SOLUTIONS TO TUTORIAL EXAMPLES

CHAPTER 4

Question 1

Remember that, on earth, a force of 10 Newtons is equivalent to a mass of 1 kg.

a) A mass of 70 kg is equivalent to a weight of 700 N, or 0.7 kN.
b) A mass of 95 kg is equivalent to a weight of 950 N, or 0.95 kN.

On the moon, the weight of each of these people would be one-sixth of their weight on earth.

a) The weight of a 70 kg mass on the moon = 70 kg × 10/6 = 117 N = 0.117kN.
b) The weight of a 95 kg mass on the moon = 95 kg ×10/6 = 158 N = 0.158kN.

Question 2

Volume of brick:
In millimetre (mm) units = (215 mm × 102.5 mm × 65 mm) = 1 432 438 mm^3.
In metre (m) units = (0.215 m × 0.1025 m × 0.065 m) = 0.0014 m^3.

Density = mass/volume, so mass = density × volume.
Mass = 1800 kg/m^3 × 0.0014 m^3 = 2.52 kg
Weight of brick = 2.52 kg × 10 = 25.2 N = 0.025 kN.

Question 3

Weight of concrete beam = volume × unit weight
= (9 m × 0.2 m × 0.35 m) × 24 kN/m^3
= 15.1 kN

Question 4

Assume:

Average weight of each student = 0.8 kN
Average weight of each desk = 0.2 kN
Average weight of each chair = 0.1 kN
TOTAL = 1.1 kN

Total weight of 60 students + furniture = 60 × 1.1 = 66 kN
Area of classroom = 10 m × 12 m = 120 m^2
Actual load /m^2 = 66 kN/120 m^2 = 0.55 kN/m^2

This is much less than 3.0 kN/m^2. OK.

Question 5

Average depth of swimming pool = 1.5 metres
Volume of water in pool = 25 m × 10 m × 1.5 m = 375 m^3
Unit weight of water = 10 kN/m^3 = 1 tonne/m^3
Weight of water in pool = 375 tonnes.
This is equivalent to the weight of 375 small cars.

Advice to architect/client: the proposed swimming pool will increase the load on the supporting walls and columns by a huge amount. They will need to be appraised and possibly supplemented or rebuilt to accommodate this increased load.

Question 6

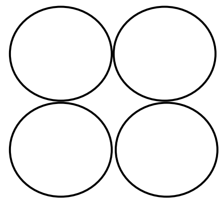
1 hectare = 10 000 m^2, and 1 hectare = 2.47 acres
Area of site = (300 m × 250 m) = 75 000 m^2 = 7.5 hectares = (7.5 × 2.47) acres = 18.5 acres.

Question 7

Calculations: £1 coin

The mass of a £1 coin is 9.7 grams.
Therefore the **mass** of a million £1 coins is 9.7 × 10^6 grams = 9700 kg.
Therefore the **weight** of a million £1 coins is (9700 × 10) = 97 000 N = 97 kN.
(This is because 10 N (weight) is equivalent to 1 kg (mass).)

A £1 coin has a diameter of 22 mm and a thickness of 3 mm.



Assuming a stacking configuration as illustrated above, each pound coin occupies a volume of (22 mm × 22 mm × 3 mm) = 1452 mm^3.

Therefore the **volume** of a million pound coins is 1452 × 10^6 mm^3 = 1.452 m^3. (because 1 m^3 = 10^9 mm^3).

Density = mass/volume = 97 kN/1.452 m^3 = 66.8 kN/m^3 (this compares well with the published unit weight of steel = 78.5 kN/m^3).

Calculations: £2 coin

A £2 coin is both heavier and larger than a £1 coin, but only 500 000 will be required (since £2 × 500 000 = £1 million).

The mass of a £2 coin is 11.9 grams.

Therefore the **mass** of 500 000 £2 coins is 11.9 × 5000 000 = 5.95 × 10^6 grams = 5950 kg.

Therefore the **weight** of 500 000 £2 coins is 59 500 N = 59.5 kN (again, because 10 N (weight) is equivalent to 1 kg (mass)).

A £2 coin has a diameter of 29 mm and a thickness of 2.5 mm.

Assuming the same stacking configuration as above, each £2 coin occupies a volume of (29 mm × 29 mm × 2.5 mm) = 2102.5 mm^3.

Therefore the **volume** of 500 000 £2 coins is 2102.5 × 500 000 = 1.051 × 10^9 mm^3 = 1.051 m^3.

Density = mass/volume = 59.5 kN/1.051 m^3 = 56.6 kN/m^3.

Discussion

The volumes of £1 worth of £1 coins and £2 coins are 1.452 m^3 and 1.051 m^3, respectively. Either of these would fit in the back of a light van. However, the main problem is the weight. The weight of a million £1 coins is nearly 10 tonnes (since 10 kN = 1 tonne) so a heavy duty vehicle would be required to transport this load. The £2 coin option weighs just under 6 tonnes – considerably lighter but still requiring a heavy duty vehicle to transport it.

On the storage question, the live load assumed in domestic construction is 1.5 kN/m^2 (British Standard BS 6399). Therefore, the floor area required for the £1 coin option = 97 kN/1.5 kN/m^2 = 64.6 m^2, and the floor area required for the £2 coin option = 59.5 kN/1.5 kN/m^2 = 39.7 m^2. So, even the lighter £2 coin option would require the load to be spread over a floor area of about 40 m^2 or 430 square feet, which is the total floor area of a typical one-bedroom apartment.

It can be seen that the weight of the 'haul' poses problems for both transport and storage. The most realistic option would be to engage the services of a security company to transport the money to the nearest bank.