Defence School of
Aeronautical Engineering

# Aerosystems Engineer & Management Training School

## Academic Principles Organisation

# MATHEMATICS

# BOOK 11

# Charts & Tables

## WARNING

**These course notes are produced solely for the purpose of training. They are not subject to formal amendment action after issue and they must NOT be used for operating and maintaining the equipment described. Operation and maintenance of equipment is governed by the limitations and procedures laid down in the authorized publications and manuals which must be complied with for these purposes**

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# KEY LEARNING POINTS

| KLP | Description |
|---|---|
| MA4.8 | Determine data values from graphs and tables |
| MA4.9 | Apply graphical techniques to the solution of engineering problems. |

This topic requires you to be able to read, interpret and extract information from a variety of engineering tables, graphs and charts. All the questions refer to a numbered graph or table, be sure to refer to the correct one. (Answers on page 8)

1. **Using Graph 1** (Page 2)

( a ) What is the density of the air at a height of 10000 ft ?
( b ) What altitude would you be at, if the air density was 0.4 kg/$m^3$ ?

2. **Using Graph 2** (Page 3)

( a ) From the graph, estimate the air pressure at 20000 feet.
( b ) If the measured pressure is 12 psi, what is the approximate altitude ?

3. **Using Table 1** (Page 4)

( a ) At a height of 14 km, what is the temperature in k and the pressure in N/$m^2$ ?
( b ) Estimate the altitude and the density of the air, if the local speed of sound is 303.8 m/s.

4. **Using Table 2** (Page 5)

( a ) At 23000 ft, what is the expected air temperature, in degrees Fahrenheit and the expected air density ?
( b) If the air pressure gauge registers 619.6 hPa, what is the air temperature in centigrade and the air density ?

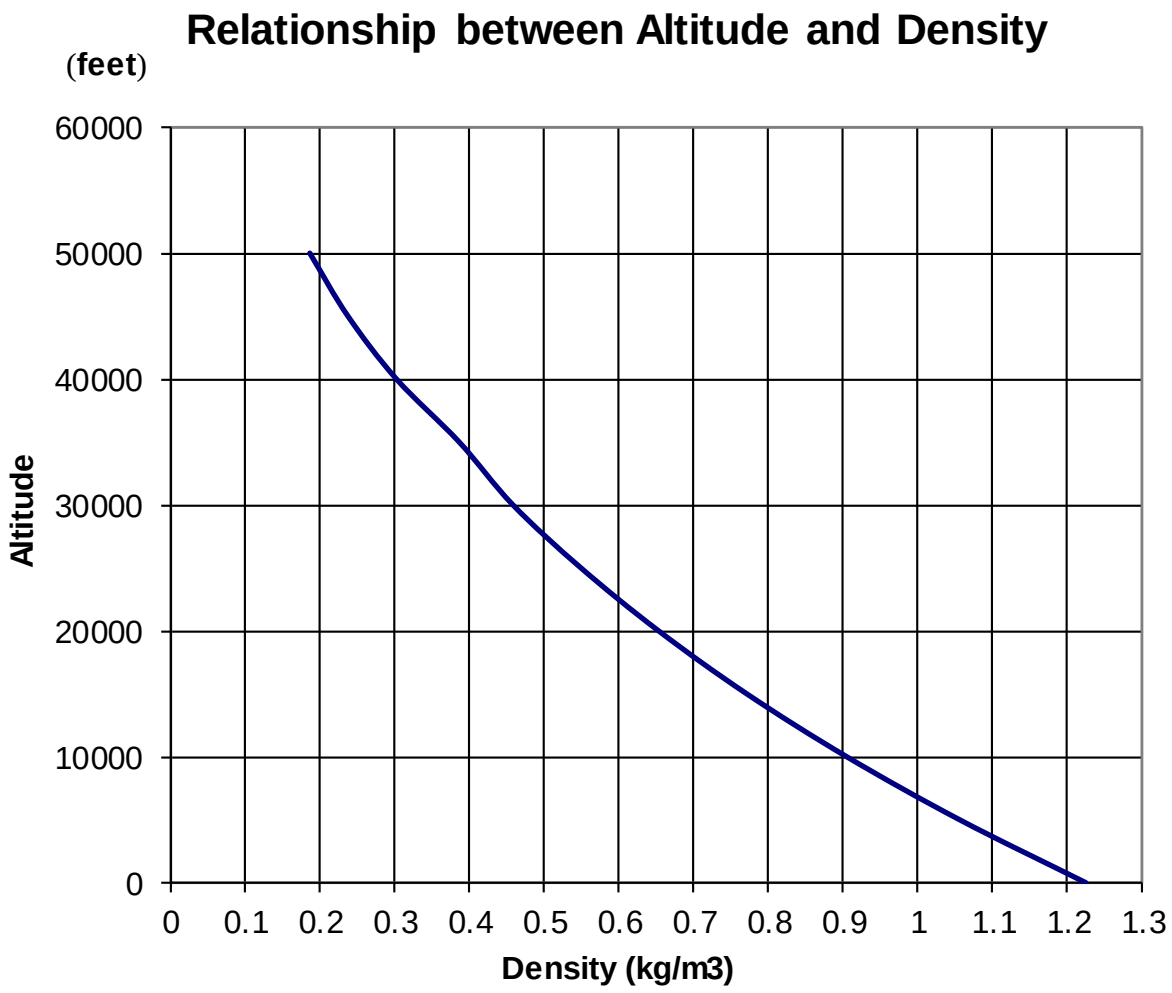
5. **Using Graph 3** (Page 6)

( a ) A circuit fused at 80 A attempts to pass 300 amps due to a fault. How long will it take to fail ?
( b ) Approximately how much current is flowing in a faulty circuit, if the fuse rated at 20 A blows after ten seconds?

6. **Using Graph 4** (Page 7)

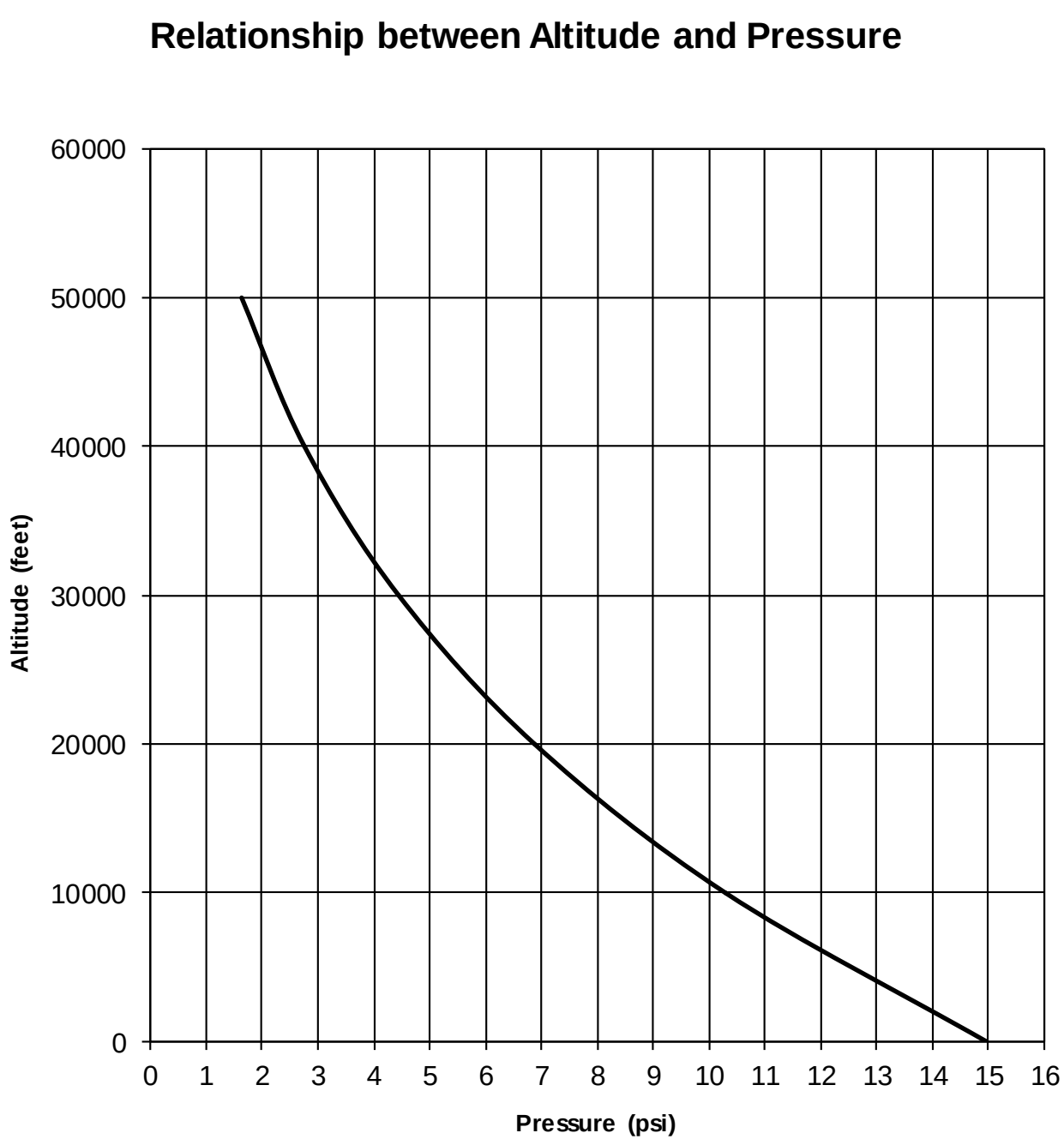
( a ) An aircraft altimeter indicates 2500 ft at an outside air temperature of 20°C. What is the actual altitude?
( b )Estimate the outside air temperature, when the actual altitude is 1500 ft, but the indicated altitude is 2000ft.

# ALTITUDE V DENSITY




**Graph 1**

# Altitude v Pressure




**Graph 2**

# International Standard Atmosphere (ISA)

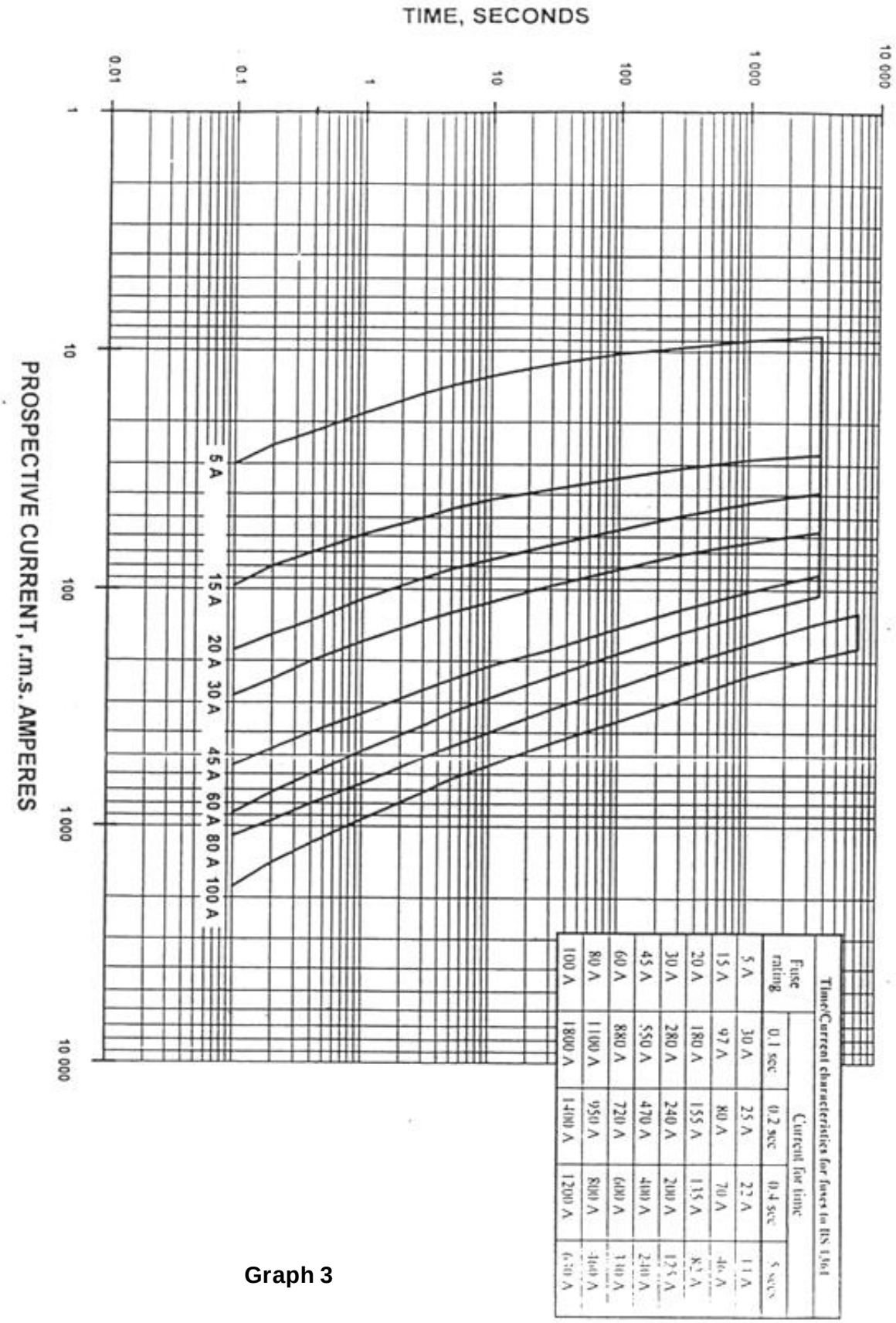
| Altitude(km) | Temperature(K) | Density(kg/m3) | Pressure(N/m$^2$) | Speed of Sound(m/s) |
|---|---|---|---|---|
| 0 | 288.15 | 1.226 | 101320 | 340.292 |
| 1 | 281.65 | 1.112639088 | 89877.32861 | 336.4322896 |
| 2 | 275.15 | 1.007475016 | 79504.16655 | 332.5274883 |
| 3 | 268.65 | 0.910087898 | 70122.31916 | 328.5762857 |
| 4 | 262.15 | 0.820070087 | 61657.64316 | 324.576987 |
| 5 | 255.65 | 0.737026106 | 54039.92719 | 320.5277921 |
| 6 | 249.15 | 0.660572567 | 47202.77296 | 316.4267854 |
| 7 | 242.65 | 0.590338099 | 41083.4773 | 312.2719256 |
| 8 | 236.15 | 0.525963269 | 35622.91484 | 308.0610337 |
| 9 | 229.65 | 0.467100501 | 30765.42154 | 303.7917798 |
| 10 | 223.15 | 0.413413999 | 26458.67894 | 299.4616678 |
| 11 | 216.65 | 0.364579658 | 22653.59927 | 295.0680184 |
| 12 | 216.65 | 0.311426046 | 19350.83514 | 295.0680184 |
| 13 | 216.65 | 0.266021925 | 16529.59497 | 295.0680184 |
| 14 | 216.65 | 0.227237462 | 14119.67534 | 295.0680184 |
| 15 | 216.65 | 0.194107551 | 12061.1081 | 295.0680184 |
| 16 | 216.65 | 0.165807789 | 10302.6681 | 295.0680184 |
| 17 | 216.65 | 0.14163397 | 8800.598503 | 295.0680184 |
| 18 | 216.65 | 0.120984554 | 7517.521992 | 295.0680184 |
| 19 | 216.65 | 0.103345703 | 6421.510638 | 295.0680184 |
| 20 | 216.65 | 0.088278496 | 5485.291419 | 295.0680184 |
| 21 | 216.65 | 0.075408 | 4685.567563 | 295.0680184 |
| 22 | 216.65 | 0.064413949 | 4002.438833 | 295.0680184 |
| 23 | 216.65 | 0.055022766 | 3418.906333 | 295.0680184 |
| 24 | 216.65 | 0.047000764 | 2920.449506 | 295.0680184 |
| 25 | 216.65 | 0.040148324 | 2494.664809 | 295.0680184 |

**Table 1**

| **Altitude** ft | **Air Press.** hPa ["Hg] | **Air Temp.** °C [°F] | **Air Density** kg/m³ |
|---|---|---|---|
| 0 | 1013.25 [29.92] | 15 [59.0] | 1.225 |
| 1000 | 977.18 [28.86] | 13 [55.4] | 1.190 |
| 2000 | 942.12 [27.82] | 11 [51.8] | 1.155 |
| 3000 | 908.18 [26.82] | 9.1 [48.4] | 1.121 |
| 4000 | 875.14 [25.84] | 7.1 [44.8] | 1.088 |
| 5000 | 843.13 [24.90] | 5.1 [41.2] | 1.056 |
| 6000 | 812.02 [23.98] | 3.1 [37.6] | 1.024 |
| 7000 | 781.93 [23.09] | 1.1 [34.0] | 0.993 |
| 8000 | 752.74 [22.23] | -0.8 [30.6] | 0.963 |
| 9000 | 724.37 [21.39] | -2.8 [27.0] | 0.934 |
| 10000 | 696.91 [20.58] | -4.8 [23.4] | 0.905 |
| 11000 | 670.37 [19.80] | -6.8 [19.8] | 0.877 |
| 12000 | 644.63 [19.04] | -8.8 [16.2] | 0.849 |
| 13000 | 619.60 [18.30] | -10.8 [12.6] | 0.823 |
| 14000 | 595.49 [17.58] | -12.7 [9.1] | 0.797 |
| 15000 | 572.08 [16.89] | -14.7 [5.5] | 0.771 |
| 16000 | 549.38 [16.22] | -16.6 [2.1] | 0.746 |
| 17000 | 527.50 [15.58] | -18.6 [-1.5] | 0.722 |
| 18000 | 506.32 [14.95] | -20.6 [-5.1] | 0.698 |
| 19000 | 485.85 [14.35] | -22.6 [-8.7] | 0.676 |
| 20000 | 465.99 [13.76] | -24.6 [-12.3] | 0.653 |
| 21000 | 446.84 [13.20] | -26.5 [-15.7] | 0.631 |
| 22000 | 428.30 [12.65] | -28.5 [-19.3] | 0.610 |
| 23000 | 410.47 [12.12] | -30.5 [-22.9] | 0.589 |
| 24000 | 393.14 [11.61] | -32.5 [-26.5] | 0.569 |
| 25000 | 376.52 [11.12] | -34.5 [-30.1] | 0.550 |
| 26000 | 360.41 [10.64] | -36.4 [-33.5] | 0.530 |
| 27000 | 344.91 [10.19] | -38.4 [-37.1] | 0.512 |
| 28000 | 329.91 [9.74] | -40.4 [-40.7] | 0.494 |
| 29000 | 315.42 [9.31] | -42.4 [-44.3] | 0.476 |
| 30000 | 301.44 [8.90] | -44.4 [-47.9] | 0.459 |
| 31000 | 288.07 [8.51] | -46.3 [-51.3] | 0.442 |
| 32000 | 275.10 [8.12] | -48.3 [-54.9] | 0.426 |
| 33000 | 262.63 [7.76] | -50.3 [-58.5] | 0.411 |
| 34000 | 250.68 [7.40] | -52.3 [-62.1] | 0.395 |
| 35000 | 239.13 [7.06] | -54.2 [-65.6] | 0.380 |
| 36000 | 227.98 [6.73] | -56.2 [-69.2] | 0.366 |

**Table 2**

The ISA consists of dry air (=0% relative humidity).




Time/Current characteristics for fuses to BS 1361

| Fuse rating | Current for time | | | |
|---|---|---|---|---|
| | 0.1 sec | 0.2 sec | 0.4 sec | 5 secs |
| 5 A | 30 A | 25 A | 22 A | 11 A |
| 15 A | 97 A | 80 A | 70 A | 40 A |
| 20 A | 180 A | 155 A | 135 A | 82 A |
| 30 A | 280 A | 240 A | 200 A | 125 A |
| 45 A | 550 A | 470 A | 400 A | 240 A |
| 60 A | 880 A | 720 A | 600 A | 340 A |
| 80 A | 1100 A | 950 A | 800 A | 460 A |
| 100 A | 1800 A | 1400 A | 1200 A | 650 A |

**Graph 3**

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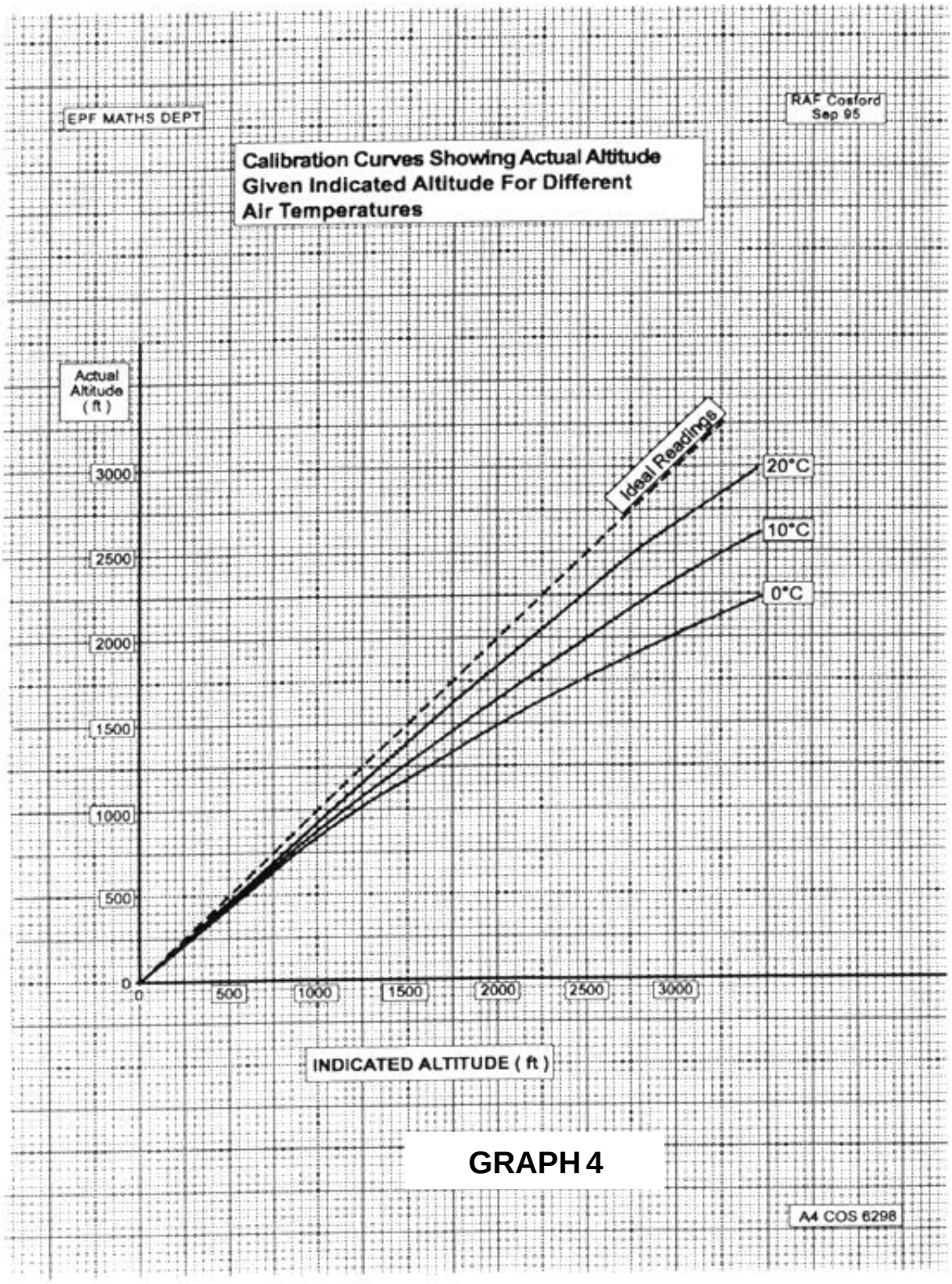
# CALIBRATION CURVES SHOWING ACTUAL ALTITUDE GIVEN INDICATED ALTITUDE FOR DIFFERENT AIR TEMPERATURES



## Answers

1. ( a ) 0.9 kg/$m^3$
   ( b ) 34000 ft

2. ( a ) 6.9 psi
   ( b) 7000 ft

3. ( a ) 216.65 k 14119 N/$m^2$
   ( b ) approx 9 km 0.4671 kg/$m^3$

4. ( a ) -22.9 °F 0.589 kg/$m^3$
   ( b ) -10.8 °C 0.823 kg/$m^3$

5. ( a ) 40 s
   ( b ) 75 A

6. ( a ) 2250 ft
   ( b ) 0 °C

## Notes