MATHS FOR ENGINEERING SUMMER PREP WORK

Instructions:

Try your best with the questions within this booklet. Most of them should be familiar to you as they use some of the higher-level skills that you studied at GCSE.
However, in some cases they may present a challenge and you may wish to use friends, family or internet resources to help remind you of some of the core principles – this is fine, but try it yourself first.
On each page there are some hints about things you may wish to revise to help you with the questions.
Remember, a good Engineer is resilient and will try their best to find the solution but isn't afraid to seek help if they need it!

Questions marked with a '*' may pose a particular challenge.

Solving simple equations

Use algebraic substitution to find the value of the unknown in each of the following.

1. Given $R_2 = R_1(1 + \alpha t)$, find α given $R_1 = 5.0$, $R_2 = 6.03$ and t = 51.5
2. If $v^2 = u^2 + 2as$, find u given v = 24, a = -40 and s = 4.05
3. The relationship between temperature on a Fahrenheit scale and that on a Celsius scale is given by $F = \frac{9}{5}C + 32$. Express 113°F in degrees Celsius.
4. *If $t = 2\pi\sqrt{w/Sg}$, find the value of S given w = 1.219, g = 9.81 and t = 0.3132
5. Applying the principle of moments to a beam results in the follow equation: $F \times 3 = (5 - F) \times 7$, where F is the force in newtons. Find Determine the value of F.
6. *A rectangular laboratory has a length equal to one and a half times its width and a perimeter of 40m. Find its area.

Transposition of formulae

Sometimes you will have to rearrange a formula to make it easier to solve.

Make the symbol indicated the subject of the formulae shown below:

1. $F = ma$ (m)
2. $v = u + at$ (t)
3. $a = \pi r^2$ (r)
4. $s = ut + \frac{1}{2}at^2$ (u)
5. $* y = \frac{a^2m - a^2n}{x}$ (a)
6. $* M = \pi(R^4 - r^4)$ (R)
7. $* x + y = \frac{r}{3+r}$ (r)
8. $* m = \frac{\mu L}{L + rCR}$ (L)

Simultaneous equations

The following are all examples of linear simultaneous equations. For the worded questions you will first have to set the equations up (this is often the hardest part).

1. In a system of pulleys, the effort P required to raise a load W is given by $P = aW + b$, where a and b are constants. If W = 40 when P = 12 and W = 90 when P = 22, find the values of a and b.
2. Velocity, v is given by the formula $v = u + at$. If v = 20 when t = 2 and v = 40 when t = 7, find the values of u and a. Hence find the velocity when t = 3.5
3. $y = mx + c$ is the equation of a straight line of slope, m and y-intercept, c. If the line passes through the point where x = 2 and y = 2, and also passes through the point where x = 5 and y = ½ , find the slope and the y-intercept of the straight line.
4. *Applying Kirchoff's laws to an electrical circuit produces the following equations:
   i. $5 = 0.2I_1 + 2(I_1 - I_2)$
   ii. $12 = 3I_2 + 0.4I_2 - 2(I_1 - I_2)$

   Determine the values of I_1 and I_2

Quadratic Equations

You will be familiar with a quadratic equation (one with a squared term) and you will know that there are lots of ways of solving them. The questions below can be solved either by factorising or, by using the quadratic formula, so you may want to look that up.

The worded questions are a challenge as you will have to think how they can be written as a quadratic. Maybe a diagram will help. Also, don't let strange letters or words put you off – you don't treat them any differently to 'x' terms.

1. Solve by factorising:
   a. $x^2 + 4x - 32 = 0$
   b. $2x^2 - x - 3 = 0$
2. Solve using the quadratic formula.
   a. $2x^2 + 5x - 4 = 0$
   b. $3x^2 - 11x = 4$
3. *The power, P, developed in an electrical circuit is given by $P = 10I - 8I^2$, where I is given current in amperes. Determine the current necessary to produce a power of 2.5 watts in the circuit.
4. *A rectangular building is 15 m long by 11 m wide. A concrete path is laid all around the building. If the area of the path is 60m^2, calculate its width correct to the nearest mm.
5. *The angle a rotating shaft turns through in t seconds is given by: $\theta = \omega t + \frac{1}{2}\alpha t^2$. Determine the time taken to complete 4 radians if ω is 3 rad/s and a is 0.6 rad/s^2.

Direct and inverse proportion

Proportion questions are very structured. If you can't remember how to do them, why not look it up first. They involve setting up a proportionality relationship, then finding a constant and finally using the constant to form an equation.

1. Charles Law states that for a given mass of gas at constant pressure the volume is directly proportional to its thermodynamic temperature. A gas occupies a volume of 2.25 litres at 300 K, determine:
    a. The constant of proportionality
    b. The volume at 420K
    c. The temperature when the volume is 2.625 litres
2. Ohm's law states that the current flowing in a fixed resistor is directly proportional to the applied voltage. When 30 volts is applied across a resistor the current flowing through the resistor is 2.4×10^{-3} amperes, determine:
    a. The constant of proportionality
    b. The current when the voltage is 52 volts
    c. The voltage when the current is 3.6×10^{-3} amperes
3. *Boyles law states that for a gas at constant temperature, the volume of a fixed mass of gas is inversely proportional to its absolute pressure. If a gas occupies a volume of 1.5 m^3 at a pressure of 200×10^3 Pascals, determine:
    a. The constant of proportionality
    b. The volume when the pressure is 800×10^3 Pascals
    c. The pressure when the volume is 1.25 m^3

Area and Volume of Common Shapes

Some tricky questions here – it may help to draw a diagram and look up your formulae for area of circles, volume of spheres, etc.

1. Determine the area of circles having a:
    a. Radius of 4cm
    b. Diameter of 30 mm
    c. Circumference of 200mm
2. Calculate the areas of the following sectors of circles
    a. Radius 9 cm, angle subtended at centre 75°
    b. Diameter 35 mm, angle subtended at centre 48°
3. An archway consists of a rectangular opening topped by a semi-circle arch. Determine the area of the opening if the width of the window is 1 m and the greatest height is 2 m.
4. *Calculate the area of a regular octagon if each side is 20 mm and the width across the flats is 48.3 mm.
5. *An anulus (look it up) has an outside diameter of 60 mm and an inside diameter of 20 mm. Determine its area.
6. If the volume of a sphere is 566 cm^3, what is its radius
7. *A metal plumb bob comprises a hemisphere surmounted by a cone. If the diameter of the hemisphere and the cone are each 4 cm and the total length is 5 cm, find its total volume.
8. *A metal sphere weighing 24 kg is melted down and recast into a solid cone of base radius 8 cm. If the density of the metal is 8000 kg/m^3 determine,
    a. The diameter of the metal sphere
    b. The perpendicular height of the cone, assuming that 15% of the metal is lost in the process

Trigonometry

Remind yourself about Pythagoras theorem and SOH CAH TOA. Most importantly, DON'T FORGET TO DRAW A DIAGRAM!!!

1. A ladder rests against the top of a wall of a building and makes an angle of 73° with the ground. If the foot of the ladder is 2m from the wall, calculate the height of the building.
2. *A man cycles 24 km due south and then 20 km due east. Another man, starting at the same time as the first man, cycles 32 km due east and then 7 km due south. Find the distance that the men are apart.
3. *From a ship at sea, the angle of elevation of the top and bottom of a vertical lighthouse standing on the edge of a vertical cliff are 31° and 26°, respectively. If the lighthouse is 25m high, calculate the height of the cliff.
4. *A laboratory 9 m wide has a span roof that slopes at 36° on one side and 44° on the other. Determine the lengths of the roof slopes.