# ES486 Introduction to Quantitative Problem Solving

1. Figure 1.1 illustrates a lake basin undergoing sediment accumulation. If the sedimentation rate is constant over time, depth of burial becomes equivalent to age. If stratum are buried at double the depth compared to others, they are twice as old and so on. This relationship can be expressed as:

Age of Deposit = (*k*)(Depth)

Where *k* is a constant rate of sedimentation. If k = 500 yr/ft, calculate the age of sediments at depths of 1 m, 2m and 5.3 m. Repeat same calculations if k = 3000 yr/m. Show all of your unit algebra and math work.

$\frac{500\ yr}{ft} \cdot \frac{3.281 ft}{m} = 1640.5\ yr/m$

$1640.5 \cdot 1 = \boxed{1641\ yr}$
$1640.5 \cdot 2 = \boxed{3281\ yr}$
$1640.5 \cdot 5.3 = \boxed{8695\ yr}$

$3000 \cdot 1 = \boxed{3000\ yr}$
$3000 \cdot 2 = \boxed{6000\ yr}$
$3000 \cdot 5.3 = \boxed{15900\ yr}$

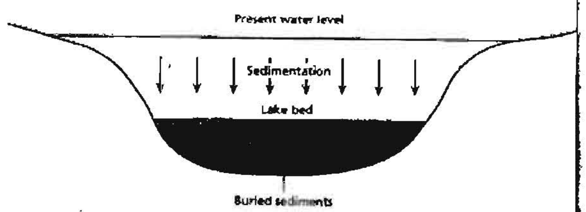



Fig. 1.1 Sedimentation at a lake floor. Older sediments are slowly buried by younger deposits.

2. The volume of a sphere is calculated as follows:

$$V = \frac{4\pi r^3}{3}$$

where r is the Earth's radius (r = 6.37 x $10^6$ m), assume the Earth is a perfect sphere. Show all of your unit algebra and math work.

$\frac{4\pi (6.37\times10^6 m)^3}{3} = \boxed{1.08\times10^{21}\ m^3}$

3. In simple models of mountain formation, the mountain is supported by thickened crust such that:

$\Delta z = h\, \rho_c/\Delta\rho$

where $\Delta z$ is the amount of crustal thickness, $h$ is the mountain height, $\rho_c$ is the density of the crust and $\Delta\rho$ is the density contrast between the crust and the underlying mantle. Calculate the increase in crustal thickness under a mountain of height 4 × $10^3$ m if the crustal density is 2.5 × $10^3$ kg/m³ and the density contrast is 500 kg/m³.

Show all of your unit algebra and math work.

$\Delta z = \frac{4\times10^3 m \cdot 2.5\times10^3\ kg/m^3}{500\ kg/m^3} = \boxed{20000\ m}$

4. A city has a reservoir with vertical sides and a surface area of 12.3 acres. Following the rainy season, the reservoir is filled to a depth of 3.0 m. During the dry season, the reservoir loses 3.5 in of water per week (wk) to evaporation. At the same time, the city pumps water from the reservoir at a rate of 100 gal/day. What volume of water will remain in storage after 3 weeks into the dry season? (answer in cubic meters, and gallons) Show all of your unit algebra and math work.

$12.3\,\text{acres} \cdot \frac{4047\,m^2}{\text{acre}} = 49778.1\,m^2 \cdot \left(3.5\,\text{in} \cdot \frac{ft}{12\,\text{in}} \cdot \frac{m}{3.281\,ft}\right) = 4425.1\,m^3/wk \cdot \frac{wk}{7\,day} = 632.2\,m^3/day\ \text{loss}$

$100\,gal \cdot \frac{m^3}{264.17\,gal} = 0.379\,m^3/day$ ∴ $49778.1\,m^2 \cdot 3.0\,m = 149334.3\,m^3 - 13267.8\,m^3 =$

$632.2\,m^3 - 0.379\,m^3 = 631.8\,m^3/day\ \text{loss} \cdot 3\,\text{week} \cdot \frac{7\,days}{wk} = 13267.8\,m^3$ $\boxed{136066.5\,m^3} \cdot \frac{264.17\,gal}{m^3} = \boxed{35{,}944{,}687.3\,gal}$

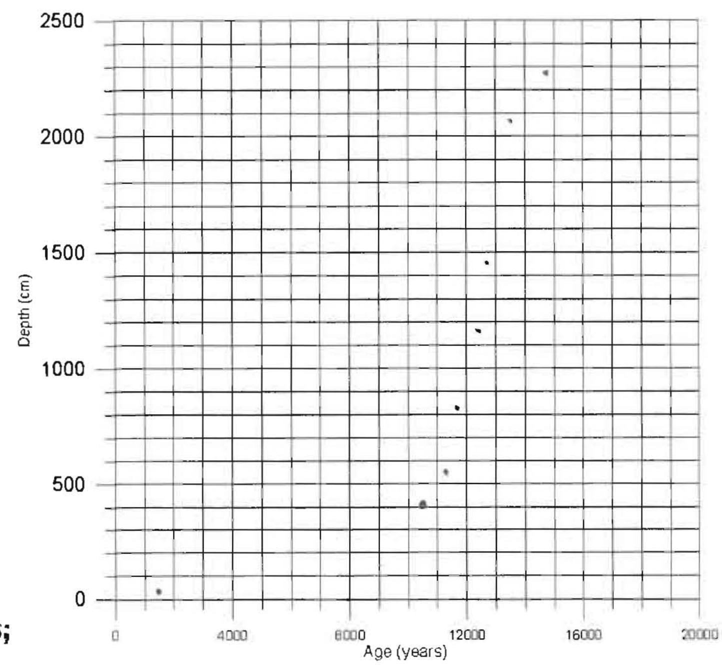
5. How long must a pump with a capacity of 25 gal/min pump to fill a tank with a capacity of 60 cubic meters? Show all of your unit algebra and math work.

$25\,gal \cdot \frac{m^3}{264.17\,gal} = 0.095\,m^3/min$ $\frac{60\,m^3}{0.095\,m^3/min} = 634\,min \cdot \frac{hr}{60\,min} \approx \boxed{10.6\,hr}$

6. The following data were taken from the Troll 3.1 well in the Norwegian North Sea.

Show all of your unit algebra and math work.

| Depth (cm) | Age (years) |
|---|---|
| 19.75 | 1 490 |
| 407.0 | 10 510 |
| 545.0 | 11 160 |
| 825.0 | 11 730 |
| 1158.0 | 12 410 |
| 1454.0 | 12 585 |
| 2060.0 | 13 445 |
| 2263.0 | 14 685 |




By plotting a graph of these data, estimate:
(i) the sedimentation rate for the last 10 000 years;
(ii) the sedimentation rate for the preceding 5000 years;
(iii) the time since sedimentation ceased.

$407 - 19.75\,cm = 387.25\,cm$
$10510_{yr} - 1490_{yr} = 9020\,yr$
i.) $\frac{387.25}{9020} = 0.0429\,cm/yr$

ii.) $2263.0\,cm - 407.0\,cm = 1856\,cm$
$14685\,yr - 10510\,yr = 4175\,yr$
$\frac{1856\,cm}{4175\,yr} = 0.445\,cm/yr$

iii) $\frac{19.75\,cm}{0.0429\,cm/yr} = 460\,yr$
$1490 - 460 = \boxed{1030\,yrs\ ago}$

7. Carbonate platform foreslopes can be much steeper than those of deltas. If the water depth is 100 m only 500 m offshore from the slope top, what is the slope? Draw a sketch, show all of your unit algebra and math work.

100 m  500m

$\tan^{-1}\left(\frac{100}{500}\right) = \boxed{11.3^\circ}$