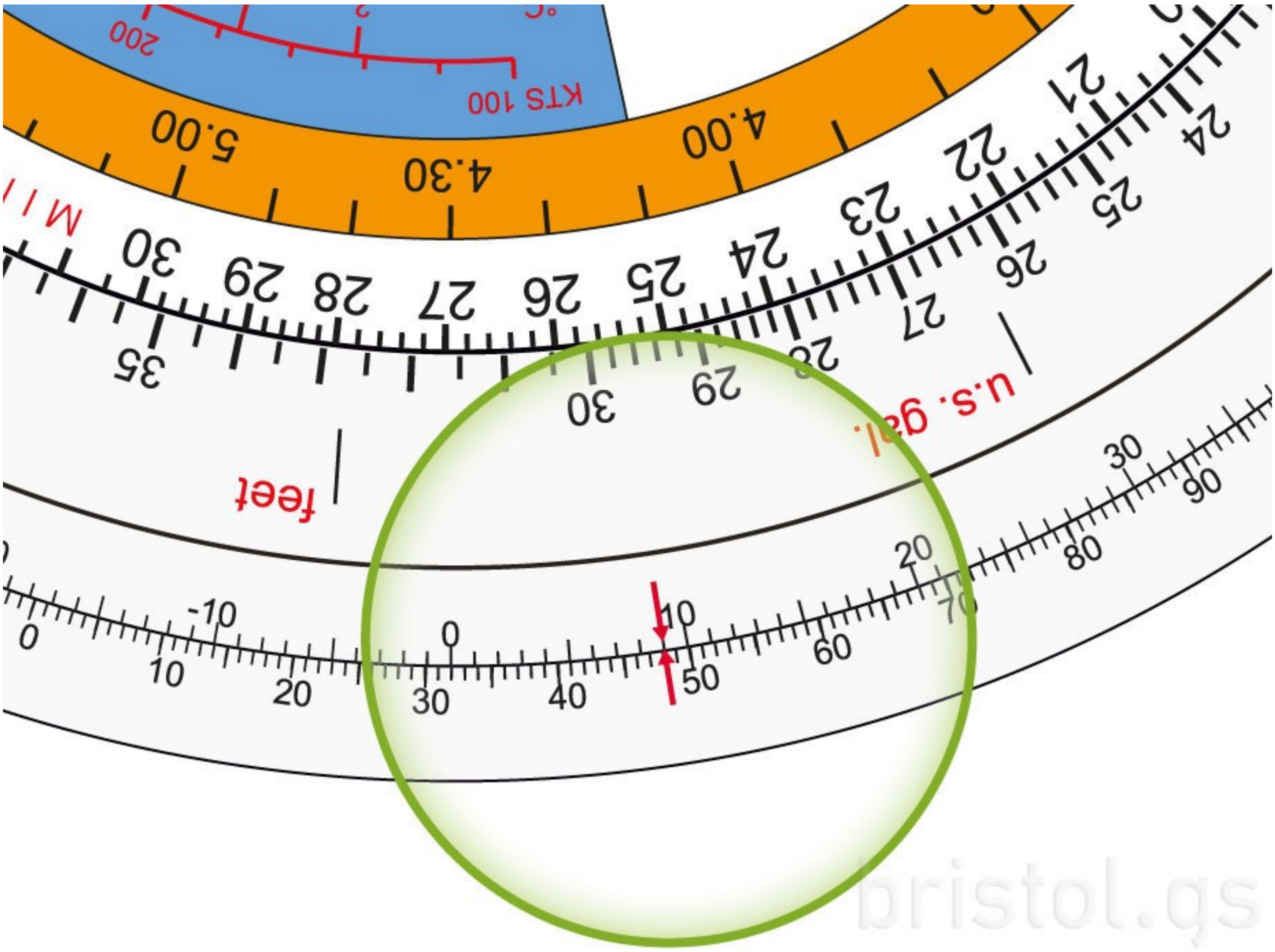
CRP-5 REVISION WORKSHEET

Conversions

You can carry out literally dozens of different conversions on the calculation side of the CRP-5. It is, quite simply, a circular slide rule. Note that YOU decide whether it is 0.1, 1, 10, 100, 1000 or whatever you need. So where the relationship is a constant, it is as simple as setting one figure against its datum, and then reading off the new value against the new datum. Always do a rough calculation in your head **before** using the CRP-5 - saves embarrassment!

Temperature Conversions

For temperature conversions, use the fixed scale at the bottom of the calculator side of the CRP-5, so no need to remember those complicated formulae about taking your first cousin's birthday away from your inside leg measurement…



1. What is 0°F in Celsius?

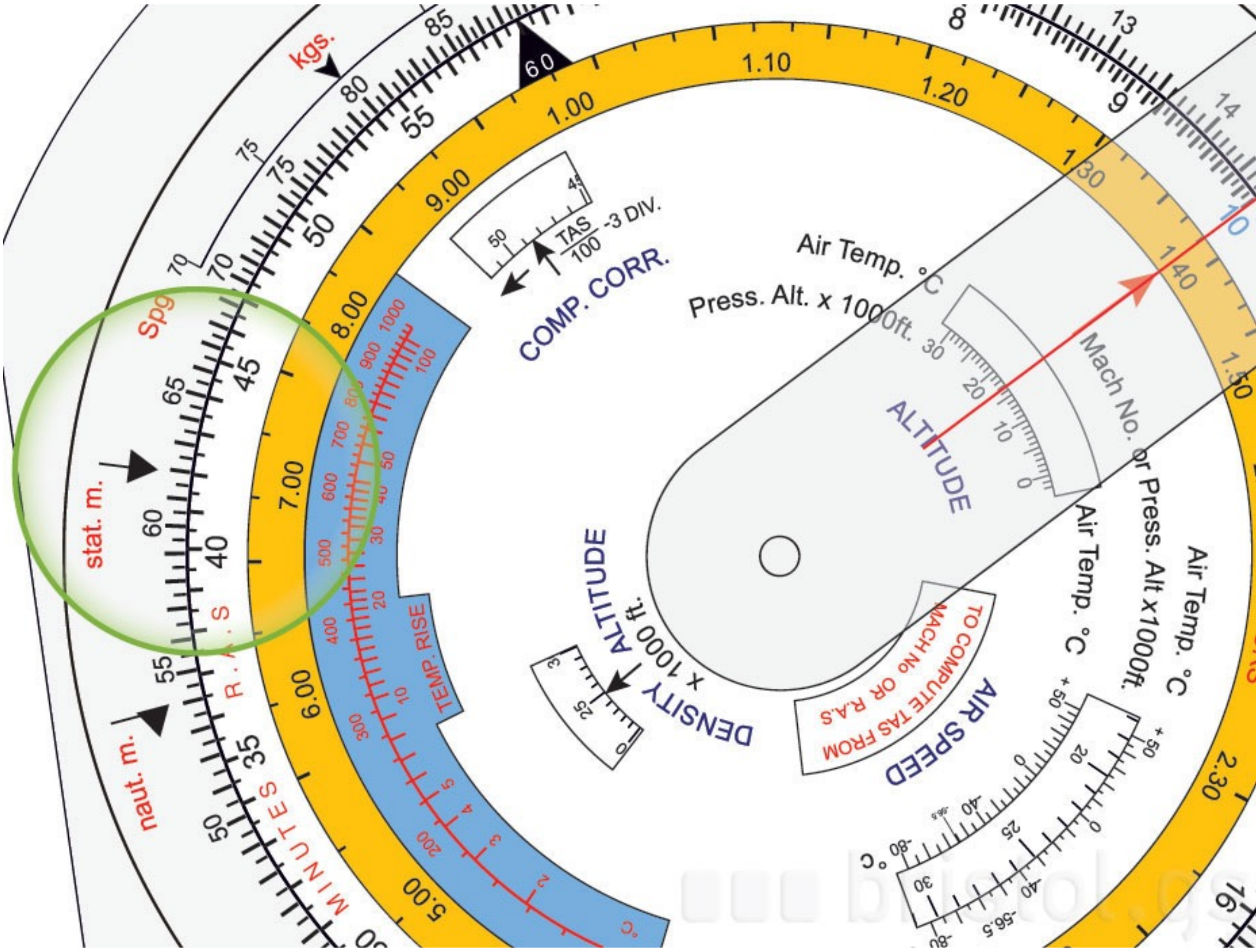
2. What is 100°F in Celsius?

3. Which is the higher, 233K or -50°F?

4. Which is the lower, 288K or 60°F?

5. Your historic aircraft has a Fahrenheit OAT gauge. At what temperature will icing first occur?

Distance Conversions



1. Your route has been measured in statute miles, but you need to know the distance in nautical miles. The illustration above should get you started nicely. the total distance is 420 miles. How much is that in nautical miles?

2. How many metres in a nautical mile?

3. How high is a statute mile in feet?

4. An old airfield document quotes a runway as being 4000 yards long. What is that in metres?

5. According to the Blues Brothers “It’s 108 miles to Chicago…” If that is statute miles, how many kilometres would that be?

Volume Conversions

1. You are refuelling at an unfamiliar aerodrome, where the fuel is delivered in US Gal. the operator tells you he has put in 30 US Gal. How many litres is that?

2. The maximum fuel capacity of the Cabri G2 is 170 litres. How many imperial gallons is that?

3. How many imperial gallons would it take to fill a Texan’s Ten Gallon Hat?

4. Your car has a fuel tank capacity of 15 imperial gallons. How many litres remain when half a tank is showing?

5. A standard barrel of AVGAS is roughly 45 imperial gallons. How many litres is that?

Weight Conversions

1. An American passenger has arrived for a charter flight. He looks larger than average, so you (politely!) ask for his weight. He tells you he weighs 250 lb. What is that in kilograms?

2. You are weighing your overnight bag for a land away in a Cabri G2. The max allowable load is 40 kg, but your bathroom scales at home only weigh in Stones and Pounds. What is 40 kg in St/Lb?

3. You are hangaring a Cabri G2 on the same overnight stop. The handlers there have a hydraulic mover, and want to know the heaviest (MAUW) your aircraft could possibly weigh, but in lb.

4. Your hosts on the overnight stop present you with a whole local cheese, labelled as 10 lb in weight. Can you carry this in your forward luggage compartment (max load 5 kg)?

5. Your Cabri G2 has a Basic Empty Weight of 430 kg. What is that in pounds?

Volume/Weight Conversions

1. The barrel of AVGAS mentioned above held a number of litres. How much would that amount of fuel weight at a specific gravity of 0.72?

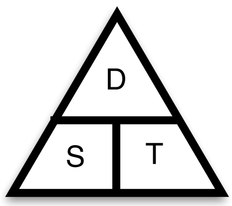
2. The 30 US gallons delivered to you earlier had an answer in litres. How many pounds would those litres weigh?

3. …and how many kg?

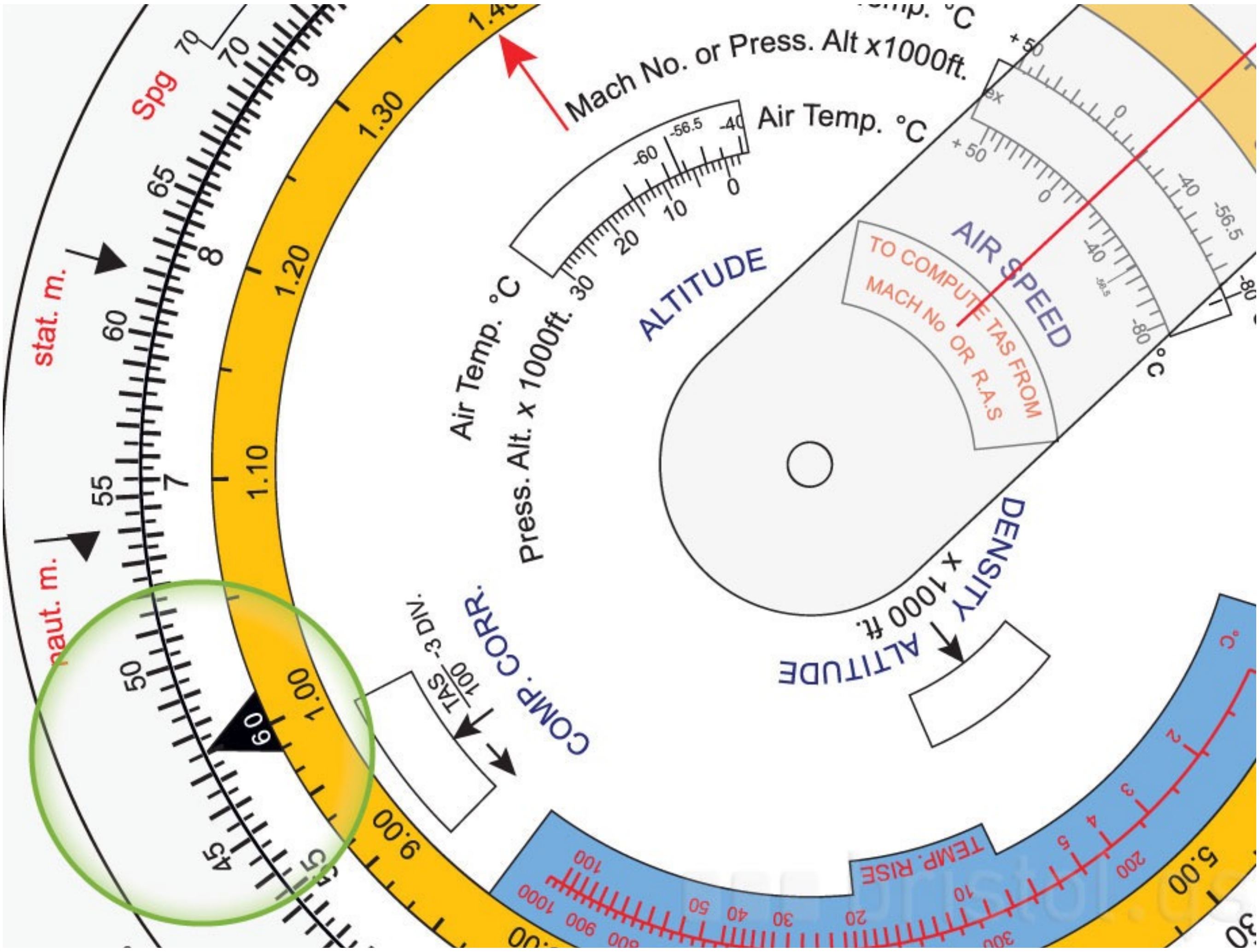
4. How much heavier would the Texan's hat be in lb if it was filled with Jet A1 fuel with a SG of 0.78?

5. What is the weight in kg of a full Cabri G2 fuel load, if the SG of the fuel is 0.73?

Distance/Speed/Time Calculations



The CRP-5 is most frequently used for resolving the basic DST triangle. This magic triangle works like all of the others, so where you want to now the value of one parameter, you look at the positions of the other two for the correct formula. Using the diagram above, you can see that to obtain T, we need to calculate D over S. The maths is taken out of your hands by using the CRP-5. Use the black triangle with 60 inside it (see the illustration below) to represent one hour, and these should then be easy problems to solve…



1. Groundspeed is 130 kt. How long will we take for a leg of 35 miles?

2. We have 27 nm to run to a funeral fly past. We must arrive exactly overhead at noon. It is now 1140. What must our groundspeed be to be overhead on time?

3. You are planning an aerial photo in company with a visiting helicopter, but his ASI is calibrated in km/h. What speed must you brief him to fly to equate to your planned speed of 75 kt as you fly past a local landmark for the photo?

4. Groundspeed is 70 kt. How long to fly 200 nm?

5. We now have an improved groundspeed of 83 kt. Now how long to fly the same 200 nm?

Fuel Consumption

As we have already seen on the DST problems, once we have set the ratio of time and distance we can read off whatever we need from the CRP-5. The same goes for fuel consumption, as it is a problem of fuel versus time.

1. We are using fuel at a rate of 54.4 kg/min in 73 minutes. What is the burn rate in kg.hr?

2. If we are predicting a burn rate of 15 US gallons per hour, how much will have been used after 25 minutes?

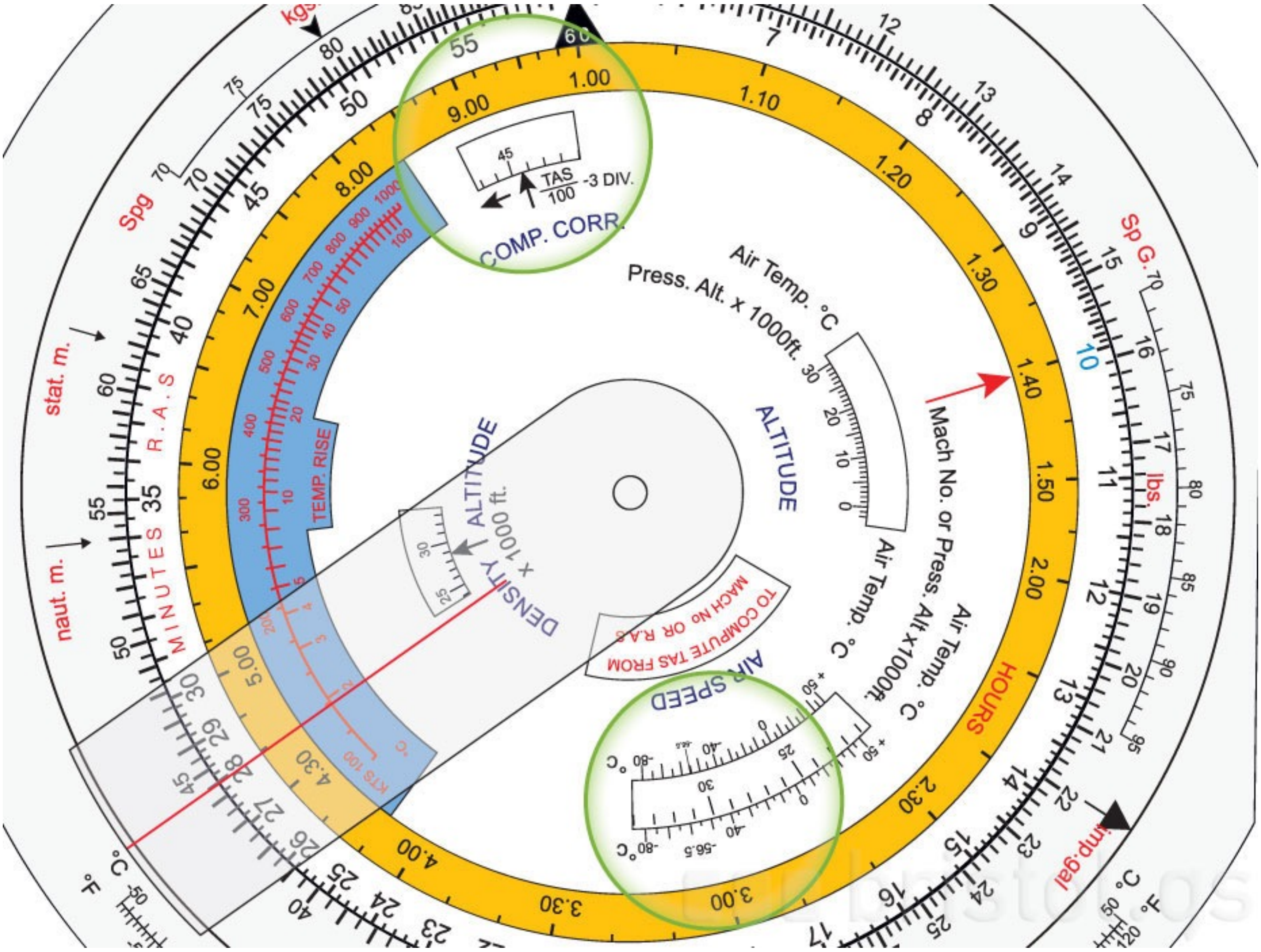
3. We have a fuel consumption predicted at 34 litres per hour. What is our endurance to tanks dry if we started with 170 litres?

4. Our gas turbine helicopter burns 2.5 kg/minute. What is the hourly burn rate?

5. So what is the endurance to tanks dry if we started with 350 kg in the same helicopter?

CAS/TAS Calculation

We seldom even think about our true airspeed (TAS) in a helicopter, but the difference between our CAS and TAS can be significant at extremes of temperature and altitude. For this we use the AIRSPEED window in the (so far unexplored) inner section of the calculator side (ringed in green at the bottom of the illustration below). What we use even less seldom is the COMP. CORR. window (the upper green highlight in the picture below), which really only comes into play at TAS of greater than 300 kt - so it is never going to worry you in the real world if you have (H) after your licence. You can be asked about it, and expected to calculate for it, in the ATPL(H) exams though…



1. Flying at FL50, with an OAT of +30°C. If your CAS is 100 kt, what is our TAS?

2. So at what temperature would our CAS and TAS be the same at 5000' PA?

3. On a winter's day, flying at 1500' with an OAT of -10°C and a CAS of 80 kt, what is your TAS?

4. Right. let's get upstairs with the big jets. FL 350, OAT -56.5°C, CAS of 280kt. What is the TAS? Don't forget the compressibility correction if the TAS is >300 kt.

5. Another for the practice. This time we are at FL250, OAT -10°C, CAS of 250 kt. What is the TAS?

Density Altitude Calculation

Lower air density means less engine power, and of course, as density is a component of the lift formula, it also means less lift for a given α. There is a formula for the conversion to be done mathematically, but the CRP-5 will do it quickly and quite accurately. The setting starts the same way as we did CAS to TAS, using the AIRSPEED window to set PA and OAT. Then, without rotating the wheel, simply read the figure in the DENSITY ALTITUDE window.

1. You are flying over the Canadian prairie. The pressure altitude is 3500', and the OAT is +30°C. What is the density altitude?

2. You are operating in the Antarctic, up to 2000' PA, and temperatures as low as -25°C. What is your density altitude?

3. Mount Snowdon is at 3,560 ft amsl. You are tasked to lift an injured climber from near the summit (so work on 3500'). The OAT on a hot summer day is 20°C. What is the DA?

4. You have been asked to land a Cabri G2 at the highest PA possible on the slopes of Mt Kilimanjaro. Near the summit, at around 19,000 amsl, the temperature is ISA equivalent, as is the lapse rate all the way down. What is the DA at your maximum PA?

5. It is six months later. You are tasked to return to Kilimanjaro and repeat the process. However, this time the temperature is ISA +20°C. Now what is your DA?

Minutes to Hours Conversion

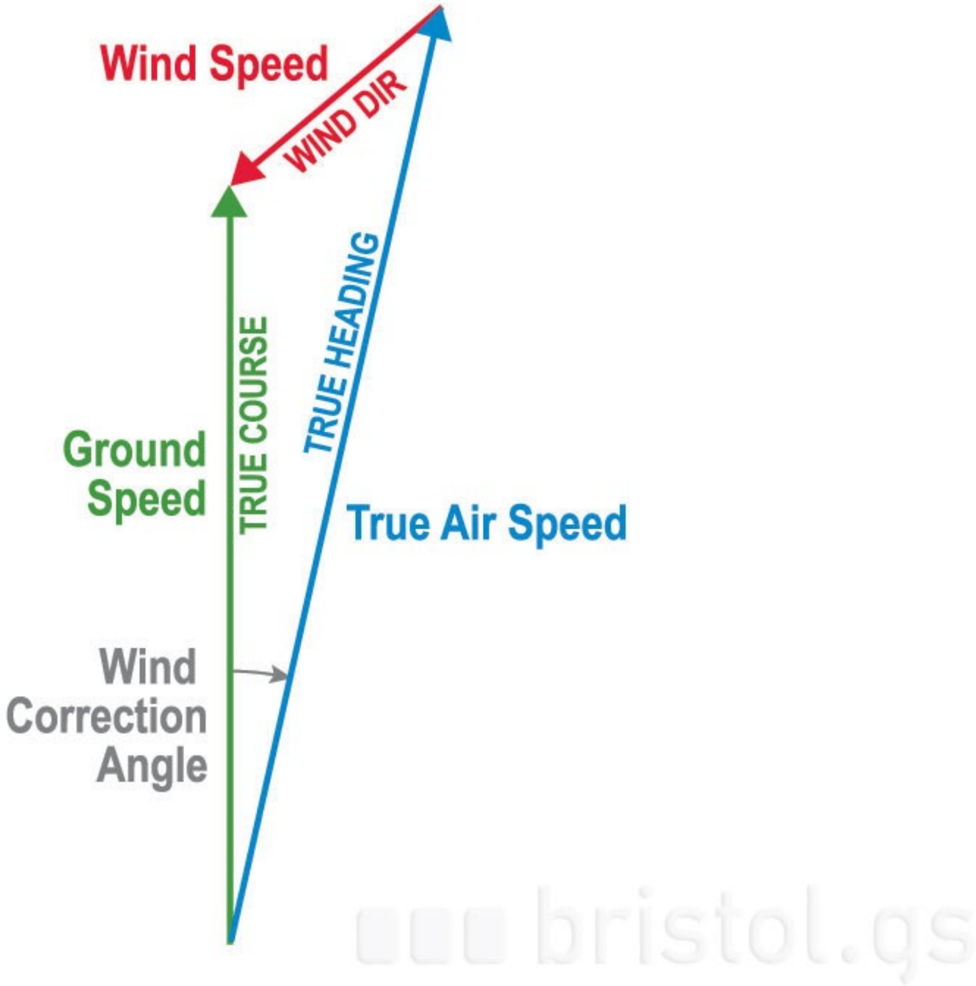
This is achieved using the yellow ring on the computer - bet you wondered what that was for? Once you have a navigation leg computed in minutes, you can easily convert it to hours and minutes by this simple method. Align the cursor on the minutes and read in to the yellow for the hours and minutes

1. Leg time is 83 minutes. What is that in hours and minutes?

2. Leg time is 274 minutes. Convert to hours and minutes

Resolving the Triangle of Velocities

Now we come to the other side of the CRP-5, the ***really*** clever bit! First, let's make sure we are all singing from the same song sheet.



We can measure the true course (track) and distance in the planning room. But that will all come to nothing once we add in the forecast wind. The wind velocity will move the aircraft off course if uncorrected, as you can see above. The wind is coming from the right, so we would drift left if uncorrected. And because it is also coming from ahead of us, we are moving slower across the ground. So to fly the course we require, we have to correct for the wind, and by calculating the groundspeed we can see how long that will take - simples!

A couple of basic rules before we crack on with the questions. Always use the low speed side of the slide - from 40 to 300 kt. Note that at speeds less than 100 kt the drift lines are 2° apart; above 100 kt they are every degree.

When marking the wind on to the slide, imagine the wind blowing towards you from the little blue circle in the centre of the rotating window disc. So the wind is always drawn **below** the blue circle. Set your cruise speed – around 80 kt in the Cabri, for example, by placing the blue circle over 80 on the slide. Then rotate the disc until the wind direction is at the top of the computer, under the TRUE HEADING triangle – we'll use 240° for this example. Now, using a soft pencil or a soluble fine marker pen, place a small cross or dot over the wind value – we'll use 25 kt for this one. So your mark should now be directly below the blue circle, and 25 kt below, located at 55 kt in this example.

Now we rotate the disc to our true course – let's use 360°. Note that our mark has zoomed off to the right, and gone ahead of the blue dot by some margin. That is all as it should be.

To correct for drift we need to move the disc towards our dot, by the same amount as the indicated drift. This is around 12°, so we move the disc to the right by 12°. The scale at the top assists us here. We now have 348° at the top, but the dot is now nearer 13° of drift. Now we move the disc another 1° right to catch up with our dot, but note that it is still close to 13°. We have solved the wind. Our True Heading is 347°, and our groundspeed is 91 kt. Further correction may still be necessary to correct to a Magnetic Heading, dependent upon the local variation shown on the isogonals.

Let's try a few…

Heading and Groundspeed (TAS, Track, W/V all known)

1. Gazelle in the cruise at 120 kt TAS, True track of 240°. W/V 040°/20 kt. Solve True heading and groundspeed.

2. Bell 47 in the cruise at 60 kt TAS, True track of 195°. W/V 300°/25 kt. Solve True heading and groundspeed.

3. Cabri G2 in the cruise at 80 kt TAS, True track of 290°. W/V 300°/40 kt. Solve True heading and groundspeed.

4. AW 169 in the cruise at 145 kt TAS, True track of 030°. W/V 180°/35 kt. Solve True heading and groundspeed.

5. Airbus EC120B in the cruise at 110 kt TAS, True track of 140°. W/V 240°/45 kt. Solve True heading and groundspeed.

Wind Velocity (Heading, TAS, Track and Groundspeed all known)

Of course, all of that works fine with forecast winds – and the met man never gets it wrong, does he? Hmmm. However, if we know all of the parameters shown above we can get a 'spot wind' from the computer. Just set heading and TAS as before, and then mark the disc as for the relevant groundspeed and drift. Some sophisticated aircraft will have a GS/DFT indicator, or you can calculate it from drift lines and the stopwatch. Then simply rotate the disc so the the wind mark is at the bottom of the disc and read off the True Heading and speed. Let's try it…

1. Heading 110° at 110 kts TAS. GS is 130 kt, drift is 20° right.

2. Heading 250° at 135 kts TAS. GS is 170 kt, drift is 15° left.

3. Heading 045° at 90 kts TAS. GS is 70 kt, drift is 25° right.

4. Heading 320° at 140 kts TAS. GS is 130 kt, drift is 20° left.

5. Heading 170° at 60 kts TAS. GS is 95 kt, drift is 10° left.

Crosswind and Headwind Components

Finally, we can use the computer to separate the crosswind and headwind components from the w/v. Note that runway directions are always Magnetic, and so are ATC reported w/v - keeps it simple! Remember that w/v in a TAF and METAR are True, not Magnetic.

For this simple exercise we use the square grid at the bottom of the slide, where the dimensions are the same in both directions. Simply rotate the disc to the wind direction, and then mark the speed in as before - below the circle. Then rotate the disc to the runway heading and see the headwind on the horizontal rows, and the crosswind on the vertical columns. If the mark goes up above the zero line then you have a tailwind component. Just slide down until the mark is on the zero line, and then count down to the blue circle. Easy, innit?

1. Rwy 28, w/v 315°/25

2. Rwy 22, w/v 190°/15

3. Rwy 35, w/v 140°/07

4. Rwy 03, w/v 025°/35

5. Rwy 14, w/v 090°/18

Answers

Temperature Conversions

1. -18°C

2. 38°C

3. This question presumes you know that 0K = -273°C. Therefore 0°C = +273K. 273 - 233 = -40°C, which is roughly the same as -40°F. So 233K is warmer than -50°F, by -10°F

4. 288K is 15°C, which is very slightly lower than 60°F

5. 0°C is where icing will first occur, so a simple read across from that to 32°F for the equivalent

Distance Conversions

1. Line up the CRP-5 as shown in the illustration, with 420 against the Stat.M little black arrow. Then simply read off 365 against the Naut.M little black arrow. At this point do a TLAR check (that looks about right); did you expect there to be fewer NM than statute miles? Yes?

2. You might have got this one from your own memory bank - it is exactly 1852m. But by setting 1 on the inner scale against the Naut.M arrow and then reading off KM-M-LTR on the outer scale, you should be able to read roughly 1850m on the inner scale

3. Now, why ever would you want to know that? Using the same method as above, you can see that it is 5280ft. Check it by calculation; 1760 x 3 = 5280. Works, doesn't it?

4. Just a shade over 3650 metres

5. 174km

Volume Conversions

1. 114 litres

2. 37.5 imp gal

3. 8.35 imp gal

4. 15 imp gal = 68 litres x 0.5 = 34 litres

5. 205 litres

Weight Conversions

Watch out for these, as the datum for each is the little black triangle below the KGS or above the lbs in the relevant specific gravity (Sp.G)sectors. Otherwise these are quite straightforward

1. 114 kg

2. 40 kg = 88 lb. There are 14 lb in a stone, so 88 ÷ 14 = 6.285. 6 x 14 = 84, so the answer is 6 stone 4 lb

3. Max Gross Weight is 700 kg. That is 1540 lb on the CRP-5

4. Well, 10 lb converts to 4.55 kg, so gratefully accept the cheese!

5. A shade over 945 lb on the CRP-5 (946 mathematically)

Volume/Weight Conversions

1. First set 205 on the inner scale to KM-M-LTR on the outer scale. Now rotate the cursor line until it aligns with 0.72 in the 'Sp. G KGS' zone (roughly ten o'clock from the KM-M-LTR position). The simply read off the value on the cursor line against the inner scale. Around 147.5 kg? Now for the TLAR check. 0.72 is less than 0.74, which would be three-quarters. 3/4 of 200 is 150 - so in the ball park, right?

2. The same procedure as the previous question, but this time go to the 'Sp.G lbs' at around the two o'clock position. Should come up with 180 lb

3. 82 kg

4. First we need to convert the volume to litres. 10 US. Gal = 3.8 LTR. Now we already have 3.8 litres against the KM-M-LTR at the top of the computer, so simply state the cursor until it lies above the SG in the lbs section, and read off 17.2 lb. Note that the divisions are not constant around the scales – they are a logarithmic expansion/contraction, which thankfully you do not have to understand! Here each division is worth 0.2

5. We already saw that it was 170 litres. Set that to the top of the wheel, and then rotate the cursor to 0.73 in the Sp.G KGS section. The read off 124. Check it with a calculator if you like; 170 x 0.73 = 124.1, so we won't quibble about the 0.1, will we?

Distance/Speed/Time Calculations

1. Black triangle on the inner scale set against 130 on the outer scale sets the GS. Now we simply rotate the cursor to be against 35 on the outer scale. The answer is 16.2', more usually expressed as 16' 12", as 0.1 of a minute is 6'

2. This is quite simple. Place 27 nm on the outer scale against 20 minutes on the inner scale, and then read off the groundspeed on the outer scale against the 60 pointer on the inner scale. 81 kt

3. No need for a DST calculation at all here. Simply convert 75 nm to km. 139 approx

4. 172", or 2 hours and 52 minutes

5. 145', or 2 hours and 25 minutes

Fuel Consumption

1. Set time on the inner scale against fuel burn on the outer, and then read off the hourly rate against the 60 triangle on the inner scale against the fuel on the outer scale. Around 44.75. TLAR check? Less than the burn in 73 minutes, so about right

2. 6.25 US gallons. TLAR check. Less than half an hour, so should be less than half the rate – and it is. In fact, the unit of measurement is not relevant. Try the same with kg or litres or imperial gallons. it is just a ratio of quantity over time. So it could be carrots per cubic fortnight, so long as we do not mix units in an equation…

3. Set 60 (inner) against 34 (outer). Now read off 170 (outer) to read 300 (inner). So 300 minutes, or 5 hours

4. Set 1 on the inner scale for time against 2.5 on the outer for fuel. Now simply read 60 on the inner against 150 on the outer. Try it with a calculator – I did!

5. Leave the burn rate where it already is, with 60 against 150, and then move the cursor around to 350 on the outer scale to show 140 on the inner scale. 140 minutes. or 2 hours 20 minutes. TLAR? You bet!

CAS/TAS Calculation

1. Remember that FL are measured against 1013.25 hPa, so the same as a pressure altitude (PA). Set the temperature of +30 (careful, not -30) in the AIRSPEED window against a Pressure Altitude of 5000. Then, without rotating the wheel, read off 100 kt RAS/CAS on the inner scale against TAS on the outer scale. Should be around 112.5. TLAR check? TAS will always be greater than CAS at our operating altitudes and temperatures

2. Set CAS and TAS both at 100, and then read off what you see in the AIRSPEED window. Should be just below -30°C, so thankfully rare in our latitudes

3. 78.5 kt TAS

4. Set FL350 against -56.5°C. It is a shorter, slightly thicker line, denoting the theoretical tropopause. Now read off 280 CAS against the TAS. Around 495 kt? Quite a difference, ain't it? Because it is >300 kt TAS we need to do the **COMP. CORR.** next. We can see that the formula is given to us below the window. Let's round our 495 up to 500. 500÷100 is 5, then we subtract 3. That means we move the wheel 2 divisions **in the direction of the horizontal arrow.** Now we can see that our 280 kt CAS has moved around to around 475 kt TAS. TLAR check? Well, the much thinner air at altitude means our ASI is massively under-reading, so we are expecting a huge increase in TAS over CAS, and we certainly have that. But as we are approaching compressibility we are expecting a little more resistance, and so the **COMP. CORR.** has reduced the TAS a little

5. 382 kt. Now, please tell me you didn't forget the **COMP. CORR.** - did you?

Density Altitude Calculation

1. A little over 6100'. If I calculated it using DA = PA +/- 120T, where T is the difference between ISA and ambient, I would arrive at 6140', so certainly in the ball park

2. -2500', so lovely dense air for lift and for engine power!

3. 5000' DA

4. This multi-part question test your knowledge of the Cabri G2 limitations, ISA and use of the CRP-5. Start with the max PA for the Cabri - 13,000'. Then look at the temperature profile. The ISA temperature at 13,000' is 15 - (13 x 2) = -11°C. Now repeat the process already used above to determine the DA. You should see 13,000' - no surprise really, as we are using ISA!

5. Just add 20 to the previously worked answer of -11°C, and you will see that the temperature is now +9°C. Repeat the process to reveals a DA of 15,250 - quite a difference!

Minutes to Hours Conversion

1. Easily done in your head, but you can see that the answer of 1 hour and 23 minutes can also be derived this way. For the odd minutes, just look at 80 opposite 1:20 and then add the extra 3 on.

2. A bit more mental arithmetic, so why not use the CRP-5 for this? 270 is 4:30, then add on the extra 4 to reach 4:34.

Heading and Groundspeed (TAS, Track, W/V all known)

1. 243° 139 kt

2. 217° 62 kt

3. 295° 40 kt

4. 037° 174 kt

5. 164° 108 kt

Wind Velocity (Heading, TAS, Track and Groundspeed all known)

1. 004° 46 kt

2. 013° 53 kt

3. 358° 40 kt

4. 028° 48 kt

5. 324° 38 kt

Crosswind and Headwind Component

1. Headwind 21 kt, Crosswind 14 kts from R to L

2. Headwind 14 kt, Crosswind 08 kts from L to R

3. Tailwind 06 kt, Crosswind 03 kts from L to R - remember, it's a tailwind!

4. Headwind 34 kt, Crosswind 03 kts from L to R

5. Headwind 11 kt, Crosswind 14 kts from L to R

That's all folks! Hope you found it helpful? Feedback greatly appreciated to
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