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## Chapter 12: Joining and assembly – HINTS

**THIS DOCUMENT IS INTENDED FOR USE BY STUDENTS.**

*Exercise 12.1 Look around your house for examples of joining, finding at least one product per sub-principle.*

Hint 12.1: this should give little difficulty, especially regarding mechanical or welded joints.

*Exercise 12.2 Which of these four joint geometries are involved in the sample products you found for Exercise 12.1? Are the materials similar or dissimilar? And are the joints permanent, or can they be undone (either easily, or with some difficulty)?*

Hint 12.2: with an eye towards Sections 12.4 and 12.5, note that brazed and adhesive joints tend to be lap- or sleeve-joints, not butt- or T-joints.

*Exercise 12.3 Look up the main difference in composition between AISI 304 and 316L. How does this explain the different weldability of these two stainless steels?*

Hint 12.3: for this you will need to consult either a welding handbook or specialist websites, such as www.efunda.com. Even then, properly explaining the topic is challenging, so take your time to find additional quality documentation.

*Exercise 12.4 The thermal conductivity of aluminium is approximately 2.8 times that of low carbon steel. What do you think this means for the efficiency of the welding process and the resulting residual thermal stresses?*

Hint 12.4: simply consider that in welding you would ideally like to heat up the least possible material around the weld, not the entire workpiece.

*Exercise 12.5 Summarize for yourself which of these five methods are applicable to carbon steels and which to wrought aluminium alloys.*

Hint 12.5: this should be a simple text analysis (or use the “links” in CES).

*Exercise 12.6 Do you think it is possible to weld different kinds of plastics together, e.g. PS to LDPE? If so, what would be the first requirement?*

Hint 12.6: the main key word here is ‘temperature’, but think about how well different polymer molecules mix.

*Exercise 12.7 Eutectic compositions have another benefit. What is it? Hint: see Chapter 3!*

Hint 12.7: consider that the ideal filler needs to be able to get into tight spaces well.

*Exercise 12.8   Assume we braze two thin-walled high strength, low alloy steel tubes together with a sleeve joint. Calculate the overlap length that is needed ensure that the joint is stronger than the tubes. For the joint's shear strength, assume a value of 20 MPa.*

Hint 12.8: in this comparison you will find that the tube diameter drops out of the equation. You will still need to assume a certain tube wall thickness though, and you will also need an assumption for the tensile strength of low alloy steel (which any materials database can give you).

*Exercise 12.9   What is the thickness of the tin coating on typical tinplate? How does this affect the recyclability of the steel?*

Hint 12.9: if you have found the thickness (in practice this comes in ranges, with thickness depending on the application) you already have most of the answer.

*Exercise 12.10   Assume we make a lap joint between two aluminium sheets using adhesive bonding. At what overlap length will the joint become stronger than the sheets, assuming a joint shear strength of 10 MPa?*

Hint 12.10: this exercise is quite similar to Exercise 12.8. Now it is the joint width that drops out of the equation. Assume a certain sheet thickness and tensile strength.

*Exercise 12.11   Which two of these four types of adhesive can generally give permanent joints, and which two can also be semi-permanent?*

Hint 12.11: this should be apparent if you have read the text well.

*Exercise 12.12   Assume we have an M6-bolt of strength class 8.8 with a 30 mm long shank. How much elastic elongation (in mm) can this bolt sustain? Will settling pose any problems? And how many turns of the bolt are needed to generate this elongation, assuming a regular thread pitch of 1 mm?*

Hint 12.12: first, use Hooke's Law to determine the elastic strain (in %), then from there derive the actual shank elongation.

*Exercise 12.13   Find illustrations of both self-tapping and self-cutting screws. What is the key difference?*

Hint 12.13: a quick Internet image search will do (tip: self-cutting is sometimes also referred to as 'self-drilling').

*Exercise 12.14   In practice, both the rivet itself (length, diameter) and the hole in which it is placed have tolerances. How do these affect the eventual joint strength?*

Hint 12.14: consider that riveting can be done in two quiet different ways: (1) displacement-driven, i.e. the riveting press moves forward a certain stroke, irrespective of the force that it builds up, and (2) force-driven, i.e. the press moved forward until a certain force is reached, irrespective of the required stroke.

*Exercise 12.15   Determine the maximum elastic deformation (in compression or tension) that standard ABS can withstand. How does this compare to a grade with 30% glass fibres? What does this suggest about the suitability of snap fits in both situations?*

Hint 12.15: consult a materials database (e.g. CES EduPack, level 3) to get the Young's Modulus and yield strength of both grades, then use Hooke's Law to determine the elastic strain that these materials can have.

*Exercise 12.16   Return to your sample products (Exercise 12.1). What can you now say about the types of joining that were involved? For instance, can you pinpoint the method now as well?*

Hint 12.16: all kinds of possibilities!

*Exercise 12.17   Assembly can be fully manual and fully robotized, and take place in either a line or cell layout. Ignoring intermediate forms, this gives four possible combinations. Which one is 'easiest' to design for, and why?*

Hint 12.17: there is only a single correct answer.