London Gliding Club

Navigation Part 1

Bronze Lectures 2014

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Objectives…

Primary

- **To pass the Bronze Navigation paper** – practical examples and coaching you ***will*** need to practice…

Secondary

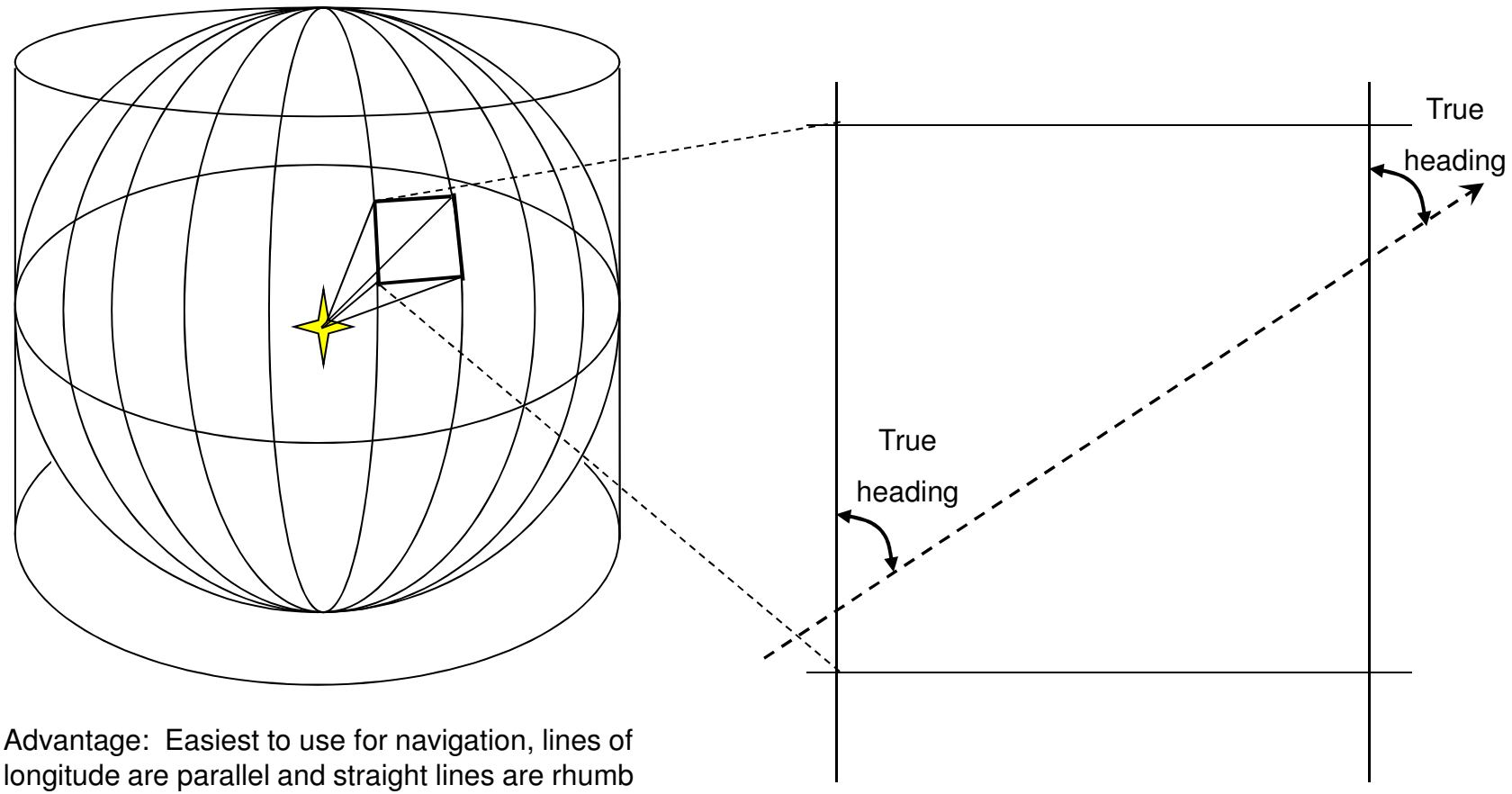
- To learn some practical navigation – for your Sliver Distance flight
- To download and interpret NOTAMS – obligatory if you fly cross country

Make sure you get these for Part 2 next week:

1:500,000 map	(an old cast off one is fine for the exam)
Navigation scale rule	(you can use a school ruler but not ideal)
Protractor, square 360^0	(you can use a school protractor but not ideal)
Map Pens fine, permanent	(don't use a water based pen it will rub off)
Meths for map cleaning	

Cylindrical projection…

"Mercator" projection after Geradus Mercator 1512 - 1594

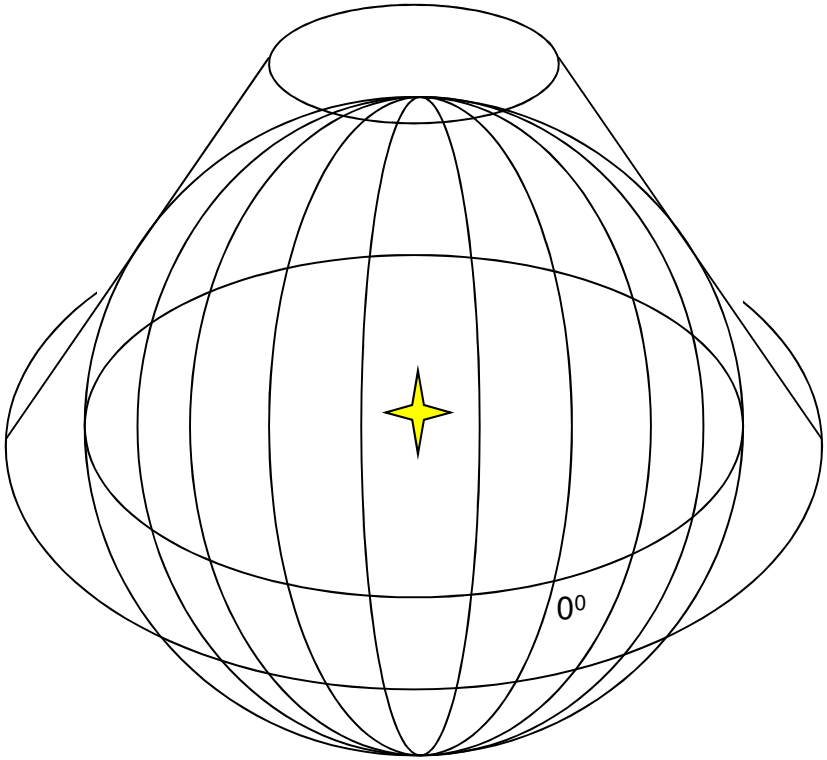


Advantage: Easiest to use for navigation, lines of longitude are parallel and straight lines are rhumb lines (courses of constant bearing).

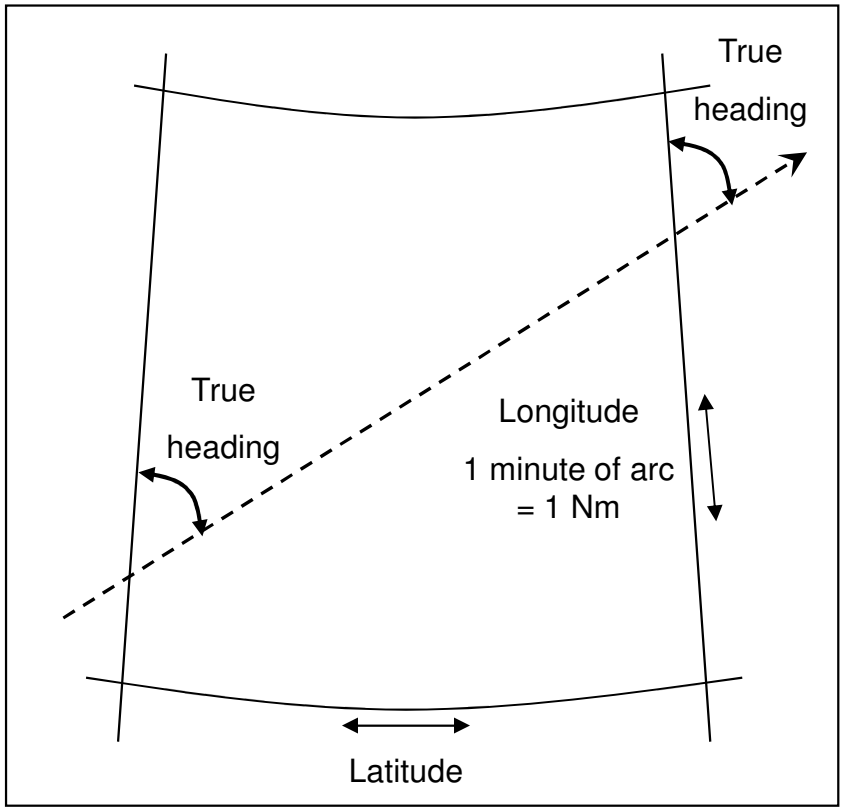
Disadvantage: Badly distorted view near the poles

Lines of longitude are parallel

Conic projection…



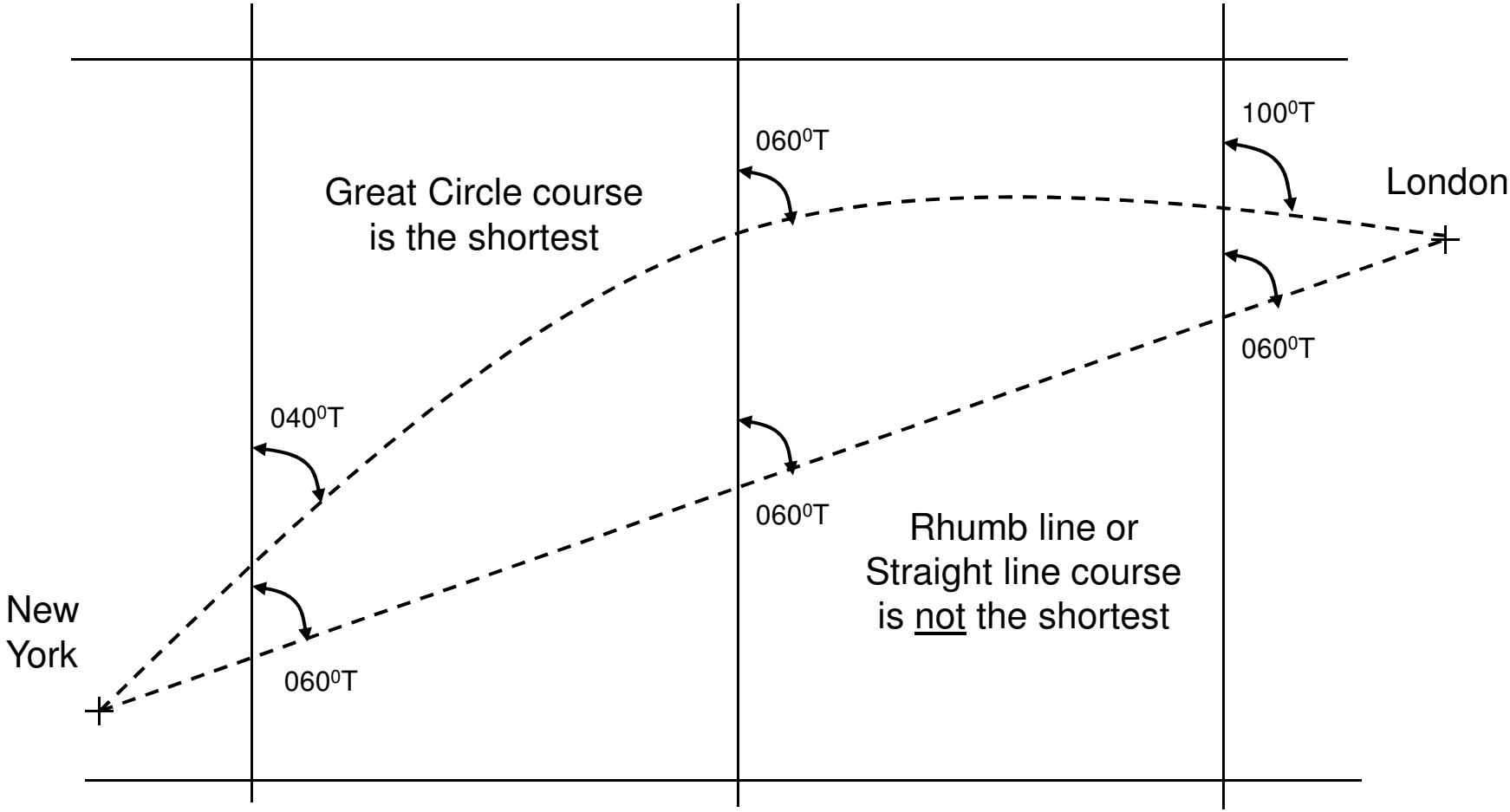
Advantage: Least distortion near tangent points
Disadvantage: Lines of longitude are not parallel
Straight Lines are not constant bearings
This is not a problem for short distances in UK



Conic projection on Half Million map

Great Circle course…

Shortest route from New York to London is via Greenland



Use a globe to check the shortest route from London to Tokyo via the North Pole

Map scales…

1:500,000 or half million

1cm = 500,000cm

1cm = 5km
1inch = 7NM

- *includes all airspace details*
- *scale a little small for eyeball navigation*
- ***legal requirement for cross country***

1 thumb = 10 NM a practical rule of thumb!

1:250,000 or quarter million

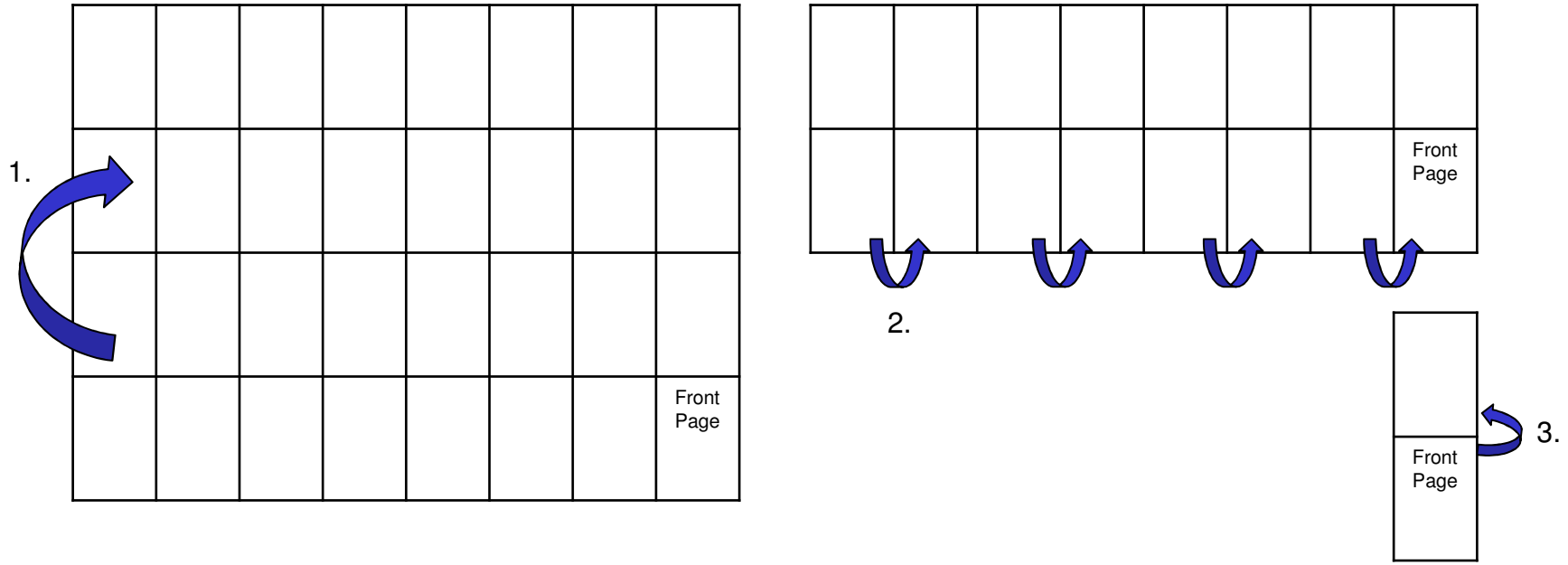
1cm =250,000cm

1cm = 2.5km
1inch = 3.5Nm

- *scale a little large for eyeball navigation*
- *airspace only up to 3000' altitude*

- ***not legal for cross country***

Map folding…



First make the creases…

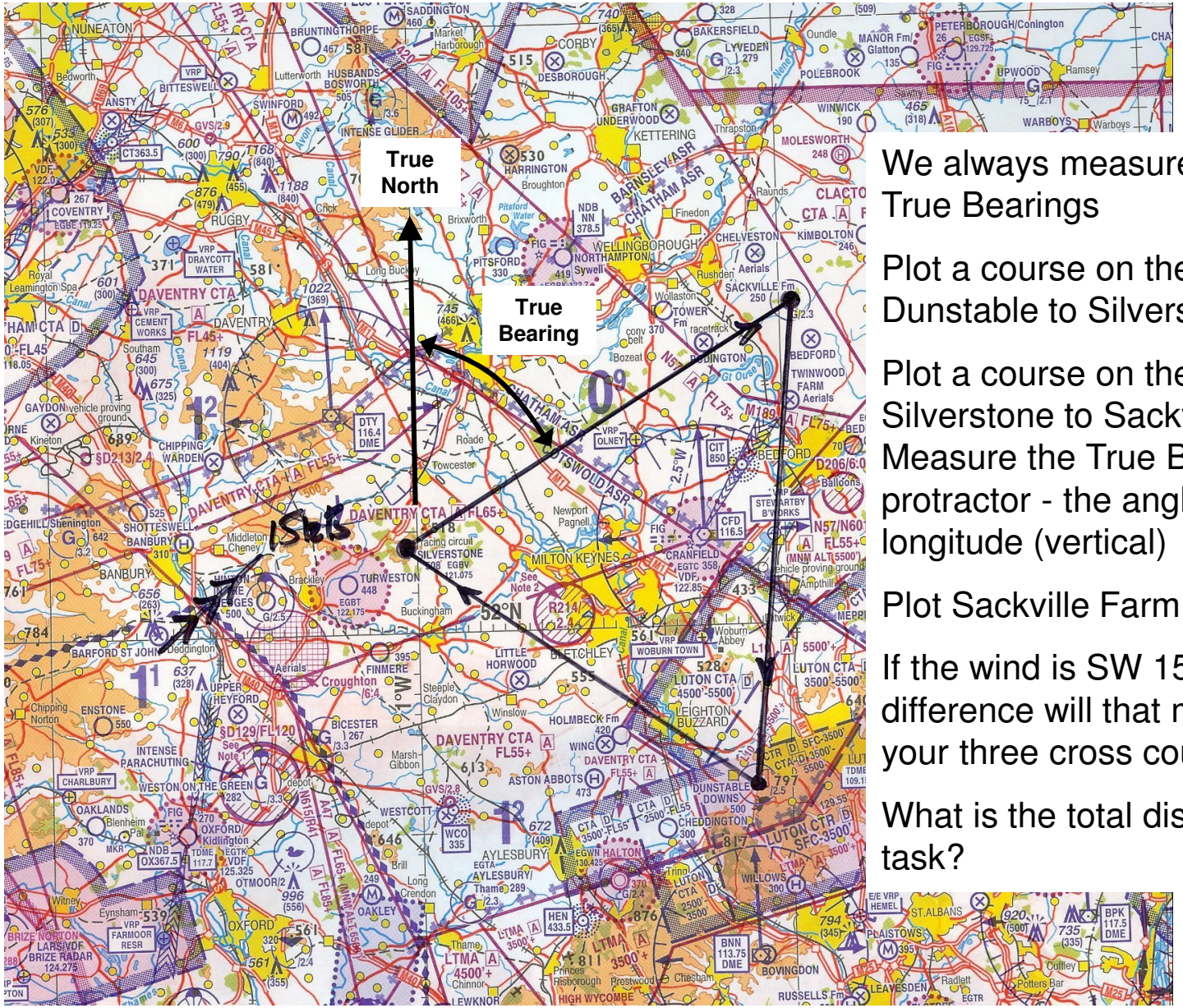
Fold horizontally in half and half again to form creases with 4 horizontal panels
Fold vertically in half and half again to form creases with 4 vertical panels
Fold vertically in half one more time to form 8 vertical panels then open out

Now form the concertina…

1. Fold horizontally in half to keep the title page at the bottom right
2. Fold the 8 vertical panels alternately to keep the title page at the bottom
3. Fold horizontally one more time to leave the title page visible

… to reach any part of the map any time

Plotting courses…



We always measure courses as True Bearings

Plot a course on the chart from Dunstable to Silverstone

Plot a course on the chart from Silverstone to Sackville Farm. Measure the True Bearing using a protractor - the angle from a line of longitude (vertical)

Plot Sackville Farm to Dunstable

If the wind is SW 15 knots what difference will that make to each of your three cross country legs?

What is the total distance for this task?

Magnetic Variation…

True North *- direction parallel to lines of Longitude.*

Magnetic North *- direction parallel to lines of magnetic flux.*

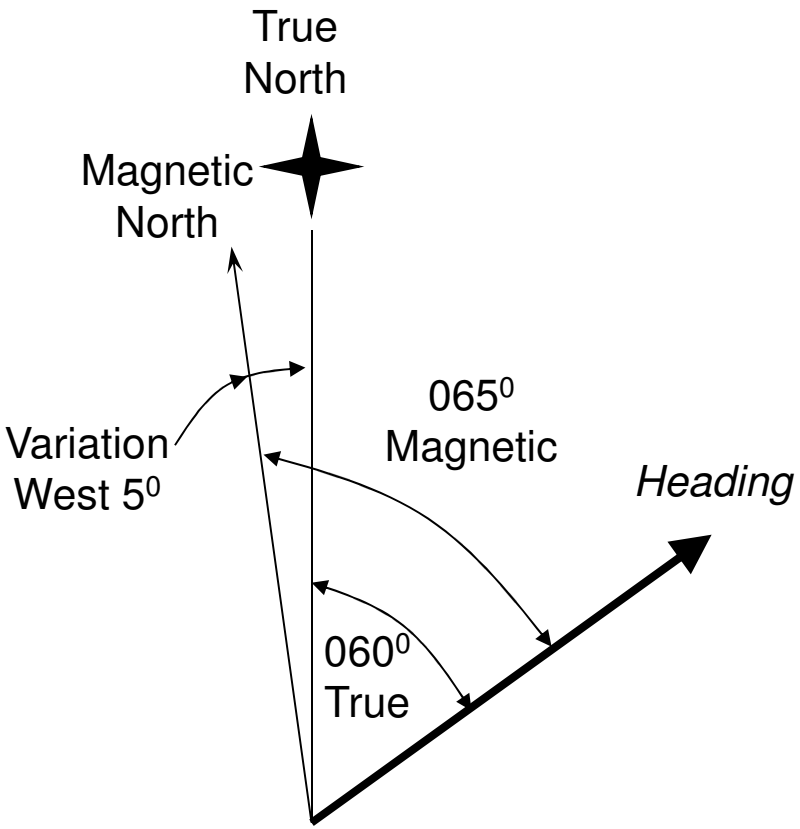
The difference between True and Magnetic North is called ***variation*** *it changes with time and location*

Look at the airspace map

What is the ***variation*** *for the area near Silverstone?*

How does it ***change*** *with distance and time?*

Find the nearest ***isogonal*** *(lines of constant variation) and find the rate of change (bottom left corner reducing 7 minutes per year)*

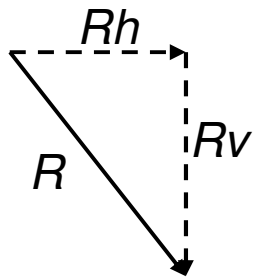


Compass Errors…

Variation - geographic error between True North and Magnetic North
It changes with location and time. Check variation at Dunstable? Talgarth?
What would it be10 years ago or 10 years in the future?

Isogonals - lines of constant variation.

Magnetic ***dip***



R *Direction of magnetic field*

Rh *Horizontal component*

Rv *Vertical component*

dip angle is about 68^0 in the UK
It causes tilt and acceleration errors that affect the compass when not in straight and level flight.
(The Cooke compass can be set horizontal when banked and so has fewer problems)

Deviation - the error caused by magnetic (and electrical) fields near the compass.
It changes with different headings. It can be adjusted and corrected in the compass

(A deviation card records the deviation error – I have only ever seen one on a ship)

Compass Errors…

Turning errors

When flying North or South in a turn the compass has an error (caused by dip)
When flying East or West in a turn the compass has no error

Acceleration errors

When flying East or West and accelerating the compass has an error (caused by dip)
When flying North or South and accelerating the compass has no error

> ***The one thing you need to remember***
> The compass is error free when not turning and not accelerating
>
> So what is the practical solution for error free heading?

Memory jogger *(not required for Bronze or for practical navigation)*

OSUN	Overshoot turning South Undershoot turning North
ANDS	Accelerate swings North Decelerate swings South

Compass courses…

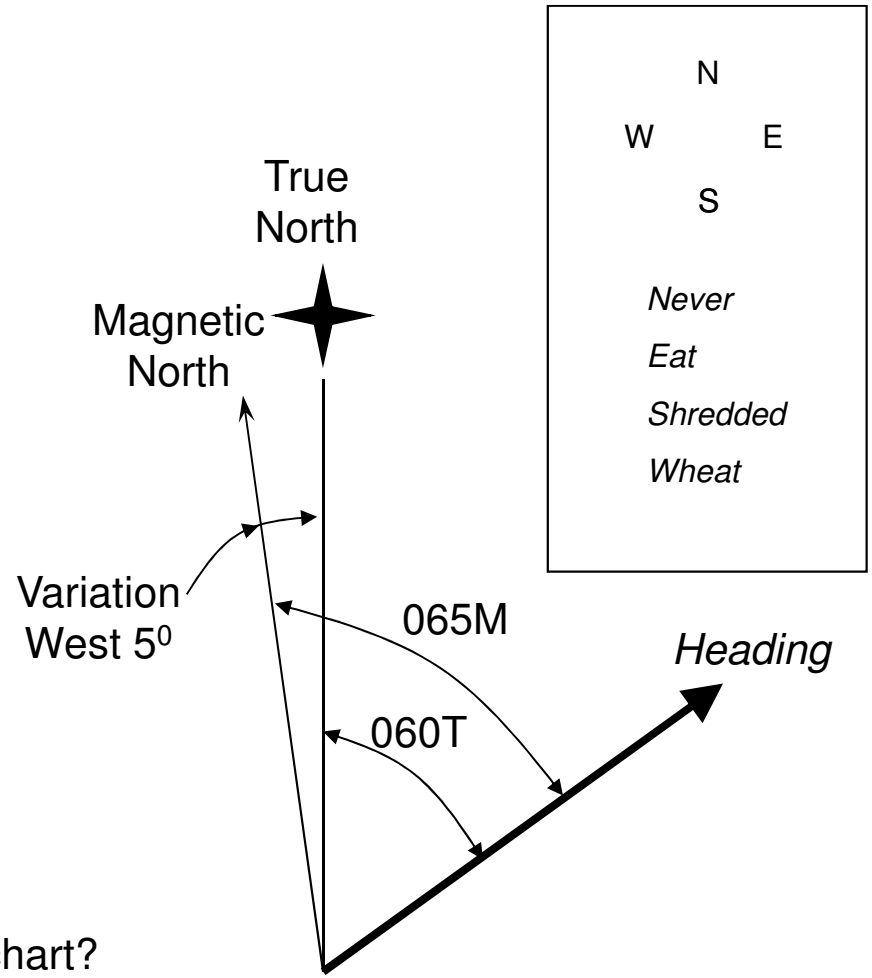
"Variation West compass best"

060 T	265 T
+005W	+005W
= 065M	= 270M

"Variation East compass least"

060T	265T
- 005E	- 005E
= 055M	= 260M

Always write all three digits and T or M after any course



Which is the most useful written on a chart?
T or M?

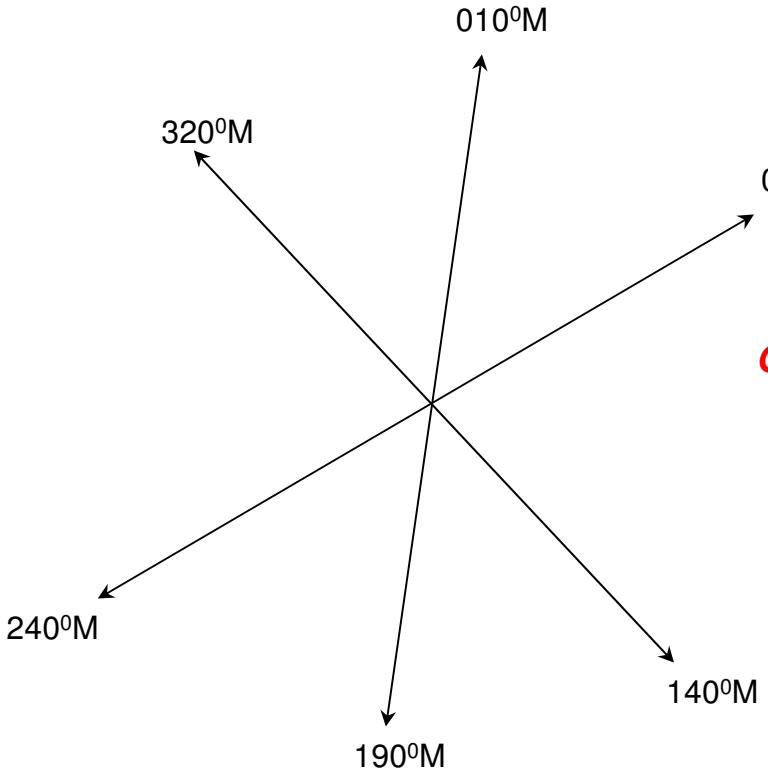
… you will need to practice converting between M and T

Reciprocal courses …

For practical navigation you should learn to do these in your head

Add 200 then subtract 20

010	140
+200	*+200*
210	340
-20	*-20*
190	320



Or Subtract 200 then add 20

320	240
-200	*-200*
120	40
+20	*+20*
140	60

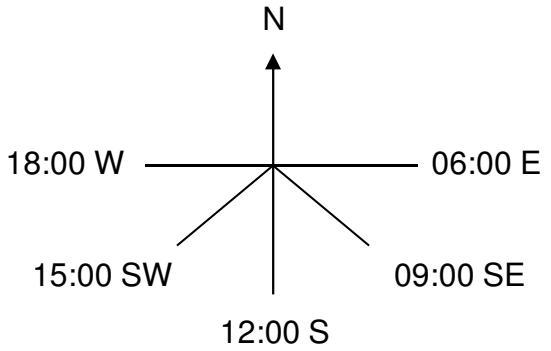
Only one that doesn't work

190	190
+200	*-200*
390	XXX
-20	Use
370	190
-360	*+200*
10	*-20*
	370

… you need to find a way that works for you

Sun Direction …

The Sun moves through 360^0 in 24 hours (with apologies to Galileo and the Heliocentric model)
That is exactly 15^0 every hour.



At 12:00 GMT (13:00 BST in summer) the sun is due ***South***
At 06:00 GMT (07:00 BST in summer) the sun is due ***East***
At 18:00 GMT (19:00 BST in summer) the sun is due ***West***

You can use the sun to check your heading in flight

Method 1 – very simple and very practical

Fly t the glider on your desired heading. Take a grease pencil and mark the direction of the sun on the canopy. Leave the next thermal with the sun lined up on the grease mark. This will maintain your heading for the next half hour or so - maximum error 7^0

Method 2 – interesting but not practical in flight

Set your (analogue) watch to GMT, point the hour hand at the sun. Due South is halfway between the hour hand and 12. This is accurate but a little tricky while thermaling.

… the sun is really useful for practical navigation

Map reading …

Read from really clear features on the ground to the same features on the map,

don't try to fit symbols on the map to what you see on the ground.

Clear Line Features

Motorways, railways, large rivers

Clear Position Features

Lakes and large towns

*Plus Other **recognisable** landmarks*

Map Reading …

Line features

- Roads – Best are motorways and major dual carriageways, with recognisable junctions
- Railway lines – No sharp bends, few junctions
- Rivers – Best are large rivers, smaller ones often have trees with no visible water
- Canals – Usually clear with no trees and visible towpath and locks
- Coastline – Not often visible but provides an unmistakable line feature

Position Features

- Large Towns – Can be hard to see in cloud shadow. Check relative size and pattern of road junctions
- Lakes – Usually very easy to see. Check relative size and shape
- Airfields – Sometimes easy to see, but runways only shown on quarter million map

Temporarily uncertain of your position…

It really helps if you

note your position on the map with the time – **do it often!**

When you are uncertain of your position

Don't panic – Aviate, Navigate, Communicate

Estimate your heading & distance since last position, consider effect of wind drift

Read from ground to map, find 2 or 3 key features and locate them on map

Mark your estimated position checking directions to your key features – does it fit?

Mark your position on the map with the time before starting off again

If you are really lost

You can call 121.5 in an emergency for a triangulation position.

"London Centre this is Golf - Charlie Lima Golf Charlie"

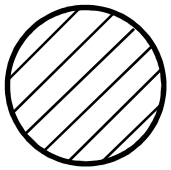
G-CLGC pass your message…

"G-CLGC is an 18 m glider from Dunstable temporarily uncertain of my position - requesting triangulation"

If you suspect you are inside airspace at any time – land immediately.

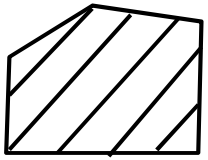
… getting lost will happen to you!

Airspace…

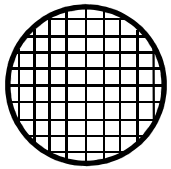


Prohibited P106/2.5 west of Benson airfield do not enter
serial number 106, up to 2,500’ AMSL

Restricted R214/2.4 west of Milton Keynes
e.g. no helicopters near prison below 2,400’ AMSL
not a restrictions on gliders but see notes on map



Danger D129/FL120 Weston on the Green
eg parachute drop zone – do not enter
Danger areas often extend to high altitude
Danger areas can be of any size and shape
*D130 see Notams for period of activity



HIRTA Croughton/6.4 High intensity radio transmission area
Danger at altitudes below 6,400’ AMSL not prohibited

Membury 1200’ AMSL
(500’ AGL)

…learn to read <u>all</u> the symbols on the map

Airspace…

ATZ

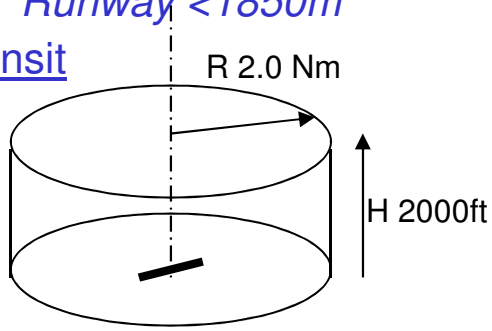
Air Traffic Zone

N.B. Heights are measured above local ground level

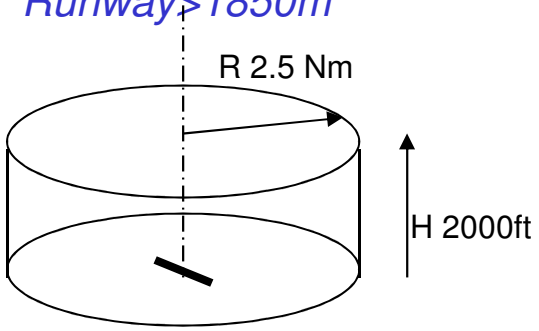
Prohibited

Must call for transit

Runway <1850m



Runway >1850m



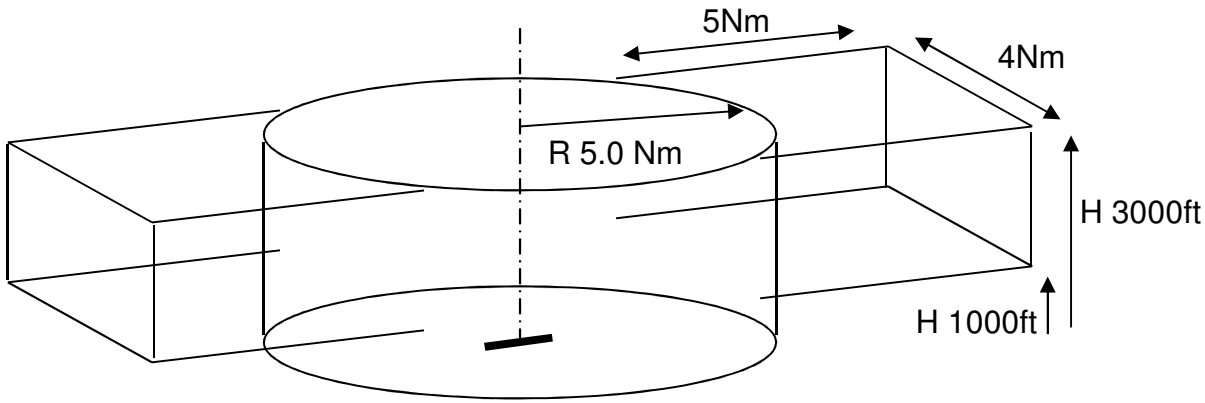
MATZ

Military Air Traffic Zone

N.B. Heights are measured above local ground level

NB Not Prohibited – but you are advised to call for transit

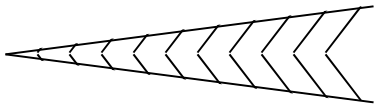
But Includes an ATZ which is!



Airspace…

- **ILS** Instrument Landing System is **not** controlled airspace, typically extends from main runway downwind from prevailing wind
- **3^0 glide slope** (3 in 60 or 300’ in 6000’) **300’ per mile from threshold**

- **1 mile = 300’**
- **2 miles = 600’**
- **3 miles = 900’**
- **4 miles = 1200’**
- **5 miles = 1500’**
- **6 miles = 1800’**



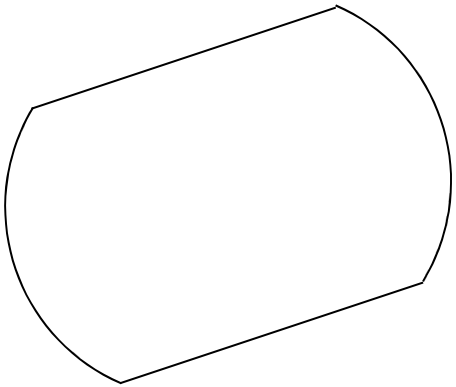
- Examples at Cambridge & Kidlington
- **Beware of extended runway centre lines or ILS approach at *<u>any</u>* sizeable airfield at the ranges and heights shown above**

Airspace…

GATWICK CTR D SFC – 2,500’

CTR

Control Zone
Prohibited from ground level



NB Altitude measured above sea level

Airways

Controlled airspace starting at level shown with pink borders
Flight Level - FL55 is an altitude of 5500’ measured by altimeter set to 1013mb
Other airways CTA’s and Control Zones are show with pink borders for class A and blue borders for class D

G1 A FL 55+

B’HAM CTA D 3500’ – FL 45

…learn to read <u>all</u> the symbols on the map

Airspace…

A **Airways, typically 10Nm wide. Control Zones, London CTR and other major airports. Gliders may not enter.**

B None currently exists in UK airspace

C **Airspace above FL 195**
Relevant to Wave Soaring windows, flight plan and local briefing required

D **Smaller Control Zones CTRs, Control Areas CTAs and Terminal Manoeuvring Areas TMAs. Dunstable airfield lies inside Luton TMA. Dunstable pilots may enter under defined conditions. Any other class D requires ATC clearance.**

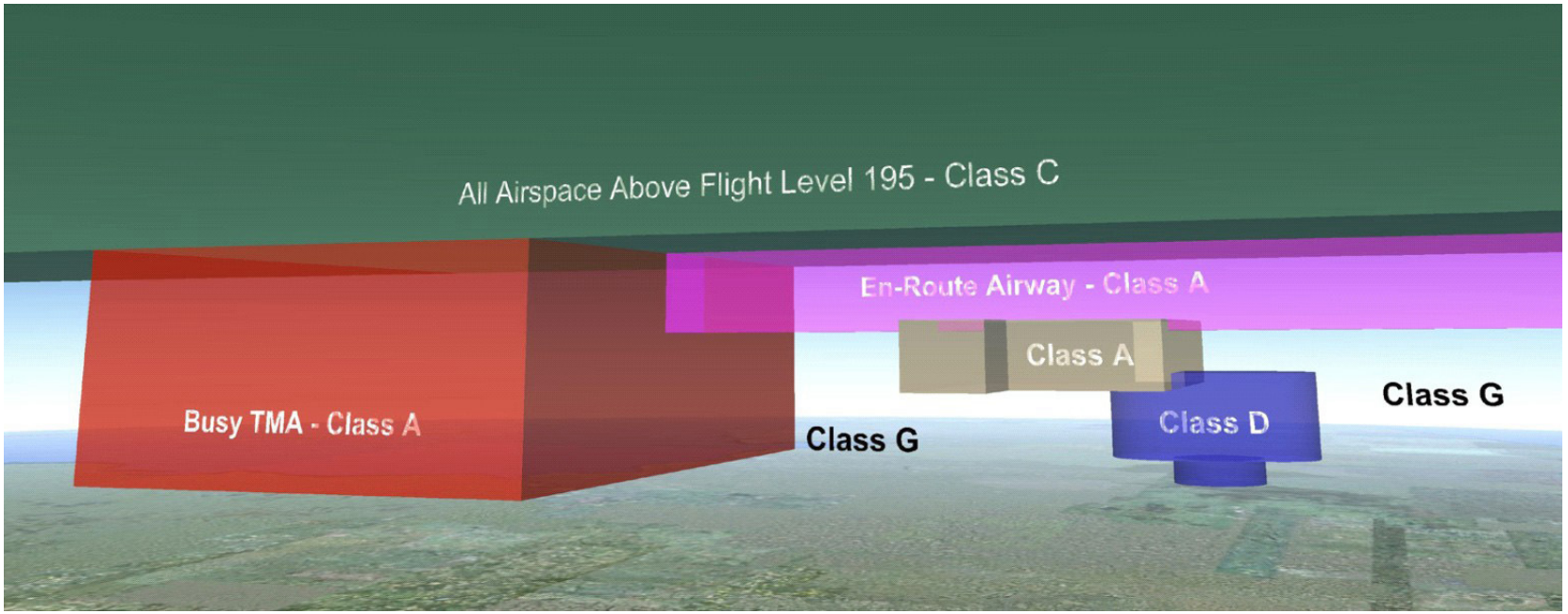
E Only exists in Belfast & Scotland. – to be closed in future

F Advisory routes are uncontrolled airspace. Gliders may cross without restriction but care must be taken – CAA announces in 2013 to be closed in future

G **Uncontrolled airspace. All UK airspace not covered by A to F**
Gliders may enter without ATC in VMC.
Laws and rules
A glider must not fly over any congested area below a height which would enable it to land outside that area, or below 1,500' above the highest object or within 2000' of surface whichever is the higher. The height is raised to 3000' for any gathering of more than 1000 people.
A glider may enter cloud if > 5Nm from a gliding site (only from 200ft below) and the pilots must wear parachutes.
You need instruments and instructor training & clearance
You are advised to make and listen out for cloud calls on 130.4 entering and at 500' intervals

…ignorance is not an excuse

Airspace visualisation…



Airspace…

Airspace reference information from the CAA website

http://www.caa.co.uk/docs/64/VFR_Guide_2011_update.pdf

Guide to Visual Flight Rules in the UK

Contents Page

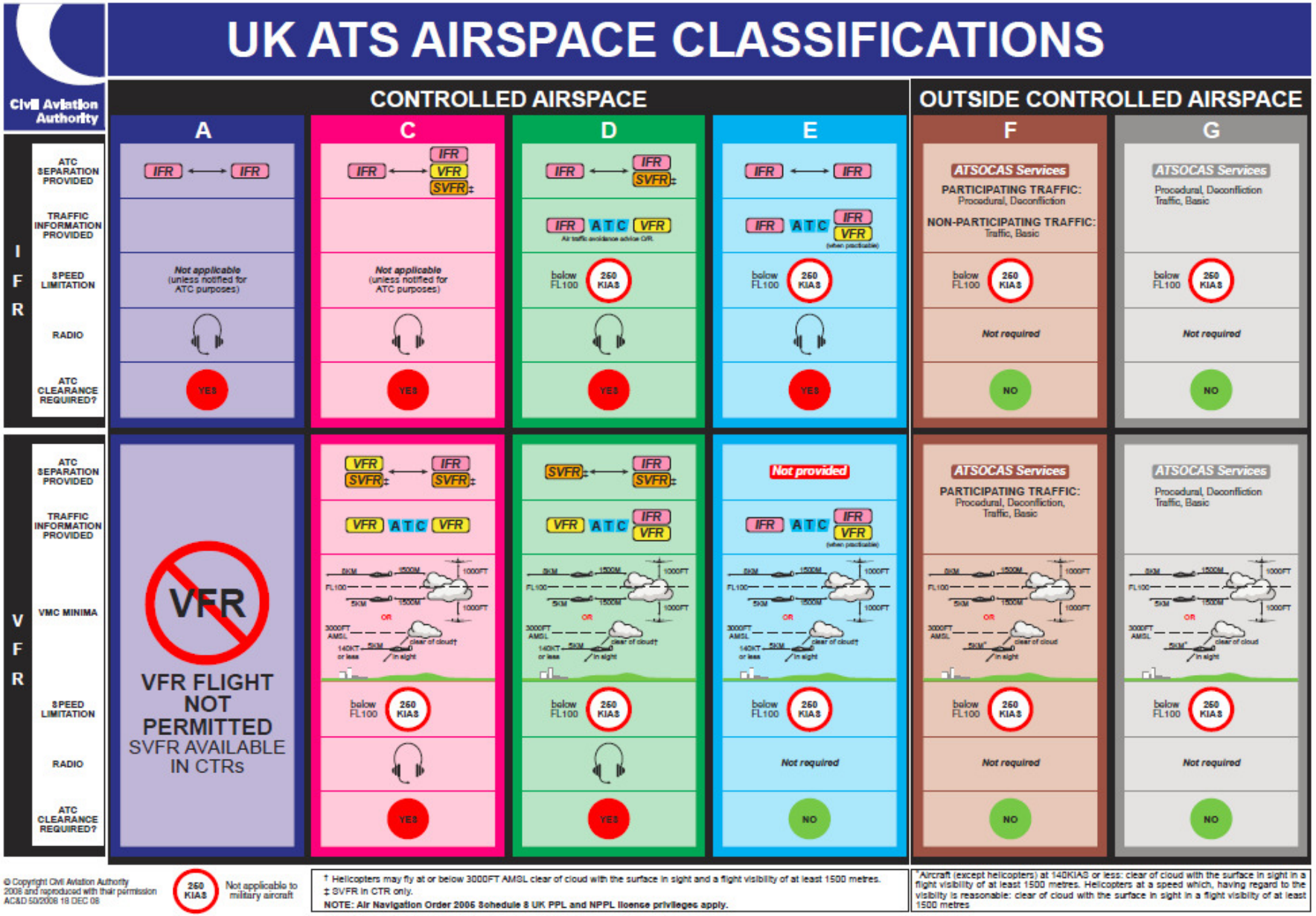
BGA website – link

http://www.gliding.co.uk/bgainfo/airspace/introduction.htm

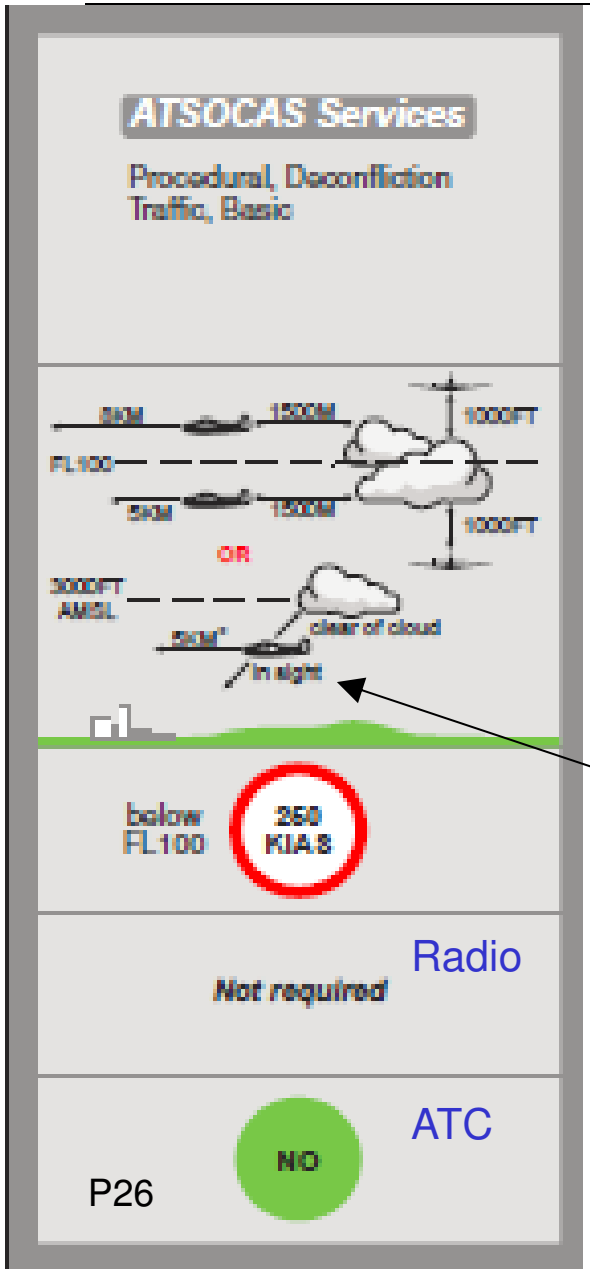
P24

… is the most important information on the map

CAA airspace chart…



VFR class G…



BGA Laws and Rules

Apply to gliders only in class G – we are not bound by the clear of cloud restrictions on GA aircraft.

6.11 No glider shall enter cloud within a radius of 5miles of a gliding club except from at least 200 feet below the lowest part of the cloud

6.12 No glider shall enter cloud unless all its occupants are wearing serviceable parachutes and have been instructed in their use

Call position and height on entering and every 500 feet climbed (advisory)

Cloud frequency 130.4

CAA rules

Aircraft at speeds of 140kt IAS or less VFR flight is permitted clear of cloud in visibility of 1500m (VMC minima)

…learn the restrictions that apply to gliders

Polar curve…

Compare the performance curves for **K21** **LS-4** and **ASH 25**

Observations…

K21 has the lowest performance at high speed

ASH 25 has the best performance at all speeds

Question…

What speed should you fly in the LS-4? (for min sink and for best L/D)

Final glide LS-4…

Best L/D ratios:	
EB 28	70?
ASH 25	57
LS8	43
Discus	42
LS4	40
K23	34
K21	35
K13	27
Space shuttle	4.5

Final Glide mental calculation…

You are 20 miles from Dunstable

What height do you need to glide home with 1000ft spare?

Assume you are flying an LS-4

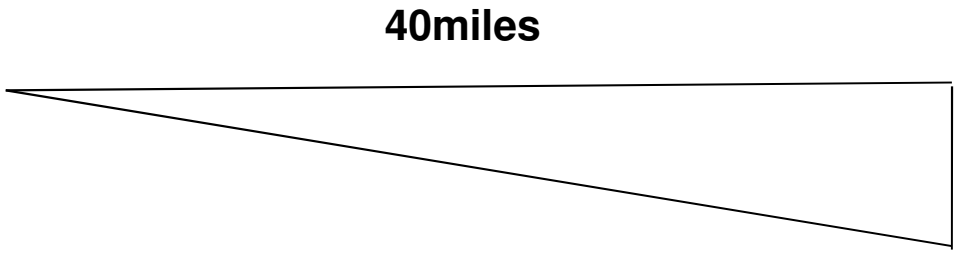
Best L/D is 40 :1

You can glide 40 miles from 6000 ft (1 mile up)

Calculate in miles per thousand 40/6 = **6.7miles per 1000ft**

To glide 20 miles you need 3000ft plus 1000ft spare

So leave your thermal at 4000ft and glide home



…calculate <u>your</u> glide range per thousand feet

Average speed calculations…

You cover 30 km in 40 minutes (same as 15km in 20 minutes or 45km in 60 minutes)
Average speed is 45 kph

You cover 20 miles in 30 minutes (same as 40 miles in 60 minutes)
Average speed is 40 mph

You cover 100 km in 2 hours (same as 50 km in 1 hour)
Average speed is 50 kph

You cover 150 km in 1 hr 30 minutes (same as 100 km in 1 hour)
Average speed is 100 kph

Time on track calculations…

On a final glide with a ground speed of 90kts how long will it take to cover the 15Nm home?

A) The standard formula

$$\frac{\text{Distance}}{\text{Speed}} \times 60 = \text{time}$$

Cant remember it? ***Distance is covered by Speedy Gonzales 60 times***

15 miles at 90 kts $\frac{15}{90} \times 60 = 10$ minutes

45 miles at 60 kts $\frac{45}{60} \times 60 = 45$ minutes

B) Estimate miles/ minute

15 miles at 90 kts 15 miles at 1.5 miles per minute = 10 minutes

45 miles at 60 kts 45 miles at 1 mile per minute = 45 minutes

…decide which method works for you

Altimeter settings…

Pressure settings:

QNE "Normal Everywhere" 1013 standard

Remember pressure up = FL up

pressure down = FL down

QNH "Nautical Height" Sea Level

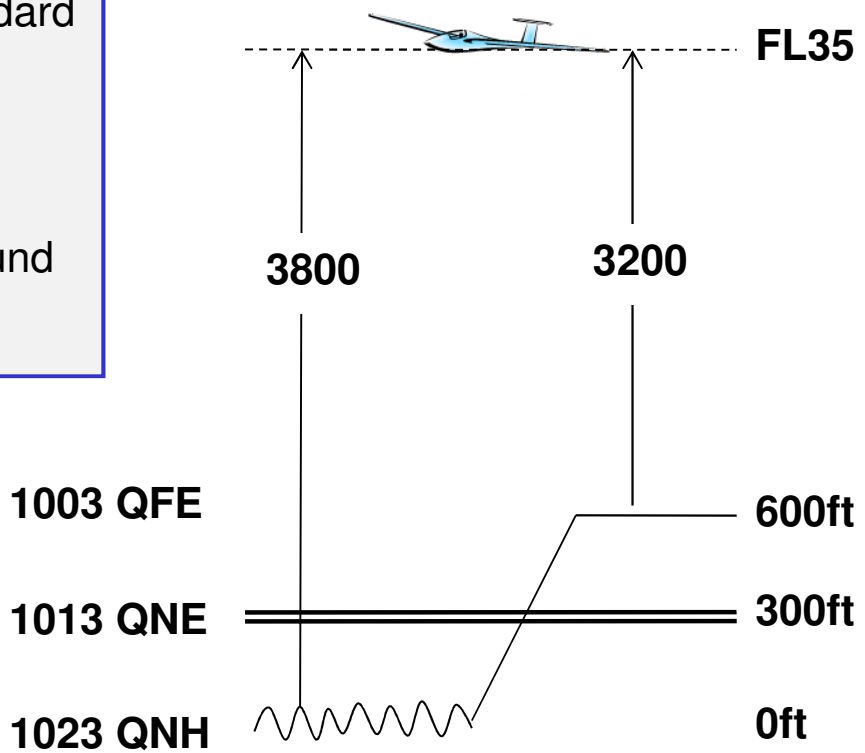
QFE "Field Elevation" Local ground

30 ft = 1mb

The airfield you left is 600ft AMSL

You set QFE before leaving at 1003mb

What will the altimeter read at FL35?



1. Draw sea and ground level
2. Get QNH and QFE (600ft = 20mb)
3. Get QNH datum (1023-1013 = 300ft)
4. Get FL above sea 3500 + 300 = 3800
5. Get FL above airfield = 3200

…draw the diagram every time

Altimeter settings…

Pressure settings:

QNE "Normal Everywhere" 1013 standard

Remember pressure up = FL up

pressure down = FL down

QNH "Nautical Height" Sea Level

QFE "Field Elevation" Local ground

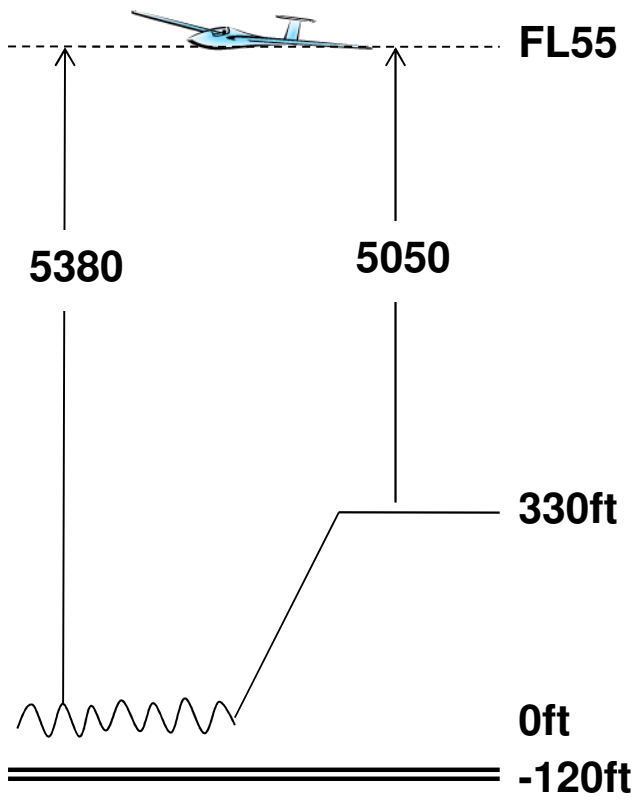
30 ft = 1mb

The airfield is 330ft AMSL

QFE is set at 998mb

What height is FL 55 above the airfield

1. Draw sea and ground level
2. Get QFE and QNH (330ft = 11mb)
3. Get QNE datum (1013 – 1009 = -120ft)
4. Get FL above sea 5500 - 120 = 5380
5. Get FL above airfield = 5050



…draw the diagram

NOTAMS…

Temporary Navigation Warnings (TNW)

Published twice a week – indexed by code number (C0439/12 useless?)

Temporary airspace warnings air displays, military exercises, royal flights

Includes all notified activities that may affect flight safety

Includes a lot of stuff of no interest to Glider pilots

Purple airways – Temporary for Royal Flights, Gliders are not permitted

http://www.nats-uk.ead-it.com/public/index.php.html

Click on NOTAMS and Register to open an account – do it now

Narrow route briefings/ Point briefings – *useless* for glider cross country…

Options

1. get an area briefing for the whole FIR – you must be joking!
2. use an interpreter like Spine – not recognized by NATs

Spine V6.5 – Soaring Pilots Intelligent NOTAMS Editor, search and download

Set up requires you have a login & password to NATs

…don't fly cross country unless you have read the NOTAMS

Homework…

Can you read Airspace from the map?

Draw a course from Dunstable to Lasham (SW of Basignstoke)
Now draw the airspace you would cross on that track

answer is on the next slide, but this may be from an older map than yours!

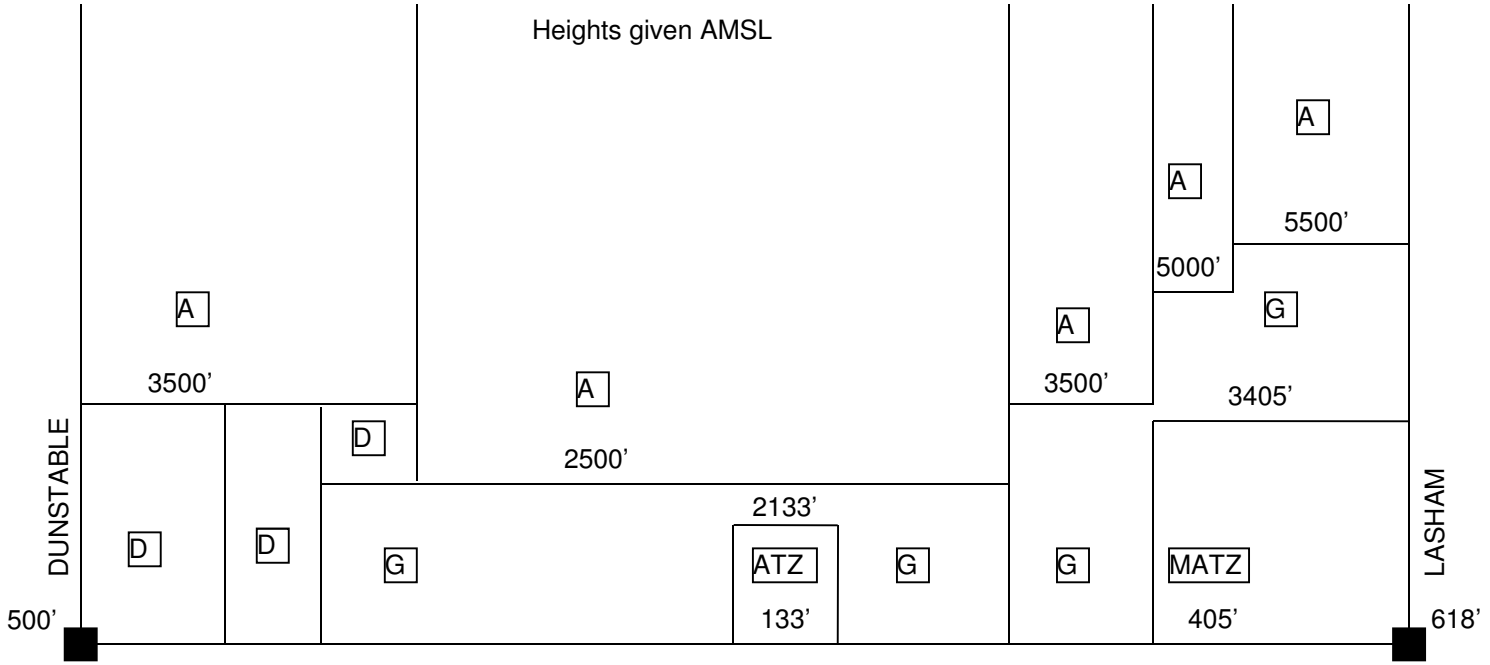
Draw a course from Lasham to Thornbury (N of Bristol)
Now draw the airspace you would cross on that track

Draw a course from Nympsfield (S of Stroud) to Dunstable
Now draw the airspace you would cross on that track

This is good test of you map reading skills on airspace

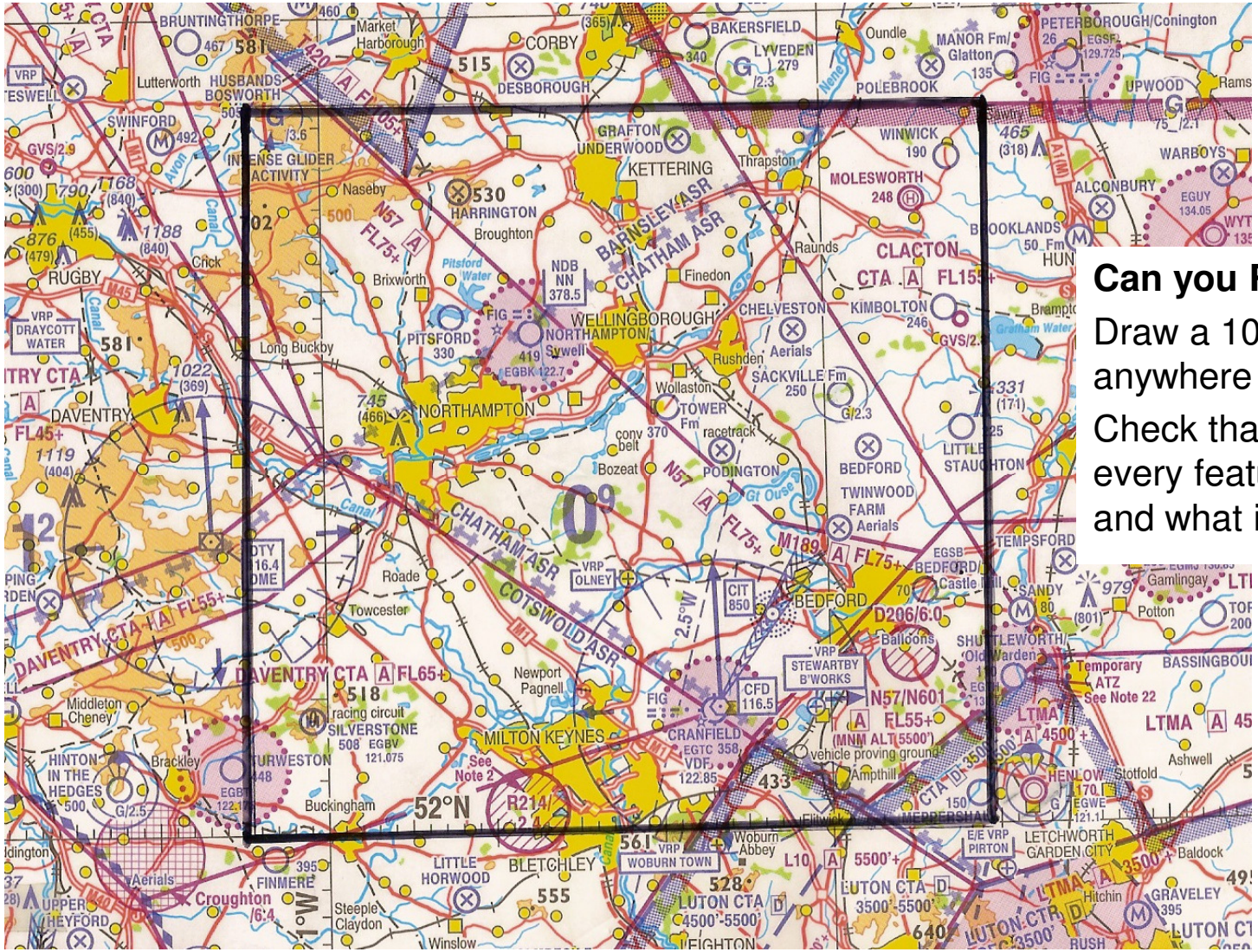
…to fly cross country you need to get this right

Homework from Nav part 1...



Updated from 2010 chart

Homework…



Can you Read the map?

Draw a 10cm square anywhere on the map

Check that you can identify every feature in that square and what it means

…to fly cross country you need to get this right

Homework…

To pass the Bronze exam you need to practice…

Practice plotting courses
Practice measuring true bearings
Practice measuring task distances
- in km
- in miles
- using your rule of thumb

Practice converting true to magnetic
Practice converting magnetic to true
Practice calculating reciprocal bearings – it could get you home!
Practice estimating speed and time
Practice converting between QFE/ QNH/ QNE

…practice makes perfect!

London Gliding Club

End

Navigation Part 1