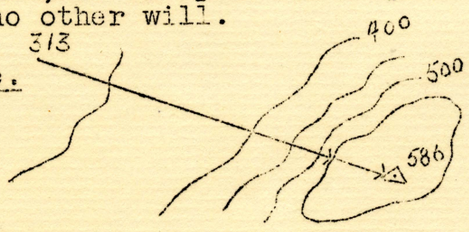
VISIBILITY PROBLEMS.

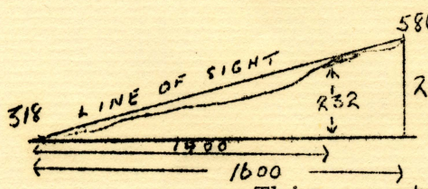
There are several methods of deciding from a map, whether it is likely that one point or the ground may be seem from another point.
First join the two points on your map by a pencil line. Then study the heights of all contours which cut this line. If no point on the line is as high as either point, and no trees or buildings interfere, the two points are mutually visible.
If the slope between two points is concave the points will be visible. If it is definitely convex they will not.
ALWAYS ALLOW 5 feet for the height of the eye above the point on which you are standing.
If a study of the contours does not make the questionoof mutual visibility obvicus, then you must proceed by one of the following methods:

1. Proportion mehtod. This is used when it is clearly seen that, if one particular point does not obstruct the view, no other will.

Example. Not to scale.



Here we have an obviously concave slope, but the 550 ft. crest line may obscure the Trig point which is 36 ft. higher. It is 1400 yds. to the crest line and 1600 yds. to the trig point from point 313.
Allowing 5 ft. for height of observers eye, the difference between the two points is 586 - 318 (i.e. 313 plus 5) = 268 ft. and the difference between point 313 and crest line will be 550 - 318 = 232.
Therefore the height of the line of sight at the crest line will be:

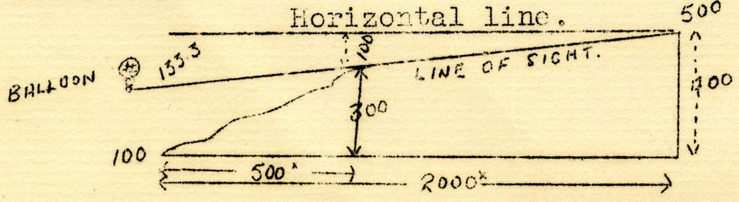


$$1600 ; 1400 :: 268 : x$$
$$\frac{7 \times 67}{2} = \frac{469}{2} = 234.5$$

And since this is greater than 232, trig point will be just visible.

This question may be framed somewhat differently, but the same procedure is followed, thus:-

Example. An observer at a point 100 ft. above M.S.L. cannot see an enemy battery 2000 yds. distant and 500ft. above M.S.L. because of a convex slope, the crest of which is 400 ft. above M.S.L. and 500 yds distant, How high should an observation balloon have to ascend to permit observation?



Here we must approach from the other end, i.e. find out how much the line of sight, which just clears the crest line at 1500 yds, will drop in 200 yds, if it drops 100 ft at 1500 yds. it will naturally drop more at 2000, so:-

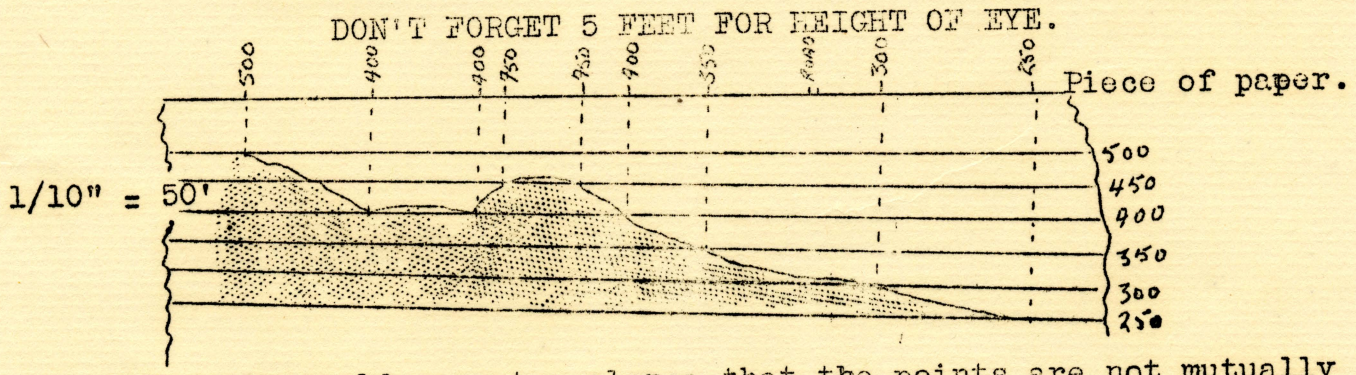
$$1500 : 2000 :: 100 : x$$

$$\frac{4 \times 100}{3} = \frac{400}{3} = 133.3$$

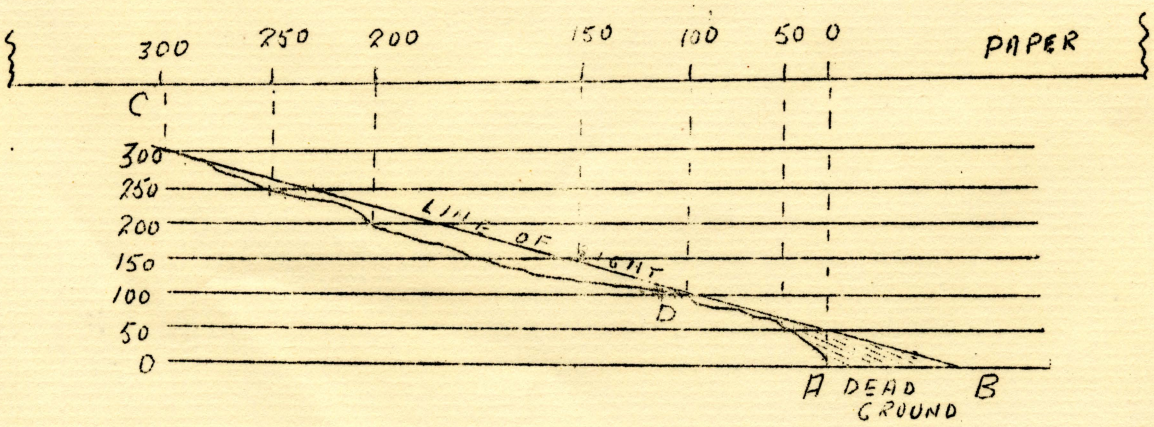
and 400 - 133.3 = 266.7 ft., so balloon would have to ascent 266.7 feet. These questions are tricky and need to be studied very carefully. Usually the best way to solve visibility questions is to draw a cross section of the country, such a cross section is also useful to determine dead ground, i.e. ground not under observation, and to visualize the ups and downs of the country.

To make a cross section.

1. Join the two points on the map by a pencil line.
2. Take a piece of paper with perfectly straight edge, and lay the straight edge along the line.
3. With a very sharp pencil mark on this straight edge (a) the starting and finishing point (b) where any contour cuts the line (number the contours 200, 300, 200, etc. as the case may be), (c) the position of any road, river or obstacle if this is called for.
4. Now in your Exam Book draw a series of parallel line 1/10 inches apart (for visibility problems only, they may be ½" apart). Number the lines according to the heights required.
5. With your straight edge placed along the top line drop perpendiculars at each contour point, mark off on the proper parallel line the point where perpendicular crosses it and join up by free hand all the points so obtained.
6. In practical work, squared paper is useful but this is not allowed in examinations.
7. Draw a line of sight connecting the starting and finishing point. If this line clears all contour points, the points are mutually visible.

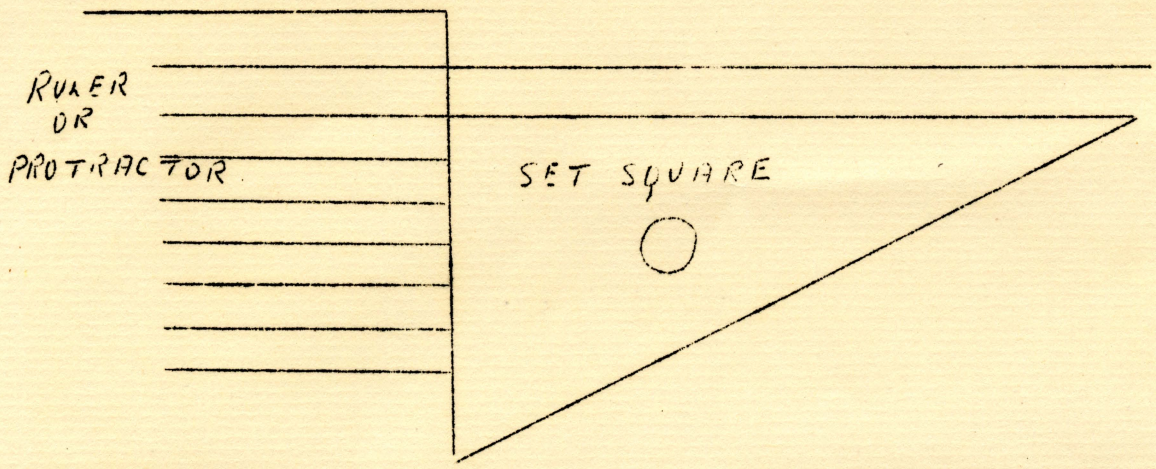


Here we could see at a glance that the points are not mutually visible and the road could not be seen.



Here an observer at C could not see A but could see B, and all ground between D and B would be dead to him.

METHOD OF DRAWING PARALLEL LINES.



Map Reference. Modified British System.

In order to locate a point on a map quickly, or to indicate it to someone, a system of reference is necessary. That used in the British Army and Air Force, is called the Modified British System.

It consists of a network of squares or GRID which is continuous over a greater number of sheets of the same series of maps.

At an arbitrary point beyond the area of operations, i.e. W. and S., of any portion in which an army may operate, a line parallel to true north, and one parallel to a parallel of latitude, are drawn; these formsthe axes of the Grid and the point at which they cross is called the point of origin.

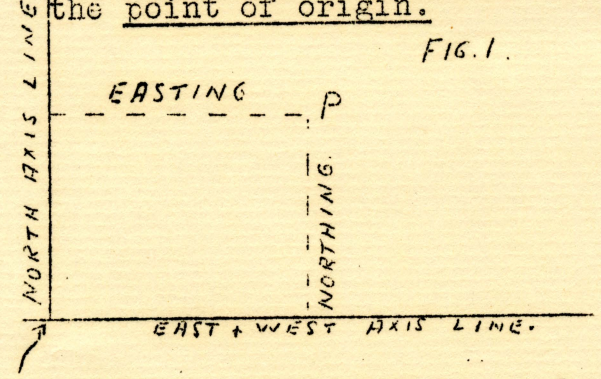


FIG. 1.

Any point (P) will then be referred to as so many miles, yards or metres East and North of the point of origin. These distances are called Eastings & Northings and the Easting is always read first. The actual figures are called full co-ordinates. For example, 1,500,000 yards East and 750,000 yards North.

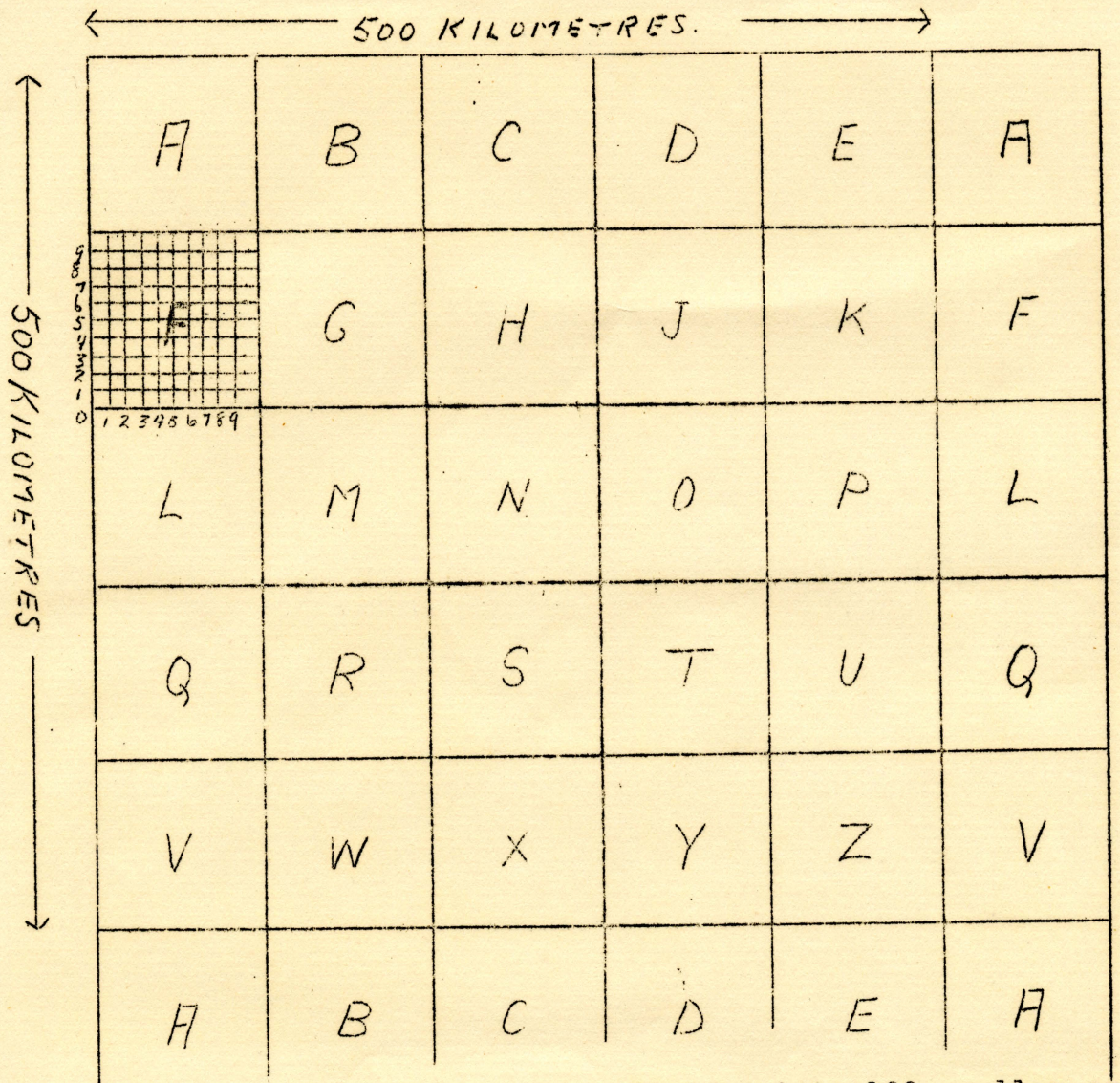
But for reference purposes only, a quicker method must be used; this is done by constructing a network of squares whose sides are parallel to the axes of the Grid.

First the whole area is covered with 25 large squares having 500 kilometre sides (i.e. 500,000 metres. If yards were used it would be 500,000 yds.) NOTE: 500 K.M. equals about 300 miles. These large squares are each lettered from A to Z ommitting I. (These letters would only be used in Air Force operations).

Then the 500,000 K.M. Squares are subdivided into twenty-five 100 K.M. squares, (100,00 metres, or 62 miles), each of these squares is also lettered as above, but on a map of 1 in. to 1 mile or larger scale the letter would only appear in a marginal note, as it would rarely, if ever, be necessary to use it. On very small scale maps, say 1/500,000, it would be used whenever confusion due to two similar references might occur.

SEE FIG. 2 OVER LEAF.

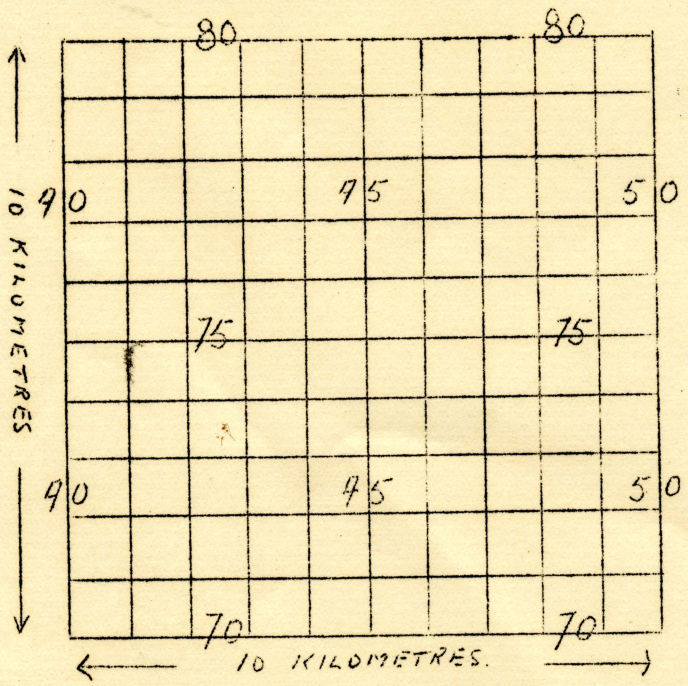
FIG. 2.



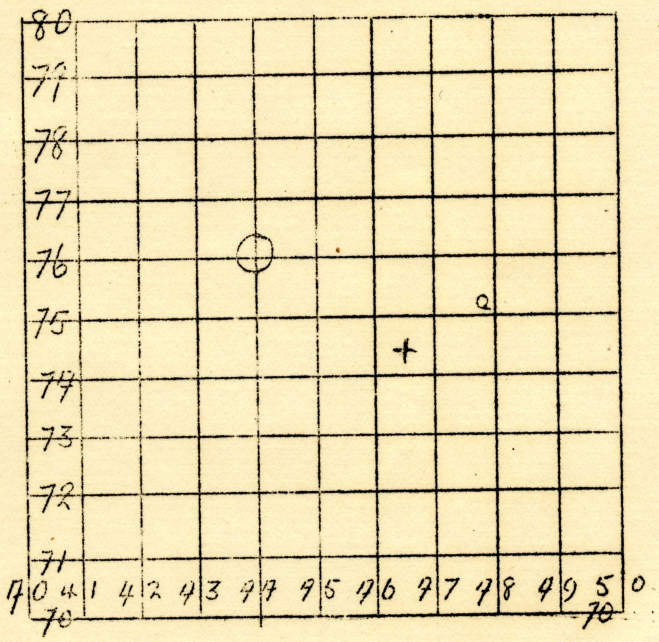
Each of the lettered squares is sub-divided into 100 smaller squares with sides of 10 K.M. (10,000 metres), see "F" above, and these are further sub-divided into squares of 1 K.M. (1000 metres). In using the 100 K.M. Square the reference of the dot in Fig.2 would be F.37 i.e.30 K.M. East and 70 K.M. North. On the latest maps <u>each grid line</u> is numbered from West to East, and South to North, thus :- 00, 05, 32, 79 etc. at the West and South of each 10 K.M. sq. and the grid lines of the 10 K.M. sq. are thickened.In early editions only, every 5th line was numbered

FIG. 3 (See figs. 3 and 4.) FIG. 4.

FORMER SYSTEM.



PRESENT SYSTEM.



These are the ones that candidates are most likely to use. The map for 1st Class Cert. is only a portion of a sheet, and is usually arranged so that several incomplete 10 k.m. squares are shown. A whole sheet would have in the S.W. corner the full co-ordinate of that corner, thus:-

170,000 M. NORTH.
1,540,000 EAST.

Meaning that the S.W. corner of the map is 1,540,000 metres East, and the 170,00 metres North of the point of origin.
But for quick map reference to this S.W. square it would be given as 4070.

ONE OF THE MOST COMMON ERRORS IS TO READ THE NORTHING FIRST, thus 7040, so get into the habit of starting at the left and working across to the right, then at the bottom and work up.

Example. The map reference to the point O in Fig. 4 is 4476 and this would also be used in describing that particular square without reference to any special feature in it, but if we wished to indicate the church without tower (+) we should give 465745, In other words the small square would be divided into 10 smaller squares either eye or with a romer, see Fig. 5. Similarly the tree would be 478751.

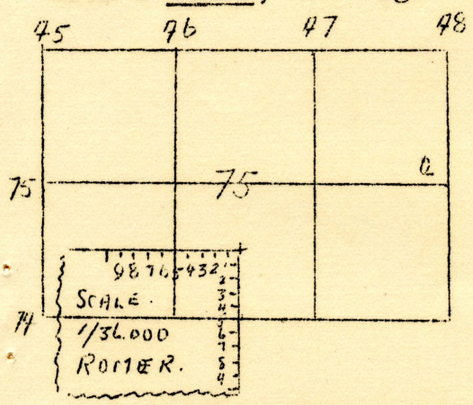


FIG. 5

If you have no romer supplied you must make one to suit the scale of your map, by using the corner of a sheet of paper and marking it from the proper scale at the bottom of your sheet.

BE SURE TO FIRST FIND OUT IF SQUARES ARE IN METRES OR IN YARDS or your references will all be incorrect.

MOST BRITISH ARMY maps use metres, most CANADIAN ARMY maps use yards. (a metre is 39-37 inches or 1.1 yards.) The reason the British use metres is because they may have to be allies with continental armies, and maps have to be interchangeable.

On a large scale map it is possible by eye to sub-divide the spaces on your romer so that you can give eight figure references, thus; 47857515, but six figures are all that are called for with the 1" map.

NOTE: a. You cannot have an odd number of figures in the reference such as 47751, it must be 2, 4, 6 or 8 figures.
b. No commas, spaces or dashes amy be used such as 478 751 or 478,751 or 478.751.

These are all errors which are frequently made. When you indicate a place on a map, always give the grid reference number even if it has a well-known name.

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APPENDIX

SCALES.

DEFINITION. SCALE. Word used to denote ratio $\frac{\text{Distance on Map}}{\text{Distance on Ground}}$, also to denote suitably divided line at bottom of map or sketch.

USE SERVICE PROTRACTOR. The service Protractor gives a number of scales from which others can be obtained in proportion. Always use this where possible unless question states otherwise.

POINTS TO BE OBSERVED IN CONSTRUCTION OF SCALES.

SCALE should ALWAYS be indicated in THREE WAYS:-

1. By REPRESENTATIVE FRACTION or R.F., i.e. the ratio expressed as a fraction, with Distance on Map (in any unit of measure) reduced to common numerator of 1, and the denominator in similar units of measure representing the Distance on ground.

Thus a scale of 1 inch to 1 mile would have an R.F. of 1/63360, there being 63360 inches in one mile. R.F can be written $\frac{1}{63360}$, also 1:63360. Scale 4 inches to 1 mile would have R.F. 4/63360 which reduced will equal 1/15840

Advantage: By means of R.F; true relations between maps which use different units of measure can at once be established.

2. By DESCRIPTION IN WORDS, i.e. 1 inch to 1 mile, 1 centimetre to 100,000 c.m. etc.

Large Scale maps, i.e., where the denominator of R.F. is less than 63360, usually express it as inches to 1 mile, e.g., 2 inches to 1 mile (R.F. 1/31680), while small scale maps, where denominator is greater than 63360 usually gives miles to 1 inch. Thus R.F. 1/1,000,000 (1/M) would be 15.78 miles to 1 inch.

This R.F. 1/M should be memorized as useful in checking calculations, e.g., what is the number of miles to 1 inch for R.F. 1/100,000? 1/M equals 15.78 miles, therefore 1/100,000 equals 1.578 miles and 1/10,000 equals .1578 miles to inch, etc.

By calculation, inches to miles equals $\frac{63360}{\text{Denominator}}$ of R.F. Thus 1/20,000 equals 63360/20,000 or 3.17 inches to 1 mile, while miles to 1 inch equals Denominator divided by 63360. Thus 20,000/63360 or .3156 miles to 1 inch.

Advantage: The description enables the eye to visualize on the map the number of miles, etc., represented by the unit of measure used for scale.

3. GRAPHICALLY, i.e. by a suitably divided line indicating certain units of measure (yards, metres, versts, or miles, etc.) usually drawn or printed at bottom of sketch or map.

Such scales are either fully-divided or open-divided. Maps usually show open-divided scales having large divisions known as PRIMARIES (showing 1,000 yards, 1 mile 1,000 metres, etc.) The left hand primary is sub-divided into smaller divisions (showing 100 yards, 1/8 mile, 10 metres, etc.) known as SECONDARIES.

Fully-divided scales are divided into small divisions throughout their length and the zero is always at extreme left.

Secondary scale is always one complete Primary division, is fully graduated and reads from zero to the left, while the Primaries read from zero to right.

LENGTH OF SCALE. On a Map, scales usually represent a multiple of 10 to 100 units of measure, thus if a unit is a mile the length of scale may indicate 10, 50, or 80 miles according to R.F. and to size of map. If unit is yard or metre, scale may indicate 1,000, 5,000, 40,000 etc., according to R.F.

On a FIELD SKETCH the length will be from 4 to 6 inches and secondaries will seldom, with accuracy, show divisions of less than 100 yards. If greater accuracy is desired, scales on Service Protractor should be used.

TO CONSTRUCT A SCALE FOR A MAP.

When R.F. only is given. Construct scale for R.F.

1/25,000 to show hundreds of yards.

1. Since yards are required, bring R.F. to yards, i.e., 1 yard equals 25,000 yds., but a yard is too long for a map scale, so we select suitable length, say 5,000 yds. If 1 yard or 36 inches equals 25,000 yds, then 5,000 yds will equal $\frac{5,000 \times 36}{25,000}$ equals 7.2 inches.

Draw a line 7.2 inches long, divide it into five equal parts, make a short vertical stroke at each end, and at each division, mark the left hand stroke 1,000, the first division 0, the second 1,000, the third 2,000 and so on. Print YARDS at each end. Divide left-hand PRIMARY division into SECONDARIES of 10 equal parts, each of 100 yds. The strokes of these divisions to be shorter than those of primary and the stroke for 500 just a little longer than the other secondaries and marked 500.

Above the scale print the R.F. also the description which must be worked out. In this case inches to the mile.

63360/25,000 equals 2.53 inches to 1 mile.

Example of checking by R.F. 1/M:-

1/1,000,000	equals	approx.	16 miles.
1/250,000	"	"	4 "
1/25,000	"	"	.4 "

If .4 mile equals 1 inch - 1 mile equals $\frac{1.0 \times 1}{.4}$ equals $2\frac{1}{2}$ inches.

<u>Where written description only is given.</u> Construct a scale for a FIELD SKETCH 3 inches to 1 mile to show miles.

Since scale is for FIELD SKETCH, length should be about 6 inches. 3 inches equals 1 mile so we have two primary divisons of 1 mile. The left-hand one is divided into 8 secondary divisions showing 1/8 miles. Print miles at each end and mark their proper secondaries $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ from right to left.

Should a scale of yards also be required, its length can be obtained as follows. 2 miles equals 1760 x 2 = 3,520 yards for length 6 inches. Scale should be from 4 to 6 inches, so 3,000 is nearest.

If 6 inches equals 3,520 yards, then 3,000 will equal $\frac{3,000 \times 6}{3,520}$ = 5.113 inches.

This can also be worked from R.F. $\frac{3}{63360}$ or $\frac{1}{21,120}$

$$\frac{1,000 \times 36 \times 1}{704} = 5.113$$

Print R.F. and written description over top of scale.

<u>Where no R.F. or description is given, but the distance between two indicated points on the ground is known.</u>

Construct a scale for a map if the distance between two known points is 5,000 yards. First measure distance between the points on map, in this case say 5 inches. R.F. will then be 5/5,000 x 36 = 5/180,000 or 1/36,000. length of scale, if we wished to show yards would be 5 inches or five primaries of 1,000 yards. Number of inches to 1 mile would be 63,360/36,000 = 1.76.

But let us suppose a scale of metres is required. 1 metre equals 39.37 inches.

R.F. is 1/36,000 so 5,000 metres equals $\frac{5,000 \times 39.37 \times 1}{36,000}$

The procedure is then the same as for yards except that METRES will be put at each end of scale.

If two aprallels of latitude are given on the map an approximately accurate scale can be made, due to the fact that the distance between parallels 1 degree apart is approx. 69 miles or 1.15 miles for each minute. Knowing this the scale is constructed as above.

NOTE: 1 minute latitude equals 1 sea mile or 2,025 yards.

BE NEAT AND ACCURATE.

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PROBLEM ON SLOPES AND CONTOURS.

QUESTION:

(a) Draw a rough map (1 inch to 1 mile) illustrating with complete contours and spot heights, the hill features on an approximately circular island, 3 miles in diameter and 349 feet high at its centre point. Insert two additional spot heights and number your contours.

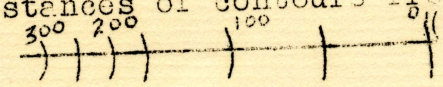
The island has:

1. A concave slope down to the sea on the north east.
2. A convex slope down to the sea on the south.
3. A steep even gradient of 1/6 on the north west for the first 250 ft. drop.
4. The whole of the north west of the island has vertical cliffs 75 ft. high.
5. There is a small re-entrant on the south-west side.

(b) Draw sections (vertical scale 1 inch equals 400ft.) to illustrate the fall of the ground from the central point, in all three directions, namely; south, north-east and north-west.

CAN BE DONE IN 30 MINUTES. RATHER TRICKY. GOOD EXERCISE.

SUGGESTIONS.

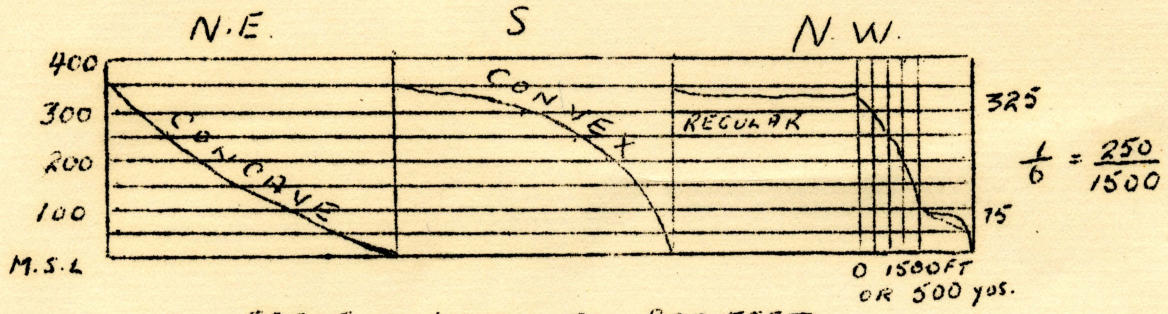
1. First draw your sections and scale, 1 inch to 1 mile showing miles and yards.
2. Draw a circle with radius 1½ inches.
3. Draw a true north line at margin.
4. Draw a N.E. S. and N.W. line from centre to circumference.
5. Transfer distances of contours from sections to the above lines thus: 

(make proper sign for cliffs on N.W.)
6. Connect them up being sure to include the re-entrant on S.W. side.
7. Break the outline at the circumference so that it is not too geometrical.

Examiners Remarks. Badly answered. Few candidates illustrated the four requisite features. Many maps drawn to wrong scale. Majority showed concave and convex slopes correctly but only a small percentage spaced their contours on N.W. to show slope of 1/6 and cliffs were usually added without reference to next contour. Few candidates drew correct sections of the island.

SKETCH. NO. 2

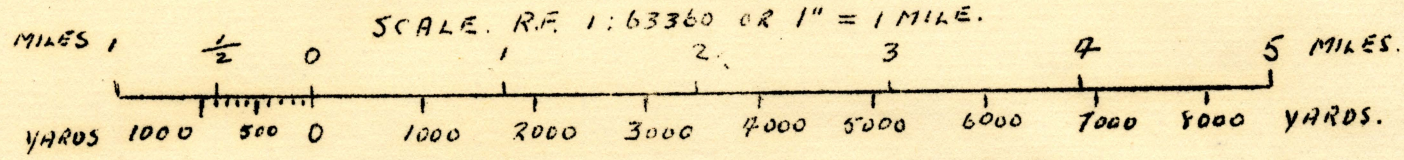
SECTIONS.

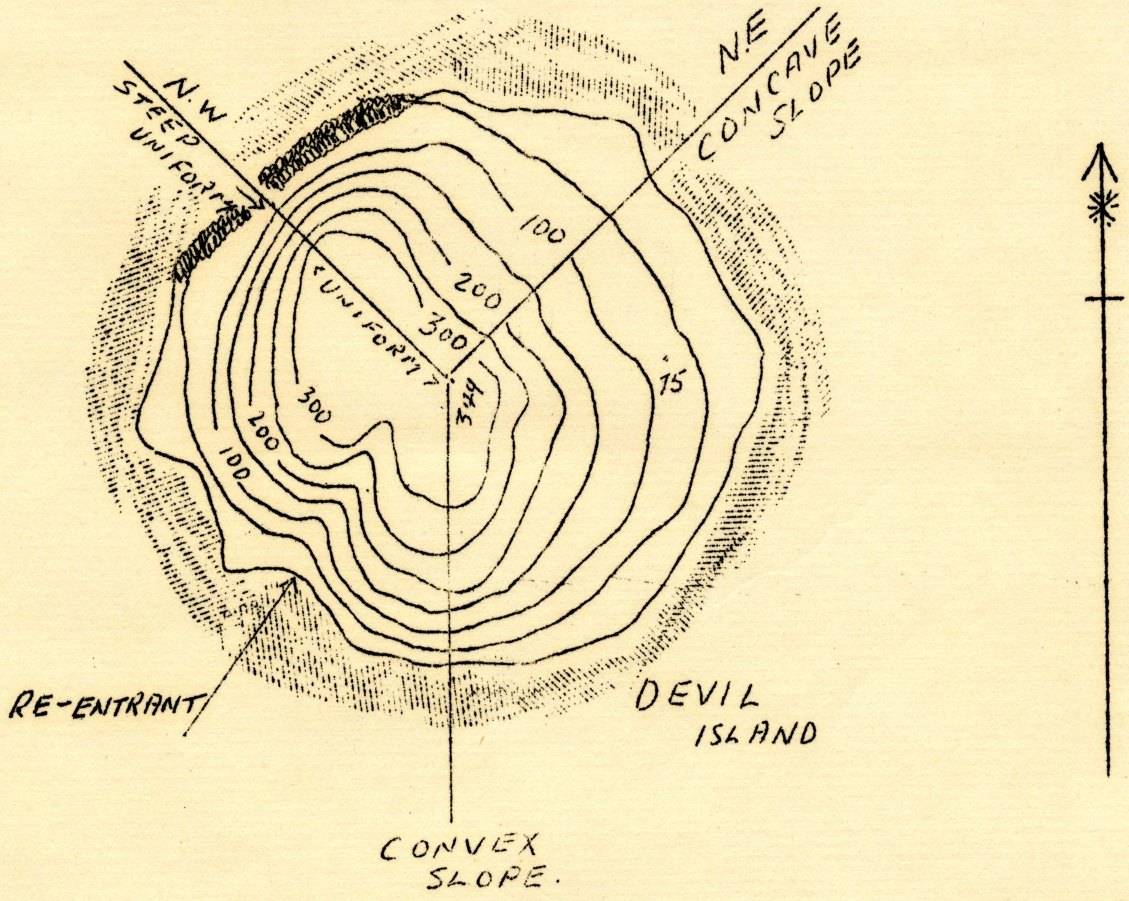


$\frac{1}{6} = \frac{250}{1500}$

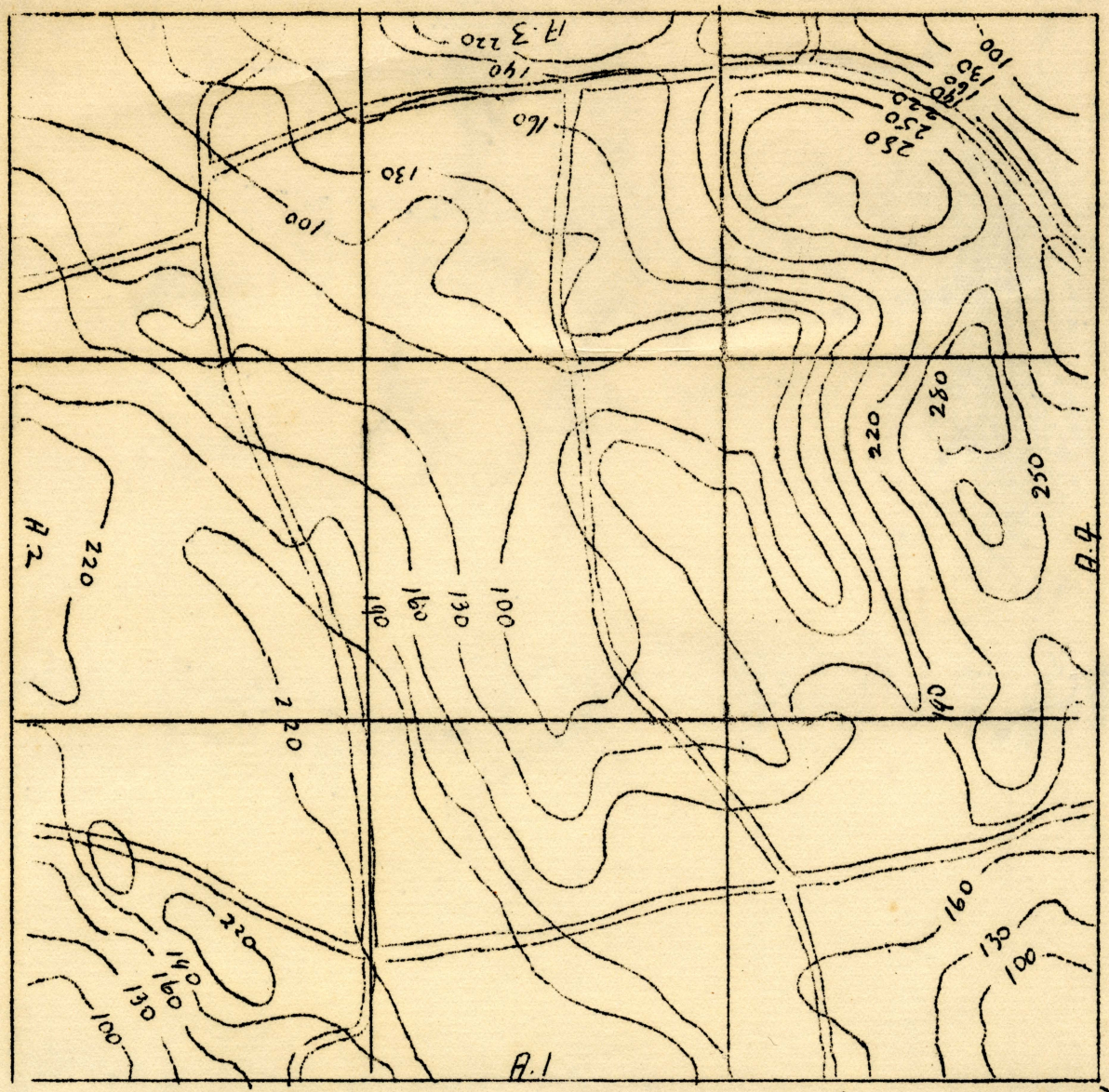
SCALE = 1 INCH TO 400 FEET.

SCALE. R.F. 1:63360 OR 1" = 1 MILE.





FOR EXERCISES — HOITE STUDY. — CONSTRUCT YOUR OWN SCALE(S)



THIS MAP GIVES 16 TYPES OF COUNTRY (CUT AND FIT.)