Investigative Projects in Engineering for Secondary School Students 2

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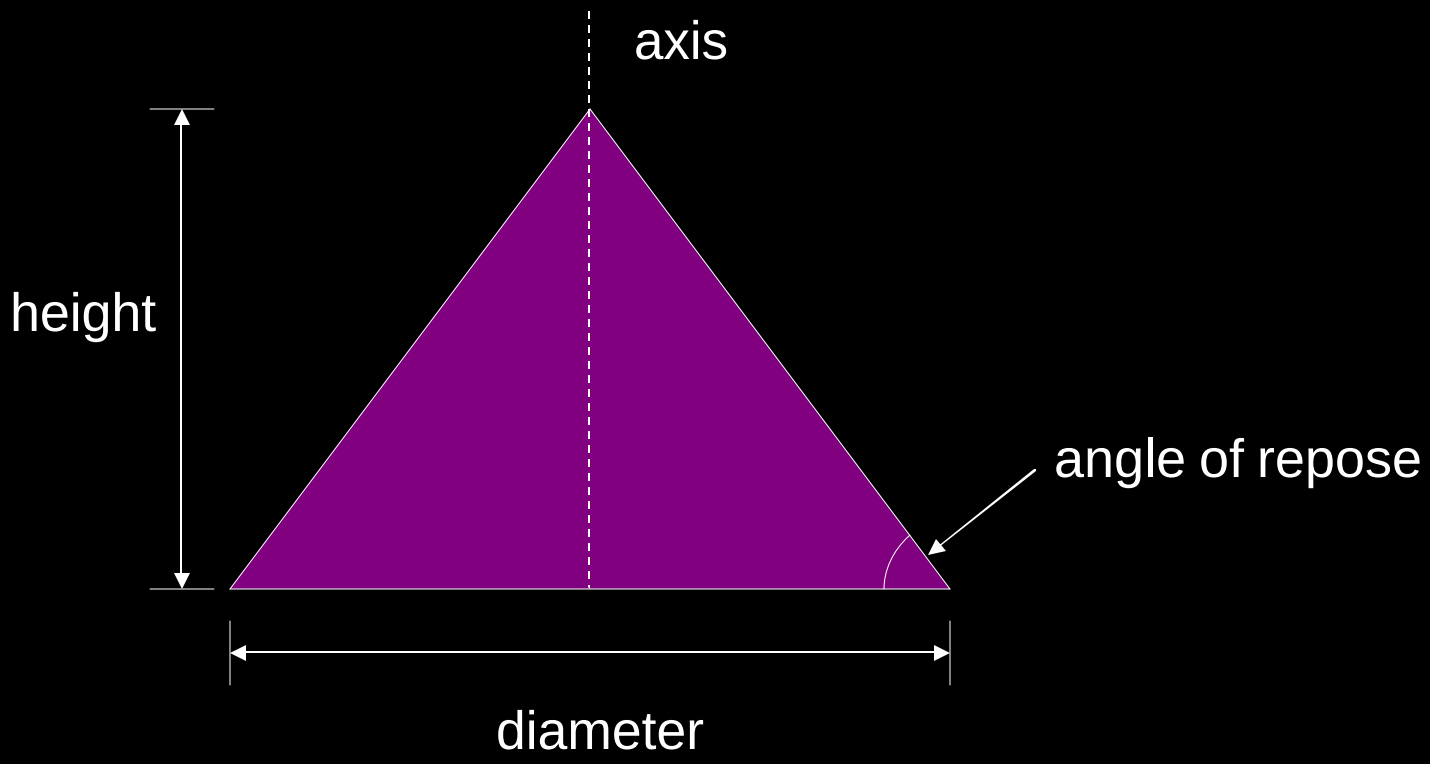
Formation of Heaps

Consider a right circular cone :



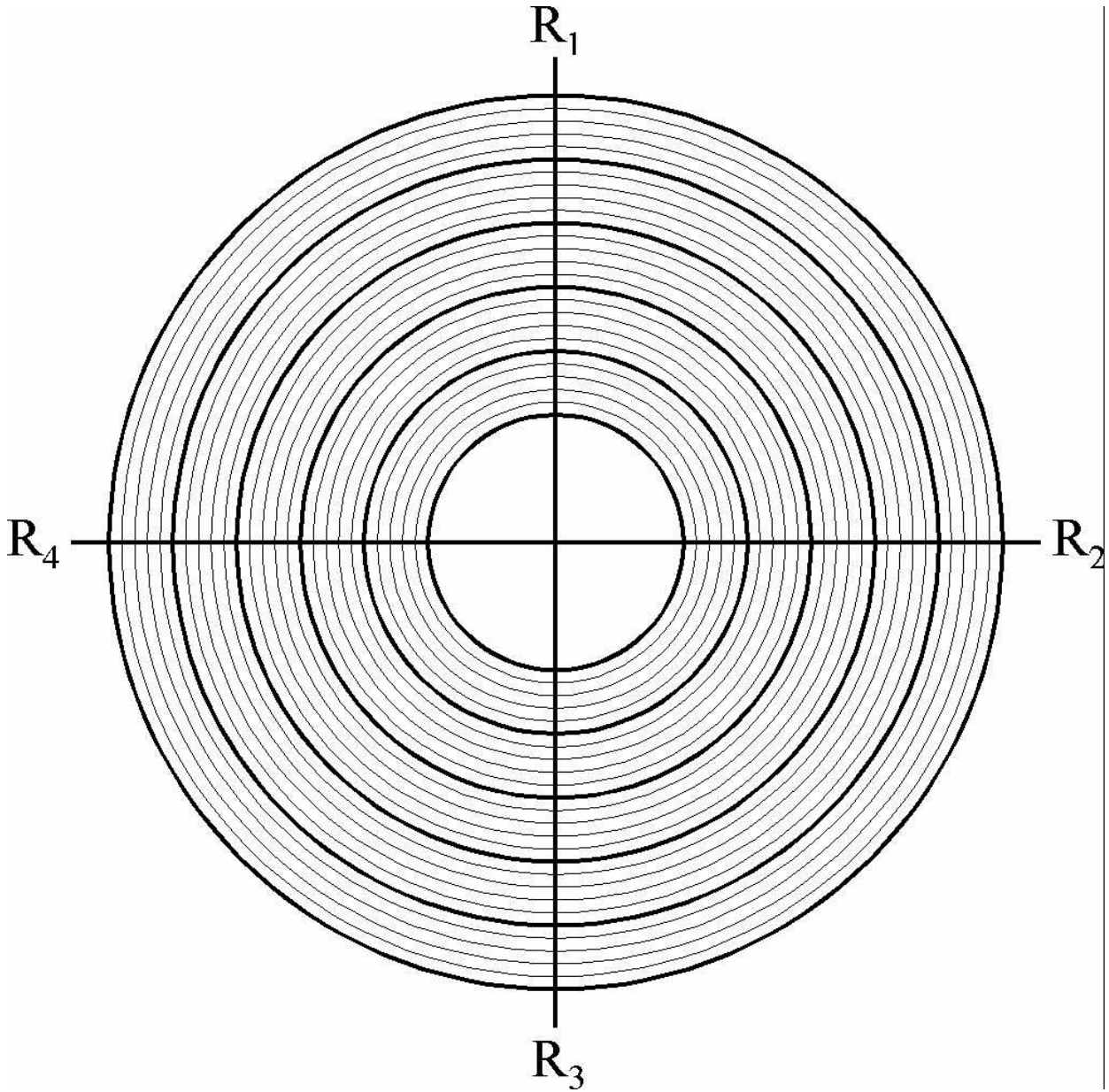
Aim : To develop experiments for the classroom to study the formation of heaps

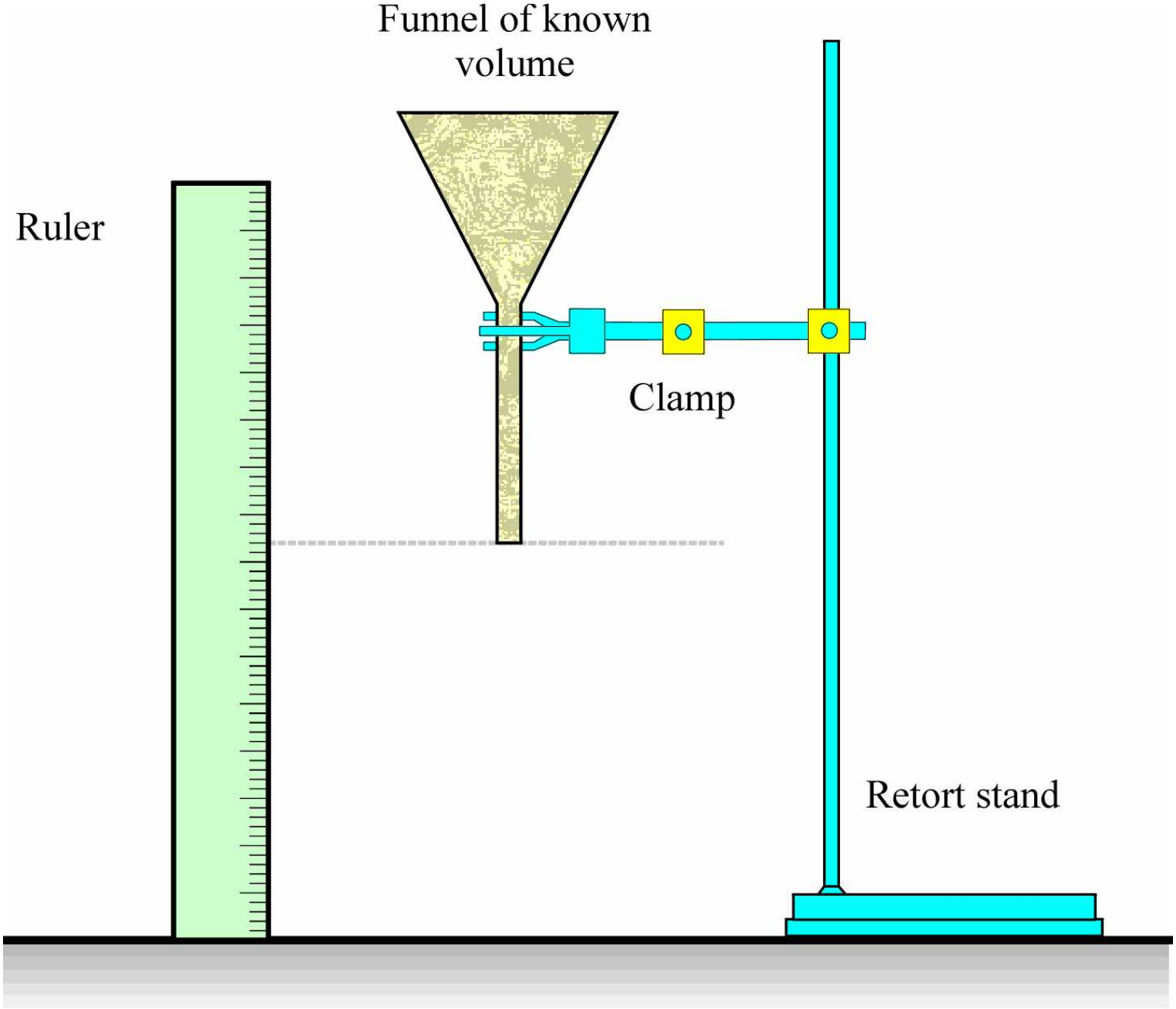
iron ore
coal
woodchips
sand

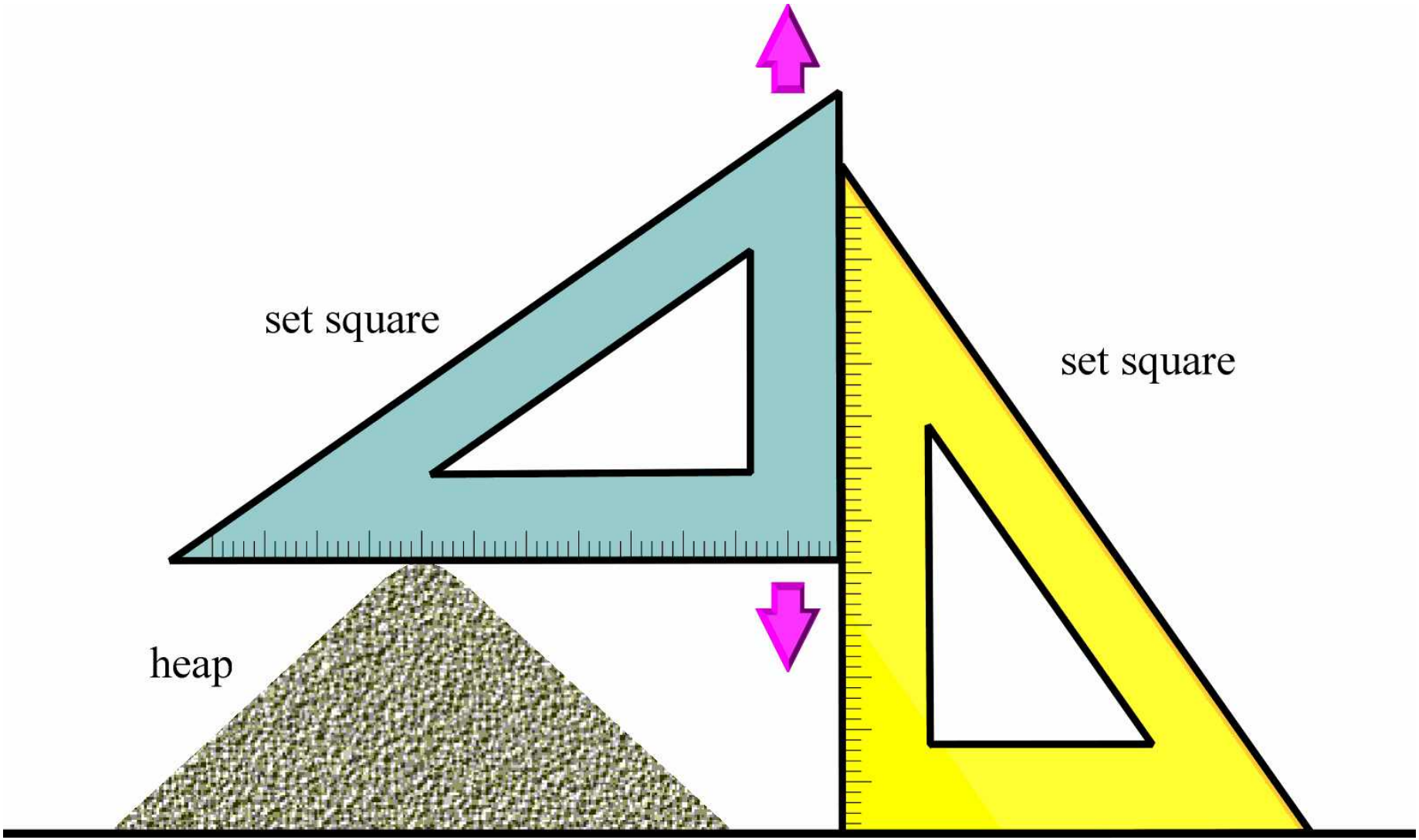
sugar
rice
100's & 1000's
milk powder
sand

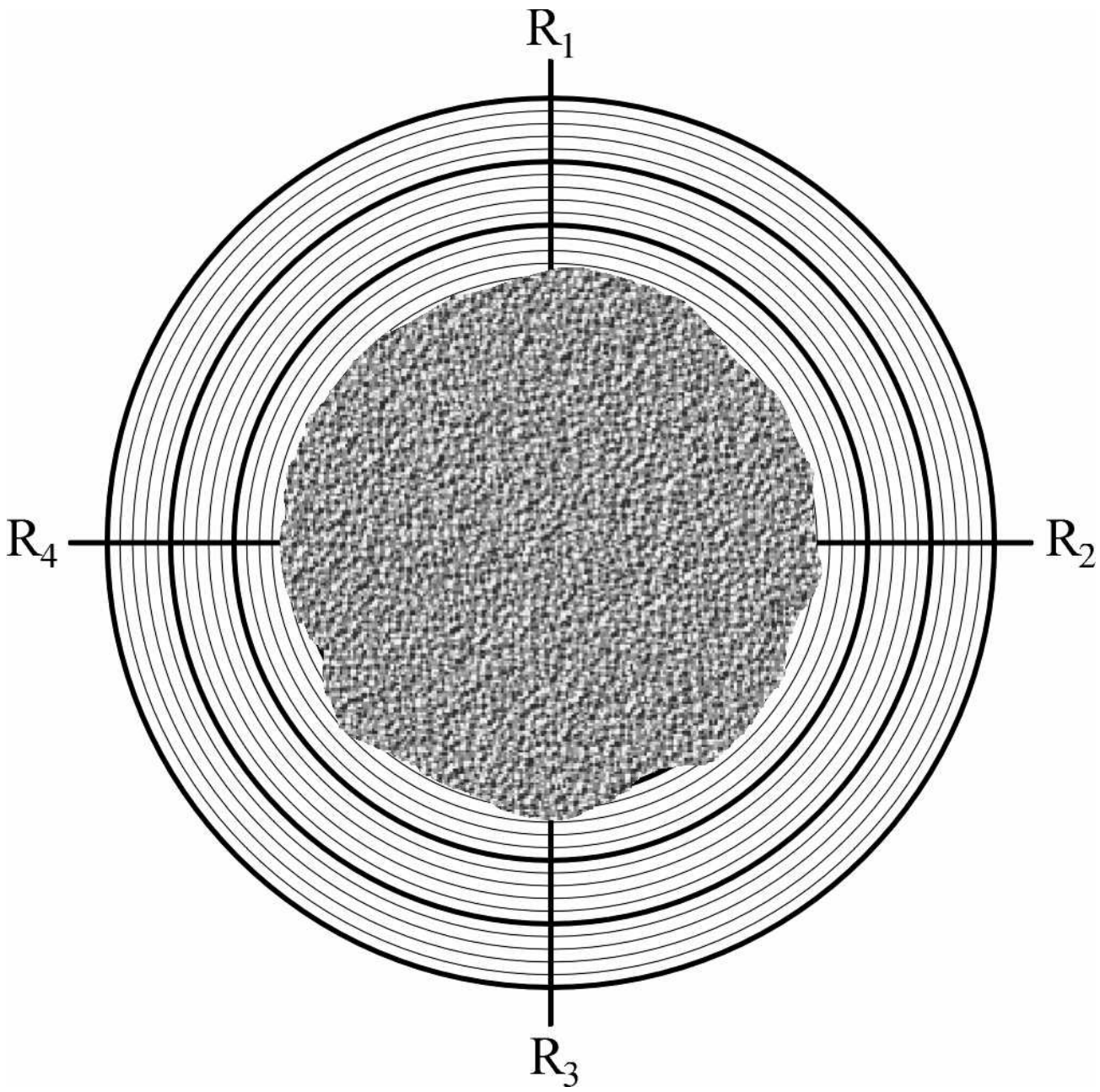
Equipment :

- funnels
- retort stand and clamps
- target sheet of concentric circles
- two set squares
- sugar, rice, 100’s & 1000’s, milk powder and/or sand


R1
R2
R3
R4


Funnel of known volume
Ruler
Clamp
Retort stand


set square
set square
heap


R1
R2
R3
R4

Milk Powder Results

The following results are for a 150 mm diameter funnel, held 150 mm above the target.

The heap formed as a cone.

Milk Powder Results

				H (cm)					R (cm)	Angle
11.0	11.0	11.0	10.9	10.98	8.3	8.5	8.5	8.7	8.50	52.2
11.3	11.1	11.1	11.1	11.15	8.4	9.3	9.4	8.8	8.98	51.2
10.8	10.7	10.7	10.6	10.70	8.7	9.4	9.3	9.1	9.13	49.5
10.8	10.8	10.7	10.6	10.73	9.1	9.8	8.8	8.7	9.10	49.7
10.2	10.1	10.1	10.0	10.10	9.5	9.4	9.5	8.5	9.23	47.6
11.2	11.2	11.2	11.2	11.20	9.6	9.5	8.7	10.0	9.45	49.8
10.8	10.7	10.7	10.6	10.70	9.6	10.0	9.0	8.9	9.38	48.8
11.0	10.8	10.8	10.7	10.83	9.0	9.3	9.3	9.3	9.23	49.6
10.7	10.7	10.6	10.6	10.65	9.0	9.0	9.4	9.3	9.18	49.3
10.7	10.7	10.5	10.5	10.60	9.7	9.5	8.8	9.2	9.30	48.7

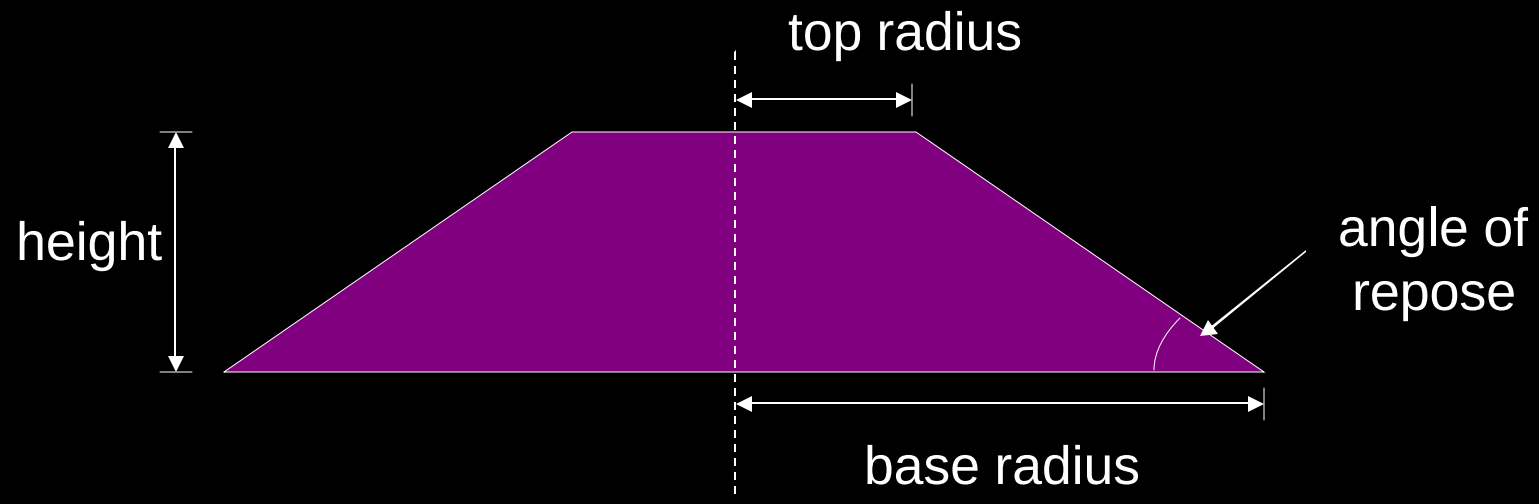
Rice Results

The following results are for a 100 mm diameter funnel, held 100 mm above the target.

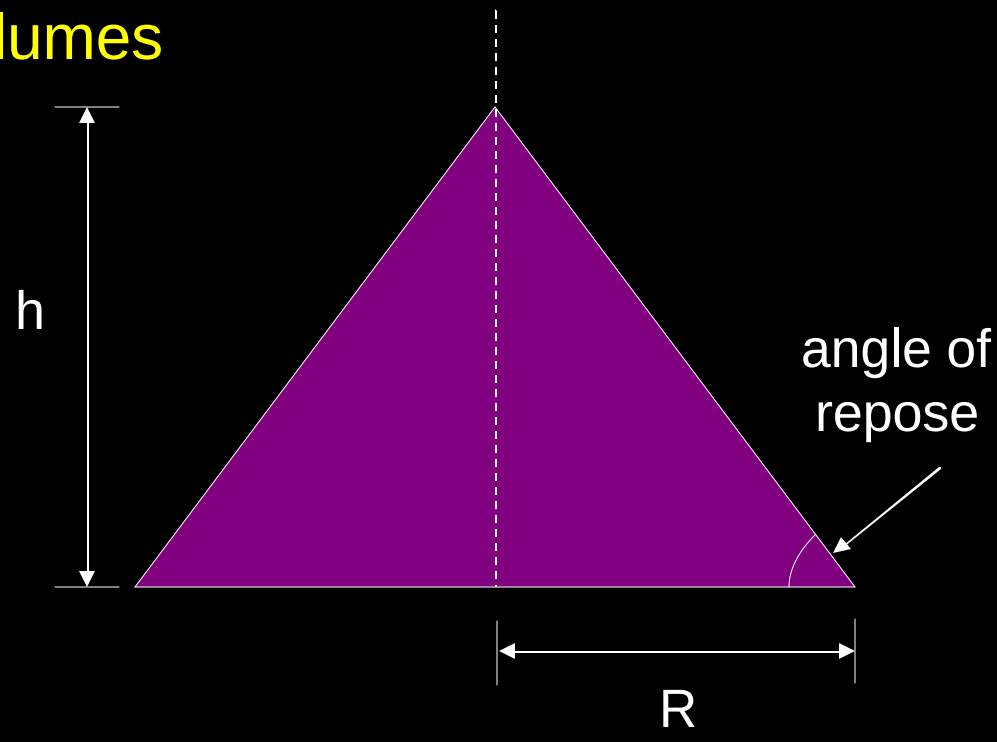
The heap formed as a truncated cone.

Rice Results

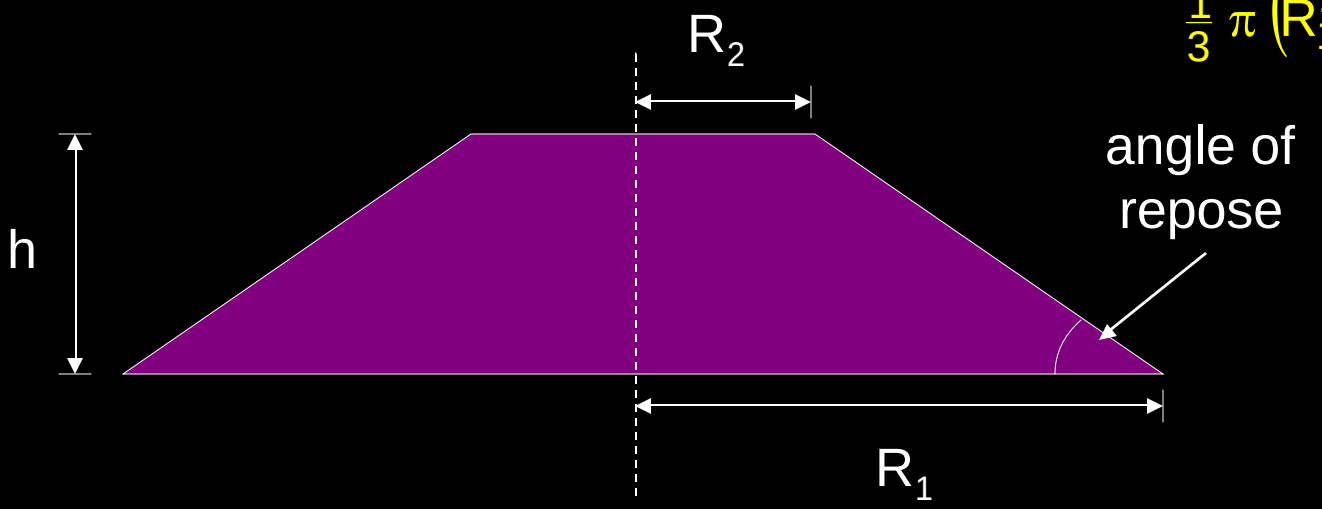
Height (cm)					Base radius (cm)					Top radius (cm)					Angle
3.5	3.4	3.4	3.4	3.43	7.2	7.2	6.5	6.9	6.95	1.25	1.0	1.25	1.0	1.125	30.5
3.5	3.5	3.5	3.5	3.50	7.5	7.2	7.5	6.8	7.25	1.5	1.25	1.5	1.25	1.375	30.8
3.5	3.5	3.4	3.4	3.45	7.4	7.4	6.6	6.7	7.03	1.0	1.5	1.25	1.25	1.250	30.9
3.5	3.4	3.4	3.4	3.43	7.6	7.4	6.5	6.9	7.10	1.25	1.0	1.25	1.25	1.188	30.1
3.4	3.5	3.4	3.4	3.43	7.0	7.4	6.9	7.1	7.10	1.5	1.25	1.5	1.25	1.375	30.9
3.4	3.5	3.5	3.5	3.48	7.5	7.1	6.8	6.8	7.05	1.5	1.25	1.25	1.25	1.313	31.2
3.2	3.4	3.3	3.3	3.30	7.0	7.0	7.0	6.6	6.90	1.25	1.25	1.5	1.5	1.375	30.8
3.3	3.4	3.4	3.4	3.38	7.2	6.7	7.1	7.4	7.10	1.25	1.5	1.5	1.25	1.375	30.5
3.4	3.5	3.5	3.4	3.45	7.2	7.1	6.8	7.0	7.03	1.25	1.25	1.25	1.5	1.313	31.1
3.5	3.5	3.5	3.5	3.50	7.3	6.8	7.0	7.0	7.03	1.25	1.5	1.25	1.5	1.375	31.8



Volumes



Volume of cone = $\frac{1}{3}\pi R^2 h$



Volume of truncated cone =

$$\frac{1}{3}\pi\left(R_1^2 + R_2^2 + R_1 R_2\right)h$$

Angles of Repose

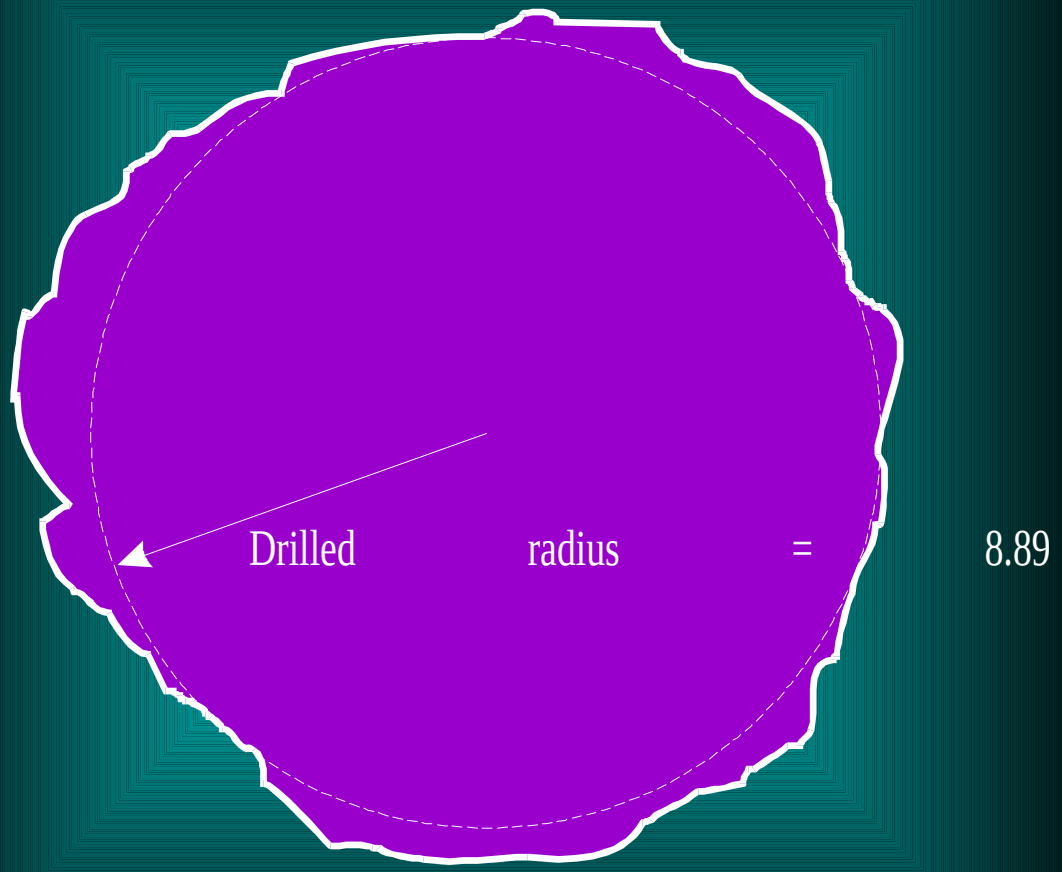
Milk powder	$50^{o} \pm 1^{o}$	cone
Sugar	$33^{o} \pm 1^{o}$	truncated cone
Rice	$31^{o} \pm 1^{o}$	truncated cone
100’s & 1000’s	$26^{o} \pm 1^{o}$	parabola cone

Petroleum Engineering

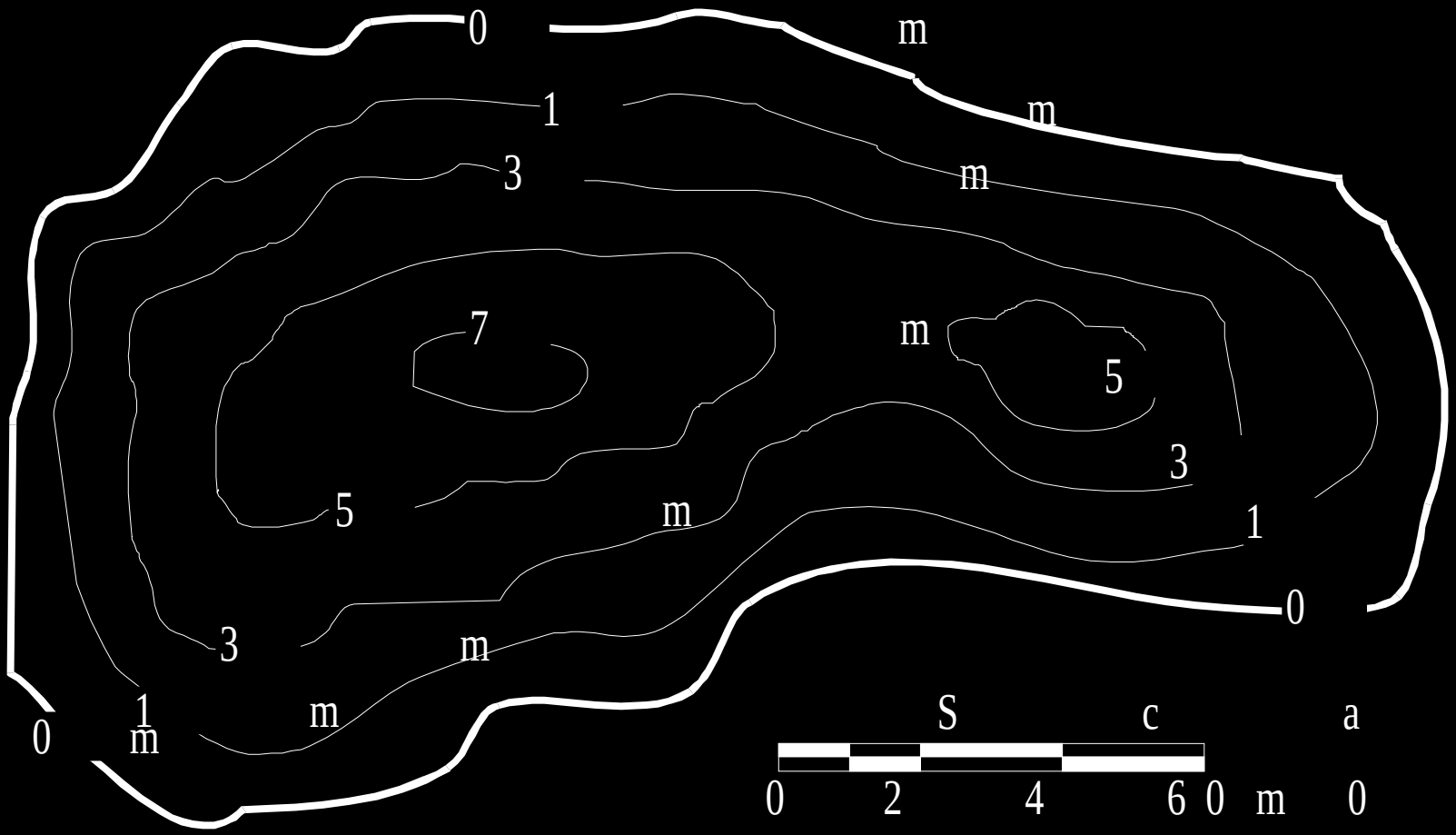
Because of cave ins a well bore is rarely circular in cross-section.

Estimate the cross-sectional area of the well at this point.

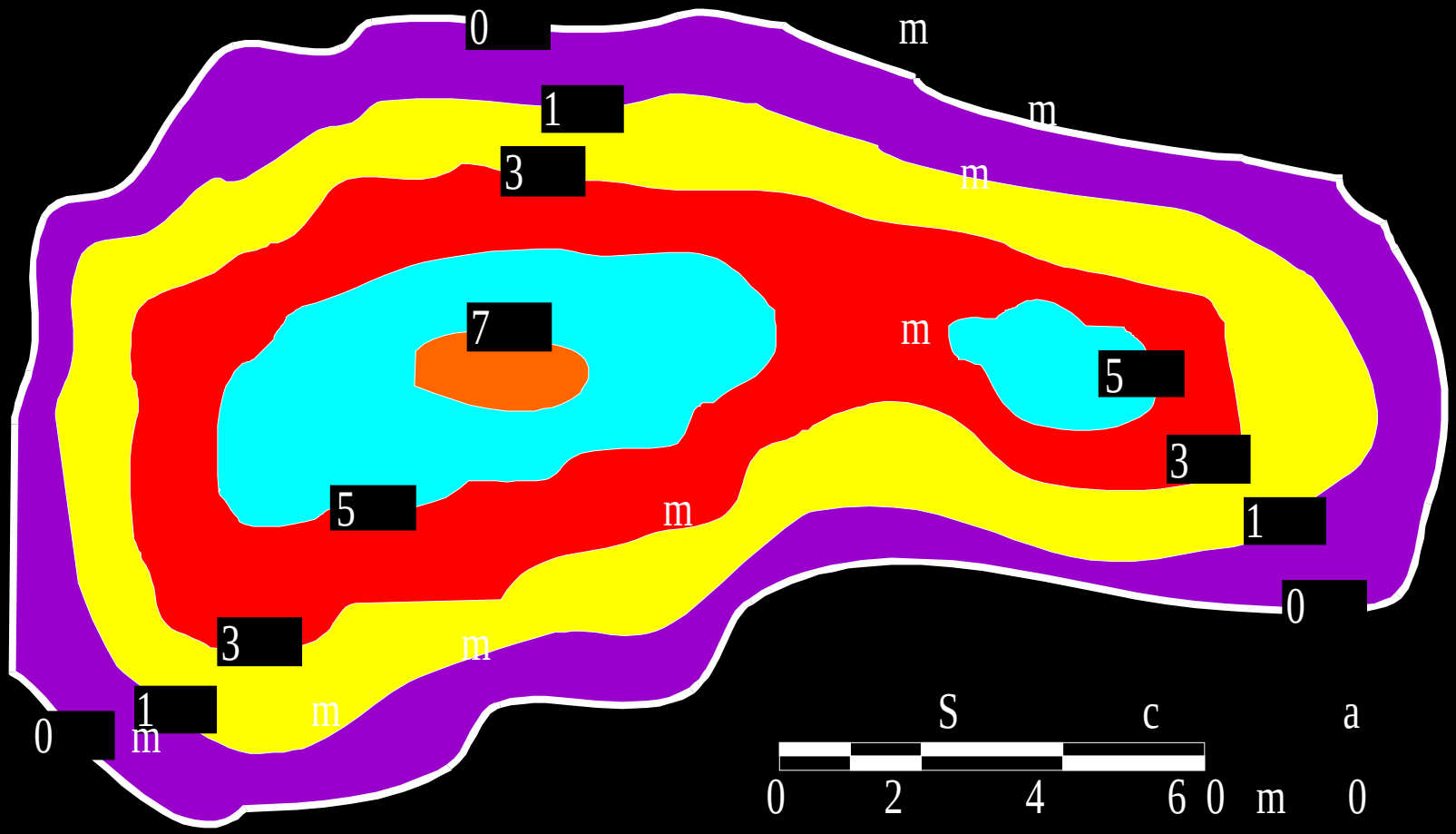
What is the average radius?



Formation thickness



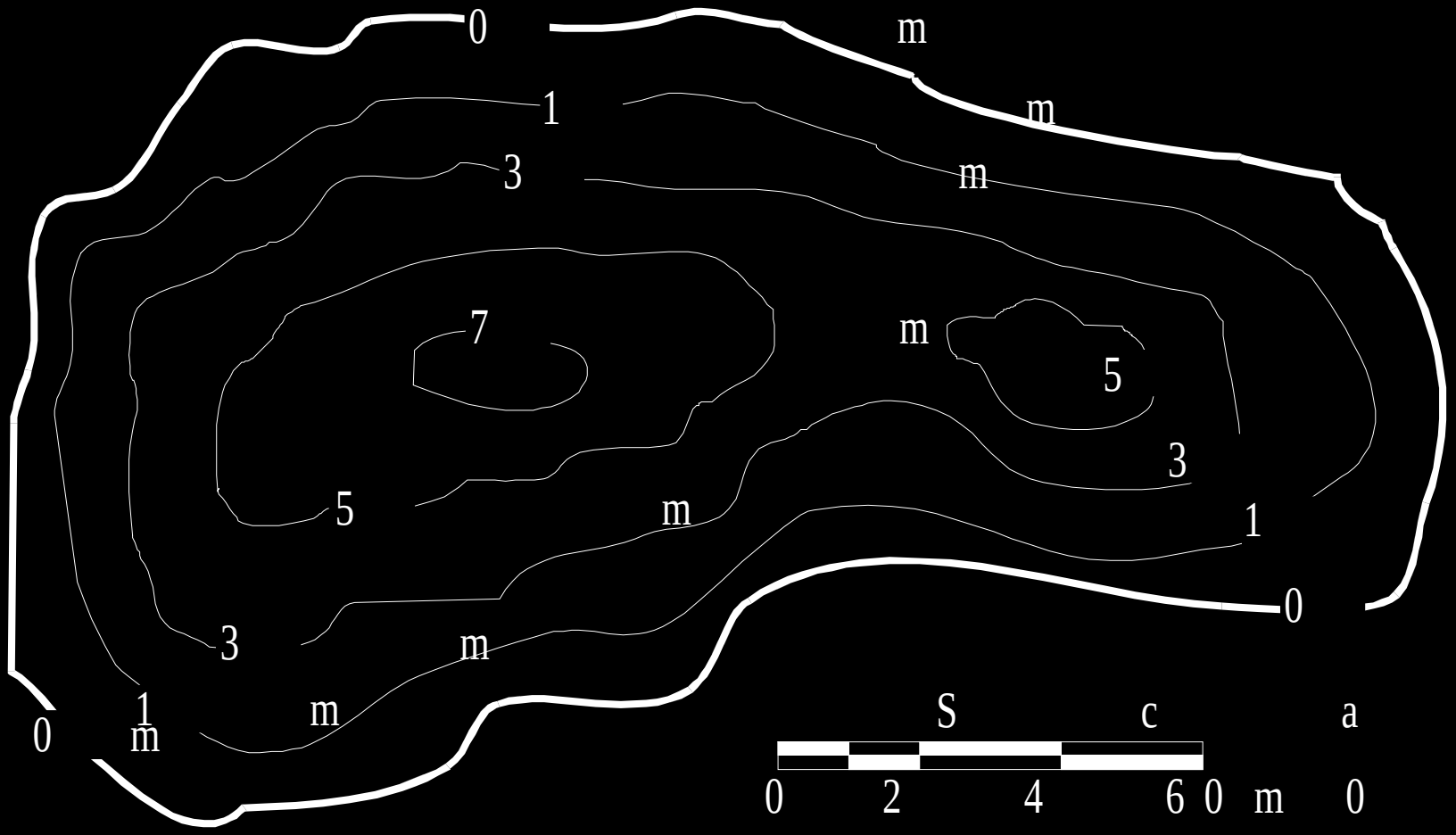
Formation thickness



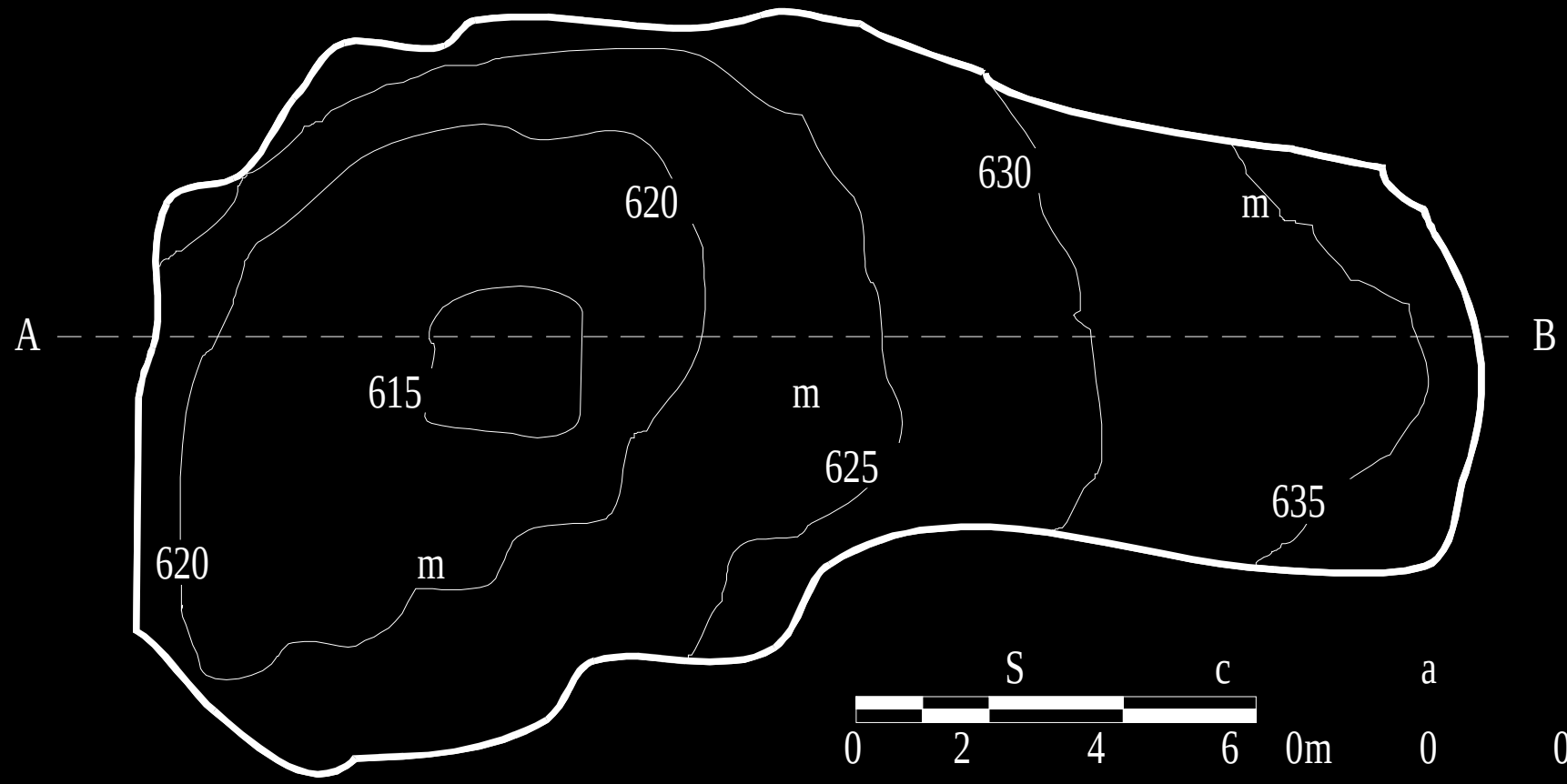
What is the volume of the oil-bearing formation ?

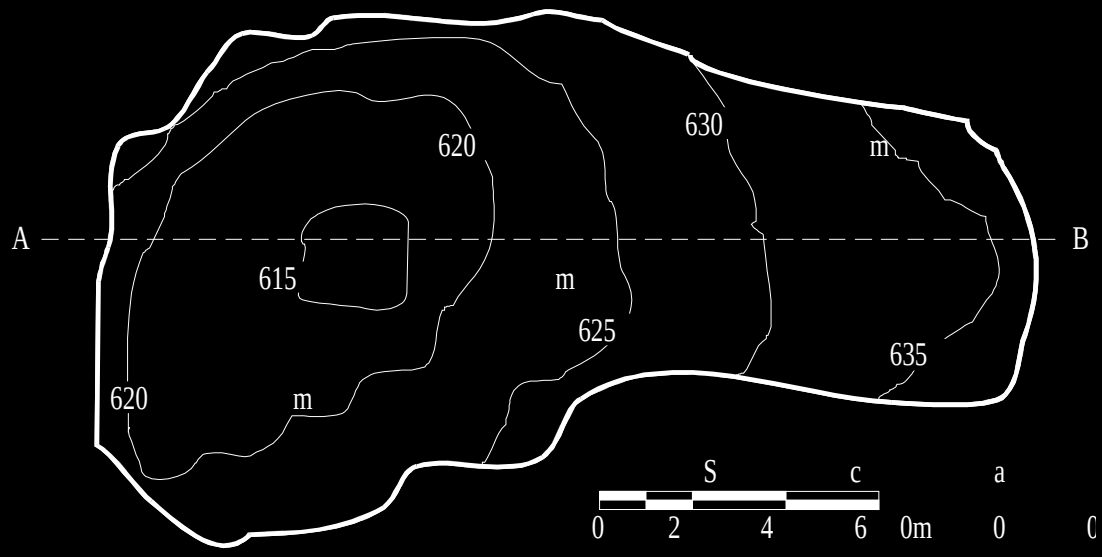
What is the average thickness of the formation ?

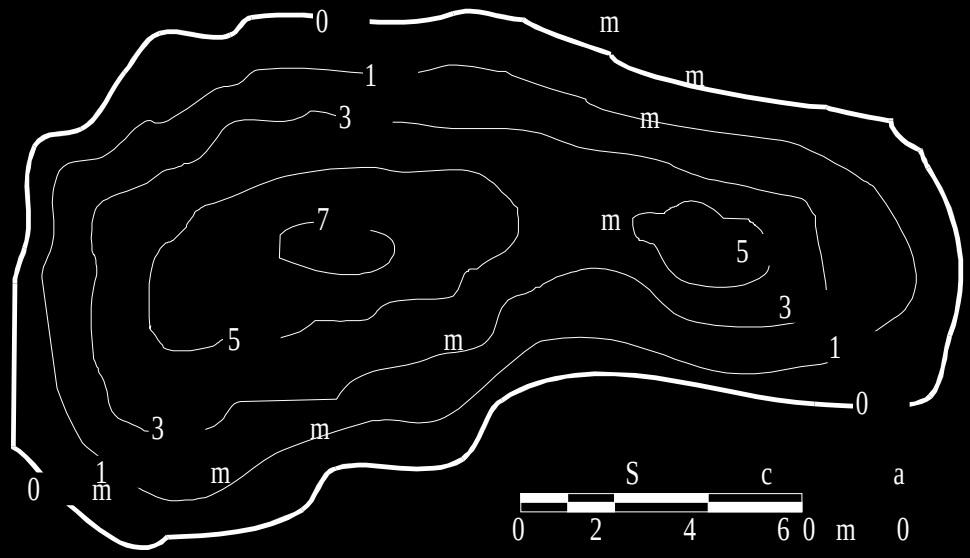
How do we calculate these values ?



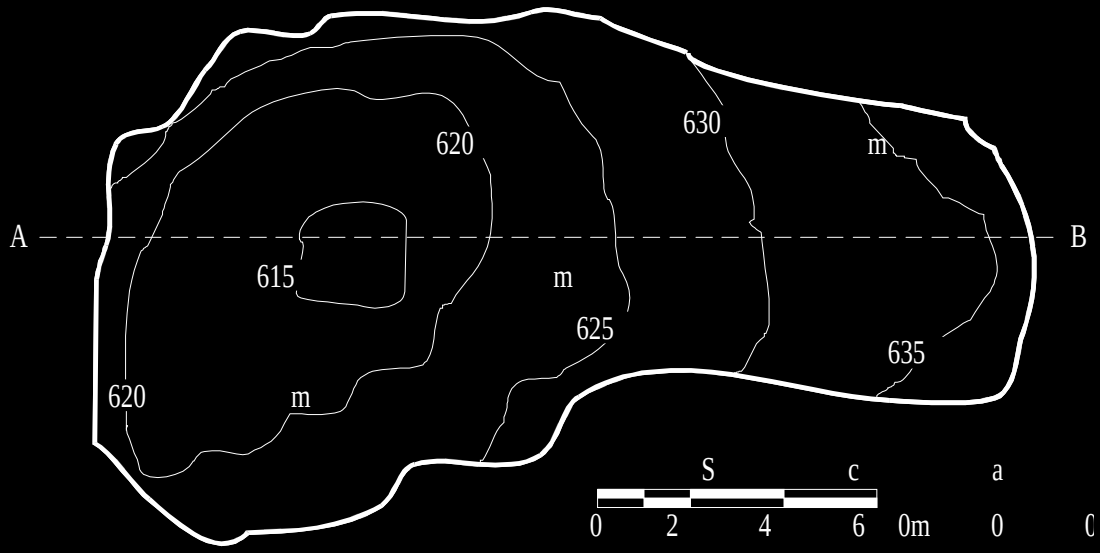
Contour map showing depth to top of formation.

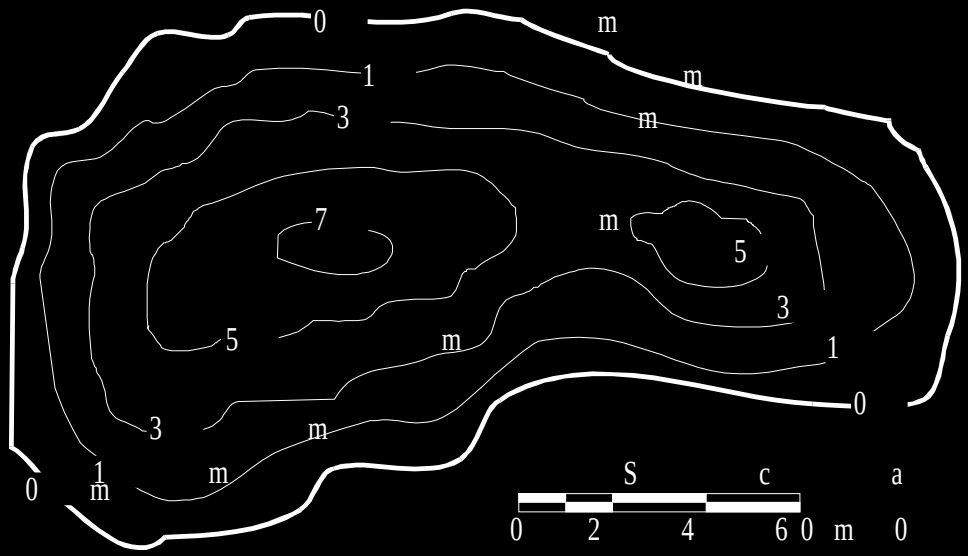






How far below the surface is the deepest part of the reservoir ?





Plot a graph showing the depth to the top and bottom of the oil reservoir along the cross-section A-B.