London Gliding Club

Navigation Part 2

Bronze Lectures 2014

Martin Hayden

Objectives…

Primary

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

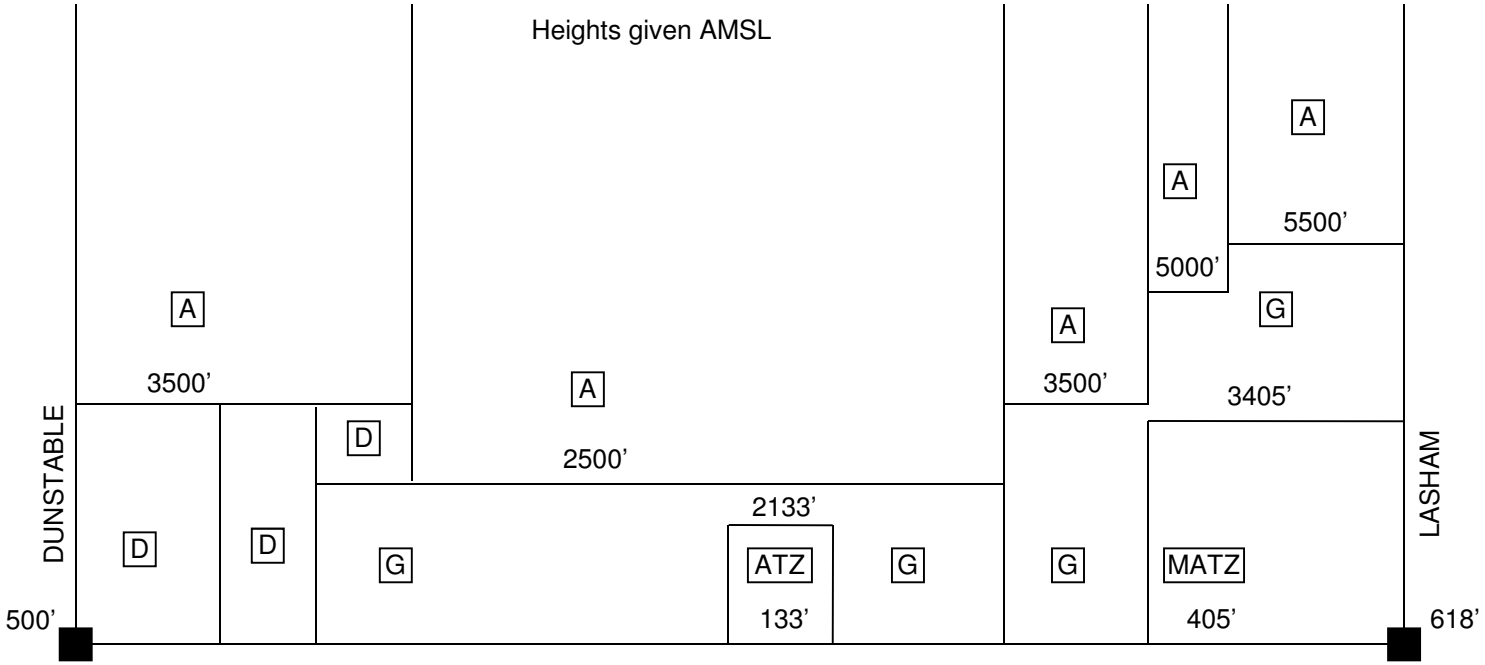
Secondary

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

Make sure you have these for Part 2:

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	

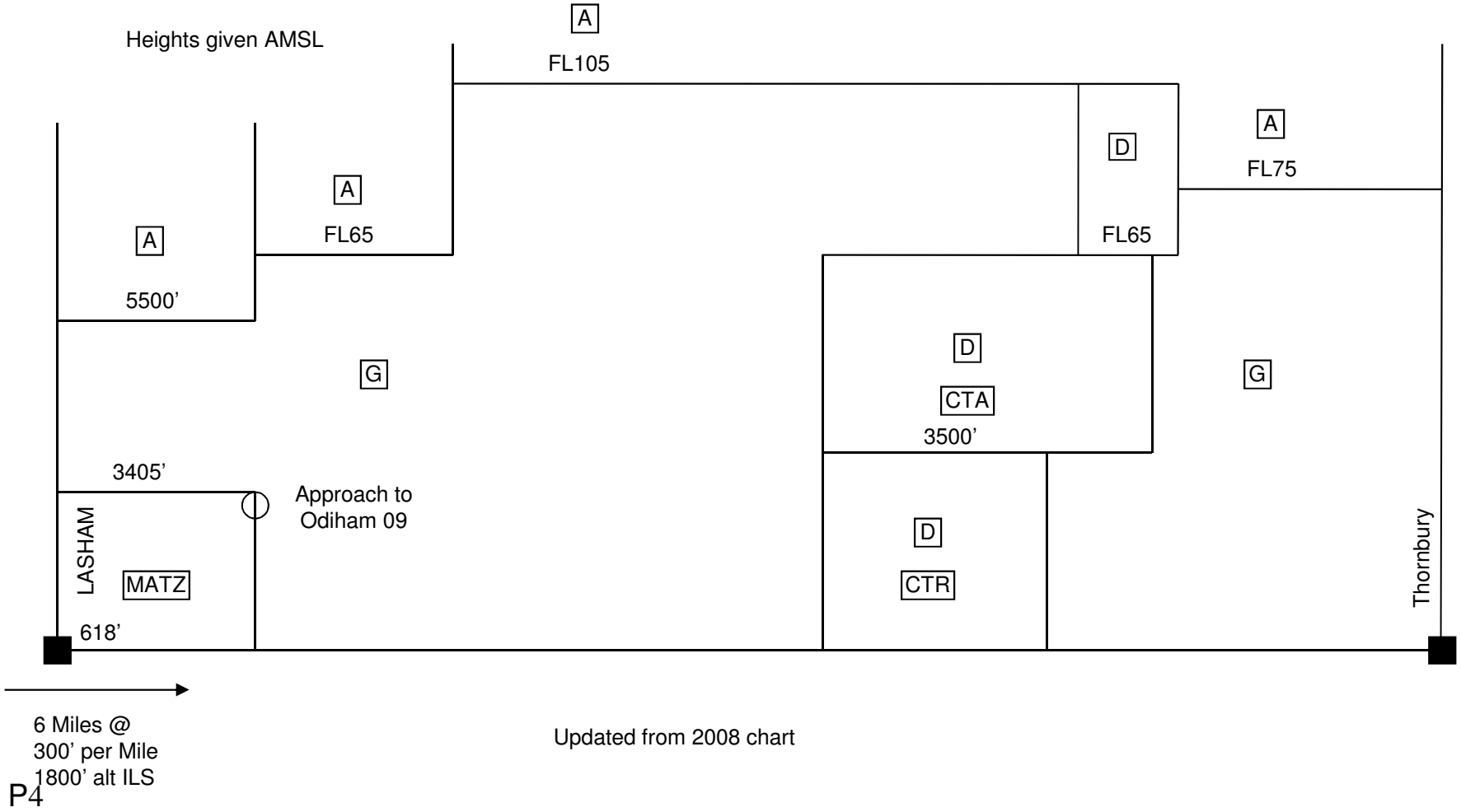
Homework from Nav part 1...



Updated from 2010 chart

Homework from Nav part 1...

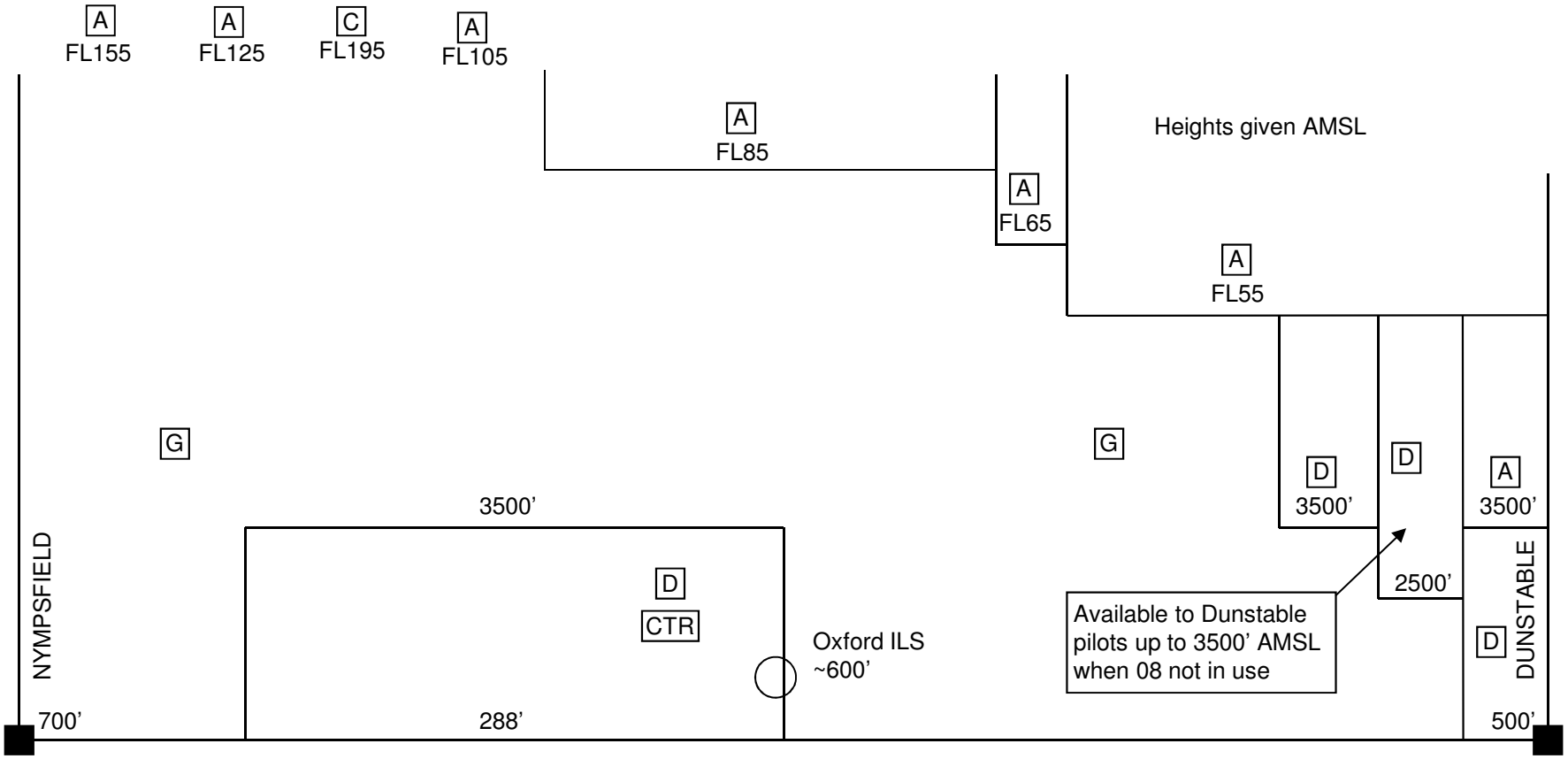
Draw a section through the Airspace from Lasham to Thornbury



Updated from 2008 chart

Homework from Nav part 1...

Draw a section through the Airspace from Nympsfield to Dunstable



Updated from 2008 chart

Plotting Examples…

1. Plot a leg from Dunstable to Lasham (SW of Basignstoke)
2. Plot a leg from Lasham to Thornbury VRP (N of Bristol)
3. Plot a let from Nympsfield (S of Stroud) to Dunstable

    a. Measure the ground track as a True bearing

    b. Calculate the magnetic bearing using Variation 4^0 West

    c. Calculate the reciprocal magnetic bearing

    d. Measure the distance in Nautical Miles

    e. Measure the distance in km

You may find these useful to remember…

+200 then -20 or
-200 then +20

Error West Compass Best
Error East Compass Least

Plotting Answers…

Plot a leg from Dunstable to Lasham direct

1a. Measure the ground track as a True bearing

203^0T

1b. Calculate the magnetic track

Variation west compass best

203 + 4 = 207^0M (round to 210^0M in practice but not in test)

1c. Calculate the reciprocal track

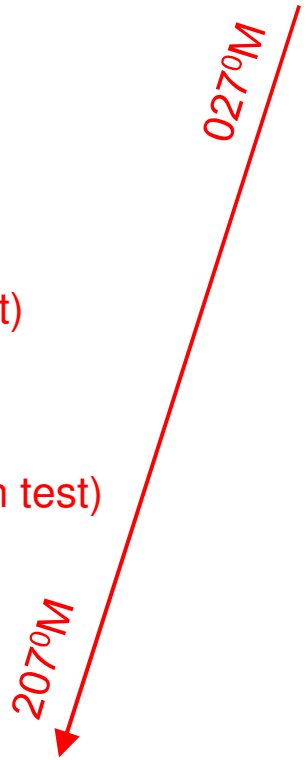
207 – 200 + 20 = 027^0M (round to 030 in practice but not in test)

1d. Measure the distance in Nautical Miles

44 NM

1e. Measure the distance in km

82 km



Plotting Answers…

Plot a leg from Lasham to Thornbury VRP direct

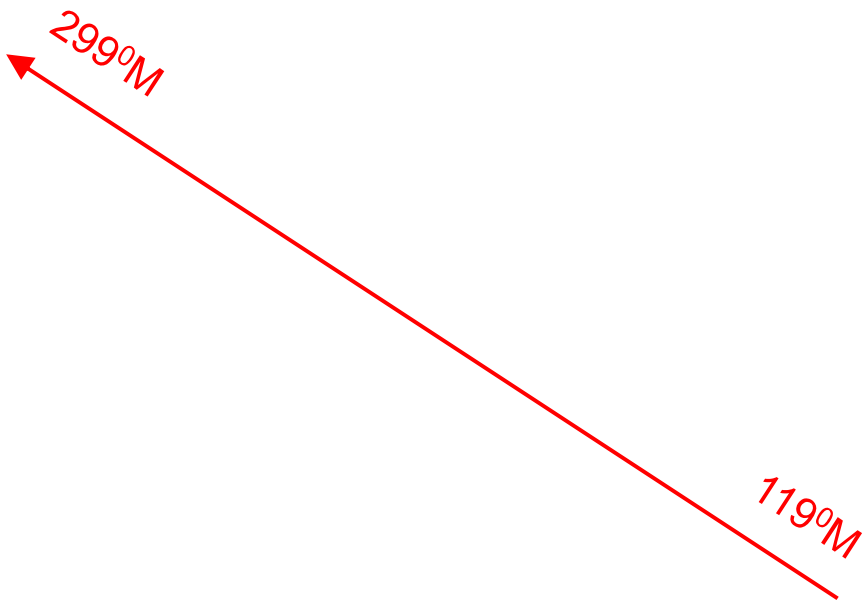
2a. Measure the ground track as a True bearing

295^0T

2b. Calculate the magnetic track

Variation west compass best

299^0M



2c. Calculate the reciprocal track

299 – 200 + 20 = 119^0M

2d. Measure the distance in Nautical Miles

61 NM

2e. Measure the distance in km

113 km

Plotting Answers…

Plot a leg from Nympsfield to Dunstable direct

3a. Measure the ground track as a True bearing

081^0T

3b. Calculate the magnetic track

Variation west compass best

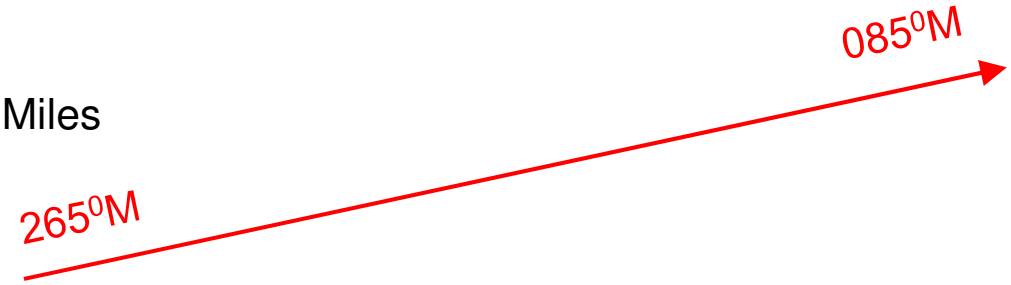
081 + 4 = 085^0M

3c. Calculate the reciprocal track

081 + 200 - 20 = 265^0M

3d. Measure the distance in Nautical Miles

65 NM



3e. Measure the distance in km

120 km

Plotting Vector Triangles…

Plotting vector triangles is probably not required either in the exam or in practical glider nav!

What heading do you need to steer from Dunstable to Lasham to allow for wind drift?

The wind is 300/12 kts and your average airspeed will be 30 kts

Step 1

Plot the desired ground track from Dunstable to Lasham

Step 2

Plot the wind speed for 1 hour from start point =12 miles

Step 3

Plot the heading from wind vector for 1 hour, arc 30 miles to intersect track

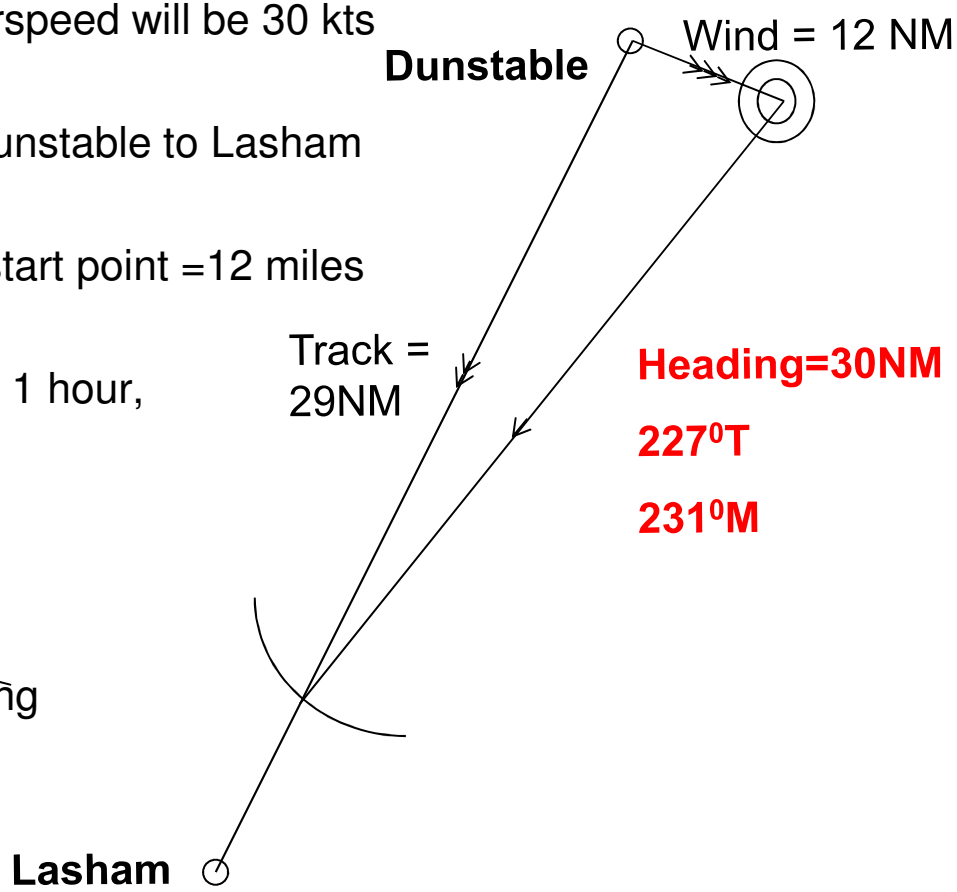
Step 4

Measure the heading True bearing

Step 5

Convert heading to a Magnetic bearing

231^0M



Plotting Vector Examples…

What heading will you steer to allow for wind drift?
What will be your estimated speed over the ground allowing for wind?
Assuming a flying speed of 30 kts and the wind from 300^0T at 12 kts

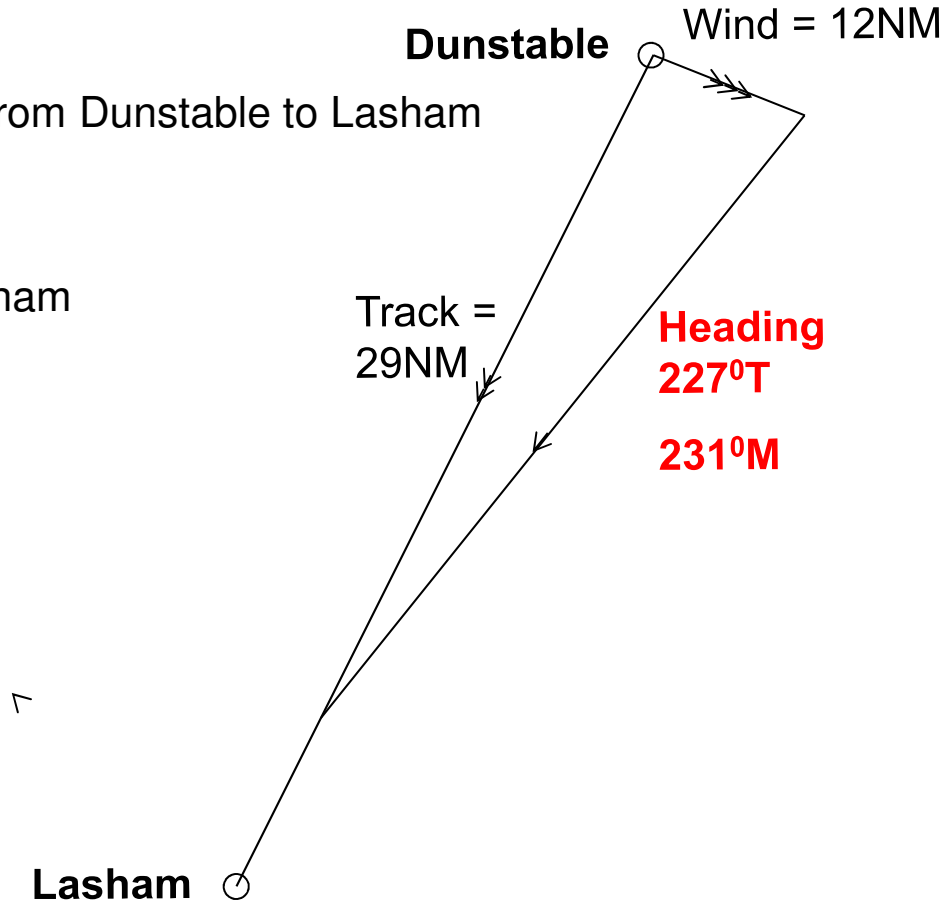
4a. Estimate the Magnetic heading to steer from Dunstable to Lasham
4b. Estimate the time from Dunstable to Lasham

5a. Estimate the Magnetic heading to steer from Lasham to Thornbury VRP
5b. Estimate the time from Lasham to Thornbury VRP

6a. Estimate the Magnetic heading to steer from Nympsfield to Dunstable
6b. Estimate the time Nympsfield to Dunstable

Plotting Vector Answers…

What heading will you steer to allow for wind drift?
What will be your estimated speed over the ground allowing for wind?
Assuming a flying speed of 30 kts and the wind from 300^0T at 12 kts



4a. Estimate the Magnetic heading to steer from Dunstable to Lasham

231^0M

4b. Estimate the time from Dunstable to Lasham

29NM per hour

44NM total

44/29 x 60 = 91 minutes

Plotting Vector Answers…

What heading will you steer to allow for wind drift?

What will be your estimated speed over the ground allowing for wind?

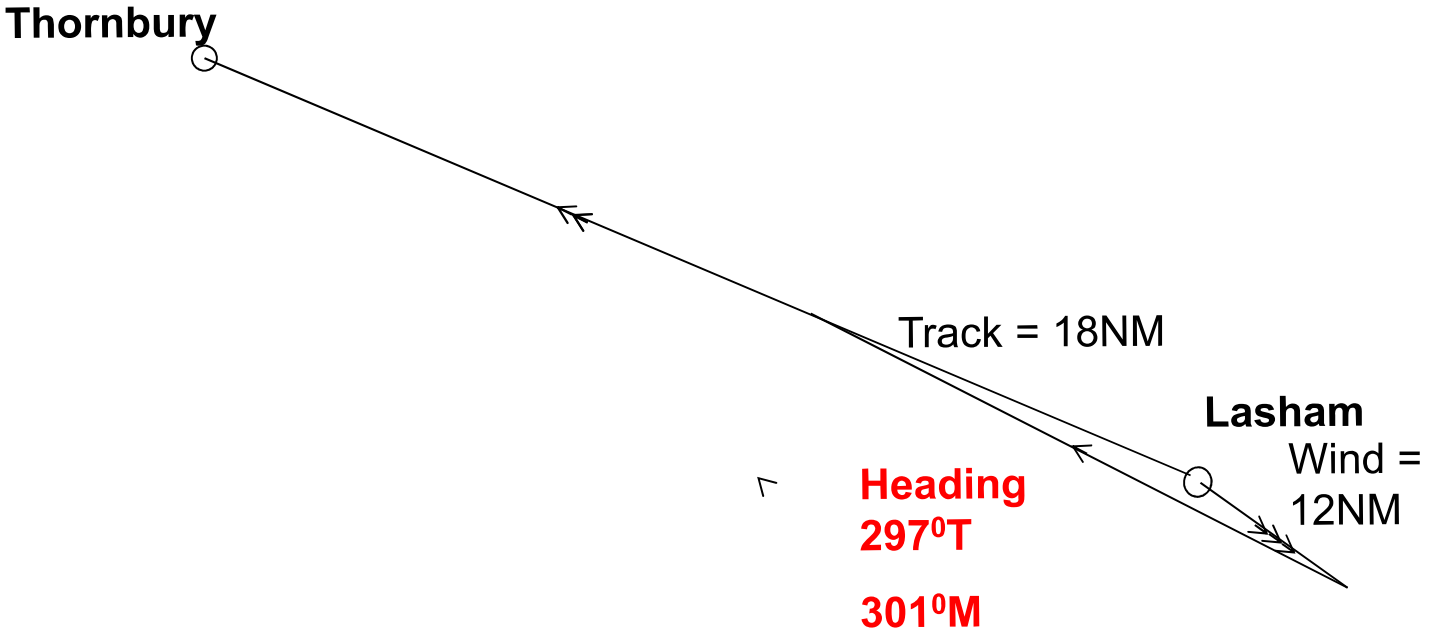
Assuming a flying speed of 30 kts and the wind from 300^0T at 12 kts

5a. Estimate the Magnetic heading to steer from Lasham to Thornbury VRP

297^0T

5b. Estimate the time from Lasham to Thornbury VRP

61/18 x 60 = 203 minutes = 3hrs 23m



Plotting Vector Answers…

What heading will you steer to allow for wind drift?

What will be your estimated speed over the ground allowing for wind?

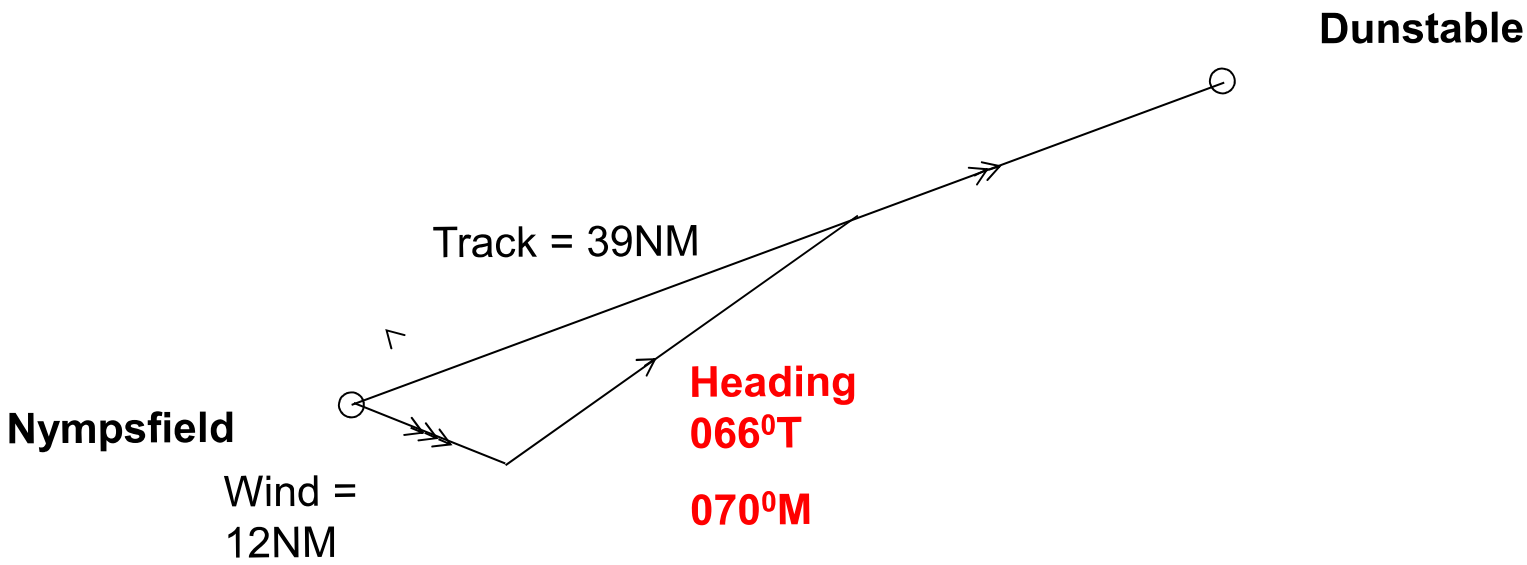
Assuming a flying speed of 30 kts and the wind from 300^0T at 12 kts

6a. Estimate the Magnetic heading to steer from Nympsfield to Dunstable

070^0M

6b. Estimate the time Nympsfield to Dunstable

65/ 39 x 60 = 100 minutes = 1hr 40m



ETA Examples…

7a En-route to Husbands Bosworth, you pass the Snow Dome in MK after 30 minutes flying from Dunstable. This is about 25km. How long will it take to get to Hus Bos from MK at that average speed?

7b You plan your final glide from 3500ft above Northampton city centre to Hus Bos. How long will it take to get there at your best L/D of 52kts?

7c Having arrived overhead Northampton from Dunstable as the first turn point on a 300km X country it took you about 1 hour, what is your average speed? How long will the whole 300k task take you?

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

Half Million Map

1cm = 5km

1inch = 7Nm

ETA Answers…

7a En-route to Husbands Bosworth, you pass the Snow Dome in MK after 30 minutes flying from Dunstable. This is about 25km. How long will it take to get to Hus Bos from MK at that average speed?

Speed 50kph with 50km to go time required = 1hour

7b You plan your final glide from 3500' above Northampton city centre to Hus Bos.

How long will it take to get there at your best L/D of 52kts?

13/ 52 x 60 = 15 minutes

(or 52 knots is a bit less than 1 mile per minute 13 miles will take a little over 13 mins)

7c Having arrived overhead Northampton from Dunstable as the first turn point on a 300km X country it took you about 1 hour, what is your average speed? How long will the whole 300k task take you?

48km in 1 hour = 48kph

300/48 x 60 = 375mins or 6 hrs 15 mins

(approx 50kph 300k will take ~ 6 hours)

Glide Angle Calculations…

- **Typical L/D 30:1** This says you can glide 30 miles from 1 mile high
  30 miles from 1Nm ~ 6000ft

- **L/D 30/1** 30/6 = 5 Nm per 1000ft
- **L/D 40/1** 40/6 = 6.7Nm per 1000ft
- **L/D 50/1** 50/6 = 8.3Nm per 1000ft

- For a K23
- L/D 34/1 34/6 = 5.7 Nm per 1000ft

- So if you fly a K23 make it easy by drawing circles on your map at 5.7 Nm intervals from Dunstable then label them 1800, 2800, 3800, 4800, 5800

  (This assumes best L/d plus 800 ft circuit height)

- Don’t forget wind will make a big difference, particularly if you are down wind!

Final Glide Examples …

8 En-route to Husbands Bosworth, you plan a final glide from Northampton city centre to arrive at Hus Bos with 800' circuit height. Assume 30:1 glide angle.

What minimum height will you need in nil wind leaving Northampton?

9 Returning to Dunstable from the west very late in the afternoon, you plan a final glide from Bicester to get you home at 800'. Assume 30:1 glide angle.

9a What minimum height will you need in nil wind leaving Bicester?

9b How long will it take to get to Dunstable at 45kts?

9c Would the final climb be legal if QNH is 1013mb?

Final Glide Answers…

8. En-route to Husbands Bosworth, you plan a final glide from Northampton city centre to arrive at Hus Bos with 800' circuit height. Assume 30:1 glide angle.

   What minimum height will you need in nil wind leaving Northampton?

   30/6 = 5 miles per 1000ft (or 1 mile per 200ft)

   13 miles = (2x1000ft + 3/5x1000ft) = 2600ft + 800ft = 3400ft leaving Northampton

9. Returning to Dunstable from the west very late in the afternoon, you plan a final glide from Bicester to get you home at 800'. Assume 30:1 glide angle.

   9a What minimum height will you need in nil wind leaving Bicester?

   30/6 = 5 miles per 1000ft (or 1 mile per 200ft)

   22 miles to glide requires 4400ft + 800ft = 5200ft leaving Bicester

   9b How long will it take to get to Dunstable at 45kts?

   22 miles at 45kts will take ~ 30 minutes (22/ 45 x 60 = 29mins)

   9c Would the final climb be legal if QNH is 1013mb?

   5200ft is below the airspace FL55 so yes it is legal

   QNH and QNE is the same so FL = Alt AMSL

Flight Level Maths…

10. You set **QFE** Dunstable at take off
Pressure drops after take off by 30mb (such a big fall is unlikely in reality)
30mb fall ~ 1000ft climb in altimeter reading
Altimeter reads 1000' higher than your actual height when you return – oops!

11. You set **QNE** 1013 and climb to just below Airspace at Flight Level 55
You climb to 5300ft (200ft clear) but on the return leg pressure drops 30mb
Flight Level 55 is now 1000' lower but you can safely climb to 5,300 indicated and still remain clear of airspace!

Pressure goes down, Flight levels go down.
OK if you set QNE. But could be a problem for QNH or QFE if not current.

For practical navigation - use the right setting on your altimeter!

Memory jogger "Pressure high to low - look out below"

Definitions to remember
QNE = "Normal Everytime"
QNH = "Nautical Height"
QFE = "Field Elevation"

1mb = 30ft
10mb = 300ft
30mb = 1000ft

Flight Level Examples…

12. **Find QNH** from QFE and height of field above sea level

Or how do you set your altimeter to QNH when all you know is the height of the field?

a) Find QNH if QFE Dunstable is 978mb (QNH = 978 + 15 = 993mb)

b) Find QNH if QFE Little Gransden is 995mb?

c) Find QNH if QFE Northampton Sywell is 1002mb?

13. **Find altitude of Flight Level** from QNH

Or how high is a flight level when you have set QNH on your altimeter?

a) QNH is 993mb (1013 to 993 = -20mb ~ Flight levels all go down ~ 20mb = 600' down)

b) QNH is 1015mb (1013 to 1015 = +2mb ~ Flight levels all go up ~ 2mb = 60' up)

c) QNH is 1019mb?

d) QNH is 1007mb?

Flight Level Answers …

These calculations are only required for the exam – you should not need these for practical navigation!

12a. Find QNH if QFE Dunstable is 978mb

QNH = 978

500ft is 15mb

978

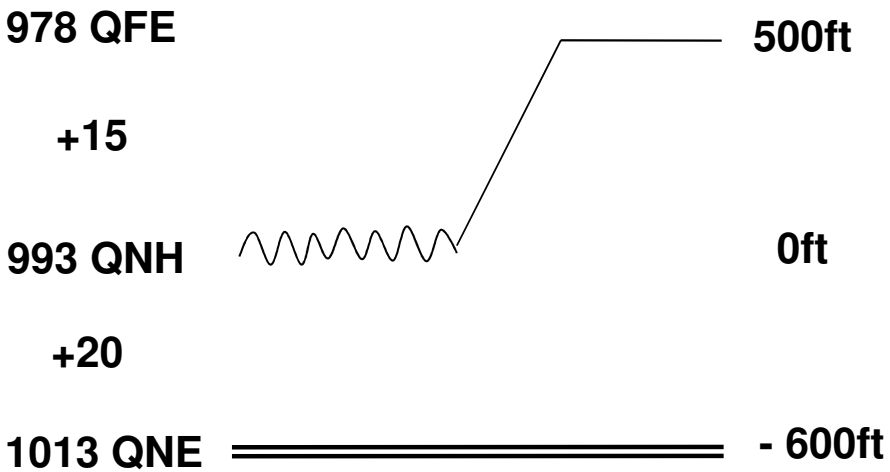
+15

QNH = 993

QNE = 1013

20mb

- 600ft



Flight Level Answers …

12b. Find QNH if QFE Little Gransden is 995mb?

Little Gransden at 250

250 = 8mb

995

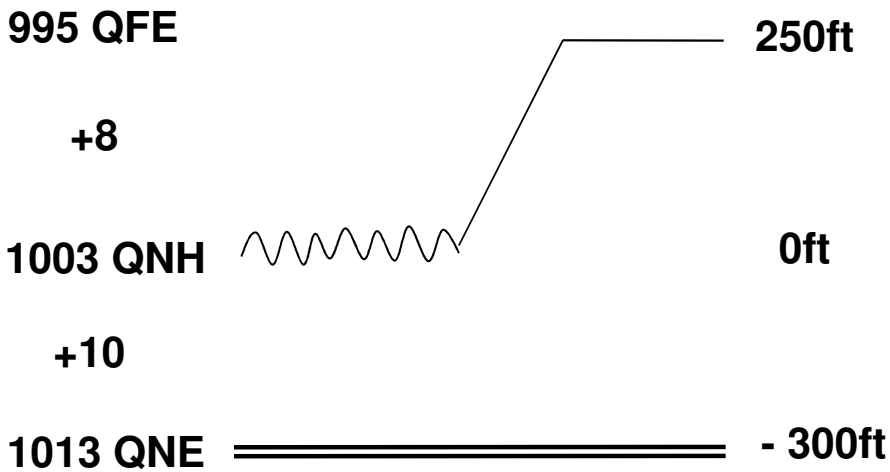
+8

QNH = 1003

QNE = 1013

10mb

- 300ft



Flight Level Answers …

These calculations are only required for the exam – you should not need these for practical navigation!

12c. Find QNH if QFE
Northampton Sywell is 1002mb?

QFE = 1002

Sywell at 419ft is 14mb

1002

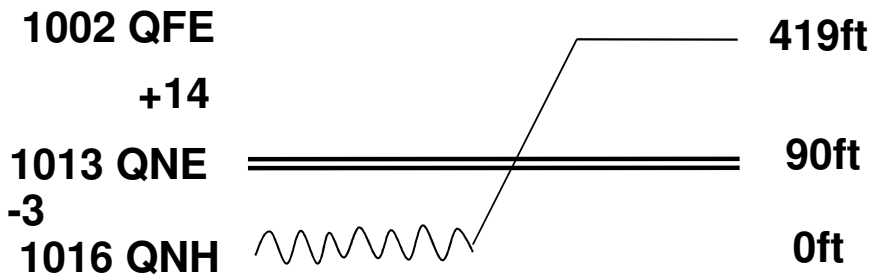
+14

QNH = 1016

QNE = 1013

3 mb

+ 90ft



Flight Level Practical Navigation…

QFE at Dunstable is 995, you set your altimeter to 0’ before take off

You are approaching Daventry CTA FL55 Class A airspace,
Your altimeter reads 4,900’ above Dunstable what do you do?

Option A –
Step 1 calculate QNH and the height of QNE
Step 2 calculate the shift in Flight level and the reduction on 5500ft
Step 3 mentally add 500’ height of Dunstable and compare the reduction

Option B –
Make a note of QFE = 995 then reset your altimeter to **1013**
Now simply read Flight levels on your altimeter

There is only ***one*** practical option. Write down QFE and QNH before you leave. Switch to QNE if you get near to flight levels. Get an update on the radio for QNH if pressure changes significantly.

Example Flight Level exam questions…

14a. QFE at Lasham is 997 and you set your altimeter to 0’ at Lasham,
What height can you fly to before entering airspace at FL55?

14b. QFE at Dunstable is 1002 and you set your altimeter to 0’ at Dunstable before flying to Lasham
What height can you fly to before entering airspace near Lasham LTMA 5000+?

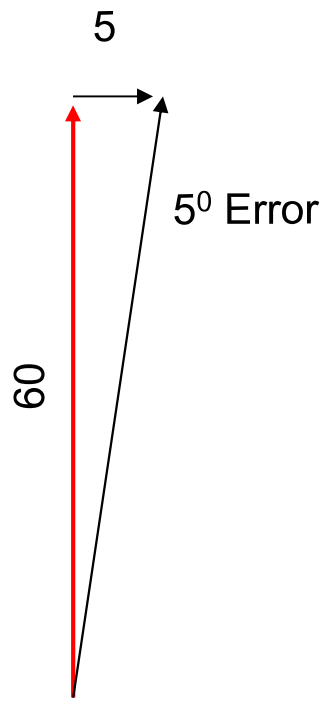
14c. Flying to Hus Bos you pass over Sywell airfield near Northampton. You set your altimeter to 0’ before leaving Dunstable.
What height on your altimeter will keep you clear of the ATZ?

14d. Flying home from Hus Bos using QNE 1013 you are approaching Class D airspace just South of Cranfield.
How would you reset your altimeter?

And a few practical considerations…
What would you think about if a warm front is approaching and pressure is forecast to fall?
(What will the pressure fall do to your altimeter?) (Where can you get a pressure update?)
(What wind shift can you expect and how will that affect your final glide?)

Rule of 60ths for wind drift…

This is the simplest but the least accurate way of estimating drift



The Rule of 60^{ths} says:
1 degree off course is about 1 mile off track in 60 miles
5 degrees off course is about 5 miles off track in 60 miles

Flying at 60 kts with 1 kt cross wind is about 1 degree off course
Flying at 60 kts with 5 kt cross wind is about 5 degrees off course

Winds at flying heights can be high
And speed made good can be low

So:
Averaging 30 kts with 5 kt cross wind is about 10 degrees off course
Average 30kts with 10 kt cross wind is about 20 degrees off course!

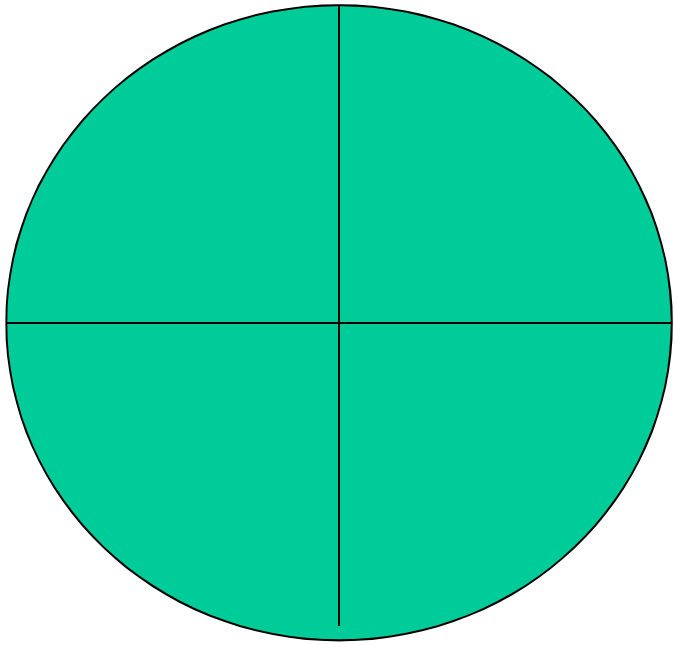
It may not be very accurate but its easy to do

…you will need to make large corrections into wind on crosswind legs

Estimating drift – power pilot method…

Wind angle on the nose or tail - no drift

60dgs or more
all the drift



45 dgs
¾ drift

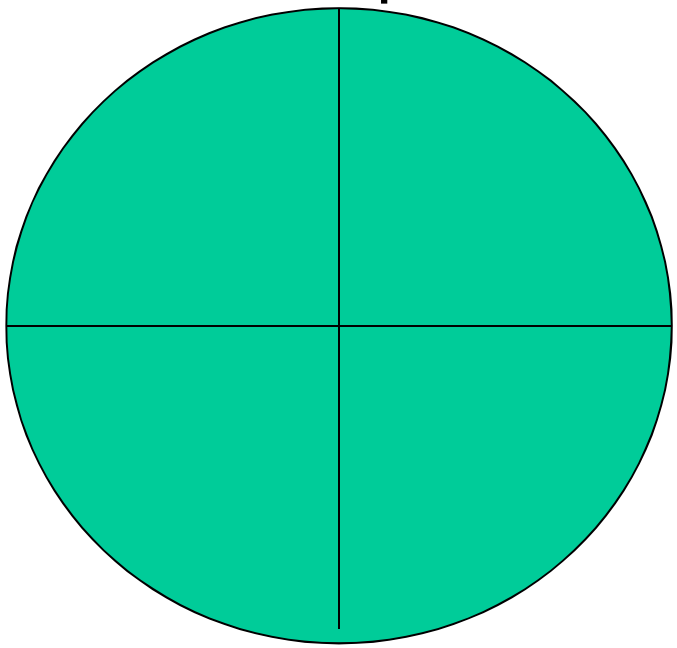
15 dgs
¼ of drift

30 dgs
½ drift

Estimating ground speed – power pilot method…

Wind angle on the beam - no speed change

60dgs or more
all the speed



45 dgs
¾ of speed

15 dgs
¼ of speed

30 dgs
½ of speed

Plotting a Silver Distance flight…

You are planning a Silver Distance flight from Dunstable to Husbands Bosworth

1. Plot a direct line course, find the distance from Dunstable to Hus Bos

2. Find the Magnetic track to Hus Bos

3. Find the reciprocal Magnetic track from Hus Bos back to Dunstable

4. What would be your offset course in wind a) 240 15kt b) 330 5kt

5. What features can you use en-route to check on a) progress b) track

P.S. before you go don't forget to make a declaration signed by an Official Observer
Remember the max. release height rule 1% of 72km = 720m is 2300ft above Hus Bos (say 2200ft above Dunstable max) Also a logger is required to make a Silver Distance claim

(Enstone is 61km 610m is 2000ft so release at 1900ft East of the club
Or release at 2000 then establish a low point at 1900 before you start climbing)

 …get the ground frequency for Enstone or Hus Bos before you go

Syllabus as Released by the BGA January 2013…

5. Navigation 1 – Map reading and Airspace

- **Syllabus**: Airspace regulations as they apply to gliders in UK, interpretation of ICAO Aeronautical charts, definition of track and heading, vertical navigation, magnetic compass, altimetry.
- **Aim:** The student will understand the relevance of the various types of airspace to glider navigation in the UK and the requirements for three-dimensional navigation.

Specifically the student should be able to:

- State the types (and dimensions where appropriate) of UK airspace and associated IFR and VFR flight regulations and procedures for gliders,
- interpret the legends on quarter million and half million scale ICAO aeronautical charts,
- describe atmospheric pressure and its measurement in millibars,
- state the value of the ICAO Standard Atmosphere as 1013.2 mB,
- describe use of QFE, QNH and flight level pressure settings,
- describe the construction of a ‘wet’ compass,
- describe the advantages and limitations of a ‘wet’ compass,
- describe angle of dip and acceleration errors,
- describe magnetic variation and the use of isogonal lines on air charts,
- explain the limited use of a ‘wet’ compass and describe ‘acceleration/dip free’ design.

…you may need to read up on some items

Syllabus as Released by the BGA January 2013…

6. Navigation 2 - practical cross country flying

- **Syllabus:** Speed to fly, glide calculations, visibility of ground features, maps, field selection, preparation for a navigational exercise.
- **Aim:** The student will acquire the requisite knowledge for the safe and expeditious conduct of a cross-country flight in a glider.

Specifically the student should be able to:

- Interpret speed to fly data from a polar curve and relate it to the practical Macready theory
- Mentally approximate the glide distance from any given height,
- Describe the techniques and considerations for selecting, preparing, markingup and using maps for cross-country navigation,
- Describe the difference in appearance of visual features under varying flight conditions,
- Describe approximation of position, 'dead reckoning' methods of navigation and actions when lost,
- Describe procedures for use when uncertain of position,
- Identify likely sources of 'lift' and describe techniques for their optimal use,
- List the factors to be considered when preparing for a field landing, including identifying wind direction and effects of obstructions on field boundaries,
- Prepare a cross-country flight plan taking into consideration such factors as
- local weather conditions, airspace, condition of fields, NOTAMs, TNWs, etc.

…you may need to read up on some items

London Gliding Club

End

Navigation Part 2