1. Tie rod $d = 12$ mm carrying $P = 25$ kN: normal stress (one decimal, MPa)?

   _____ MPa

2. Solid shaft $d = 30$ mm, $T = 300$ N $\cdot$ m: surface shear stress (one decimal, MPa)?

   _____ MPa

3. Simply supported 3 m span with a central $P = 6$ kN: largest moment (one decimal, kN $\cdot$ m)?

   _____ kN $\cdot$ m

4. Rectangle 40 x 80 mm, V = 3 kN: maximum transverse shear (two decimals, MPa)?

   _____ MPa

5. $\sigma_x = 100$, $\sigma_y = 40$, $\tau_{xy} = 25$ MPa: Mohr radius (one decimal, MPa)?

   _____ MPa

6. Below the transition slenderness, the column stress comes from:

   ☐ the yield stress directly

   ☐ the eccentricity formula

   ☐ the Johnson parabola

   ☐ Euler with a safety factor

7. A steel rod that is free to move is heated by 40 K. It has:

   ☐ neither

   ☐ both stress and strain

   ☐ strain but no stress

   ☐ stress but no strain

8. Shear stress in a solid circular shaft under torsion is:

   ☐ maximum at the axis

   ☐ zero at the axis and maximum at the surface

   ☐ uniform across the section

   ☐ zero at the surface

9. Under a central point load on a simply supported span, the moment diagram is:

   ☐ parabolic everywhere

   ☐ a triangle peaking at mid-span

   ☐ a rectangle

10. For a symmetric section, c is the half-depth.

    ☐ True ☐ False

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1. **221.0 MPa**

   $A = \pi \times 6^2 = 113.1$ mm^2, so $\sigma = 25\,000/113.1 = 221.0$ MPa.

2. **56.6 MPa**

   $\tau = 16T/(\pi d^3) = 16 \times 300\,000/(\pi \times 27\,000) = 56.6$ MPa.

3. **4.5 kN · m**

   $M_{max} = PL/4 = 6 \times 3/4 = 4.5$ kN · m.

4. **1.41 MPa**

   $\tau_{max} = 1.5V/A = 1.5 \times 3000/3200 = 1.41$ MPa.

5. **39.1 MPa**

   $R = \sqrt{30^2 + 25^2} = 39.1$ MPa.

6. **the Johnson parabola**

   Euler would give more than yield there; the Johnson curve meets Euler at $\sigma_y/2$.

7. **strain but no stress**

   Free expansion only changes the length. A restraint is needed to make stress.

8. **zero at the axis and maximum at the surface**

   $\tau = T\rho/J$ grows in a straight line with the radius ρ.

9. **a triangle peaking at mid-span**

   It rises in straight lines from both supports to $PL/4$ under the load.

10. **True**

    The farthest fibre is half the depth from the neutral axis.

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