# AQA

# Level 3 Technical Level
# DESIGN ENGINEERING
# MECHATRONIC ENGINEERING

Unit 1 Materials Technology and Science

## Formula sheet

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| Area of a circle<br><br>$A = \pi r^2$ or $A = \dfrac{\pi D^2}{4}$ | Density<br><br>$\rho = \dfrac{m}{V}$ |
| Stress<br><br>$\sigma = \dfrac{F}{A}$ | Strain<br><br>$\varepsilon = \dfrac{\delta L}{L}$ |
| Angular measure<br><br>$360^0 \equiv 2\pi$ radians | Newton's second law<br><br>$F = ma$ |
| Trigonometry<br><br>$\sin = \dfrac{opp}{hyp}$, $\cos = \dfrac{adj}{hyp}$ and $\tan = \dfrac{opp}{adj}$ | Young's Modulus<br><br>$E = \dfrac{\sigma}{\varepsilon}$ |
| Ohm's Law<br><br>$V = IR$ | Electrical power<br><br>$P = VI$, $P = I^2R$ and $P = \dfrac{V^2}{R}$ |
| Resistance in series<br><br>$R_{total} = R_1 + R_2 + R_3 \ldots$ | Resistance in parallel<br><br>$R_{total} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} \ldots$<br><br>Two resistors in parallel<br><br>$R_{total} = \dfrac{R_1 R_2}{R_1 + R_2}$ |
| Straight line graph<br><br>$y = mx + c$ | Energy<br><br>$PE = mgh$ and $KE = \dfrac{mv^2}{2}$ |
| Frequency<br><br>$f = \dfrac{1}{T}$ and $f = \dfrac{\omega}{2\pi}$ | Boyle's law<br><br>$P_1 V_1 = P_2 V_2$ |

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| Charles' law $$\frac{V_1}{T_2} = \frac{V_2}{T_2}$$ | The combined gas laws $$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$ |
| The equation of state $$\frac{PV}{T} = mR$$ | The pressure law $$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$ |
| Torque $$T = Fr$$ | Gear ratio (2 gears) $$R = \frac{\omega_{in}}{\omega_{out}} = \frac{N_{out}}{N_{in}}$$ |
| Friction $$F = \mu N$$ | Efficiency $$\eta = \frac{\text{Output}}{\text{Input}} \quad \text{and} \quad \eta_\% = \frac{\text{Output}}{\text{Input}} \times 100$$ |
| Conversion from bar to Pascals $$bar \times 101 \times 10^3 N\,\text{m}^{-2}$$ | The gravitation constant $$g = 9.81\ m\ s^{-2}$$ |