



$\sqrt{1156}$



What is the approximate area of the **Isle of Wight**?

If two people can stand in 1m^2 , what fraction of the 2012 worldwide population (7.046 billion) could fit on the IOW?

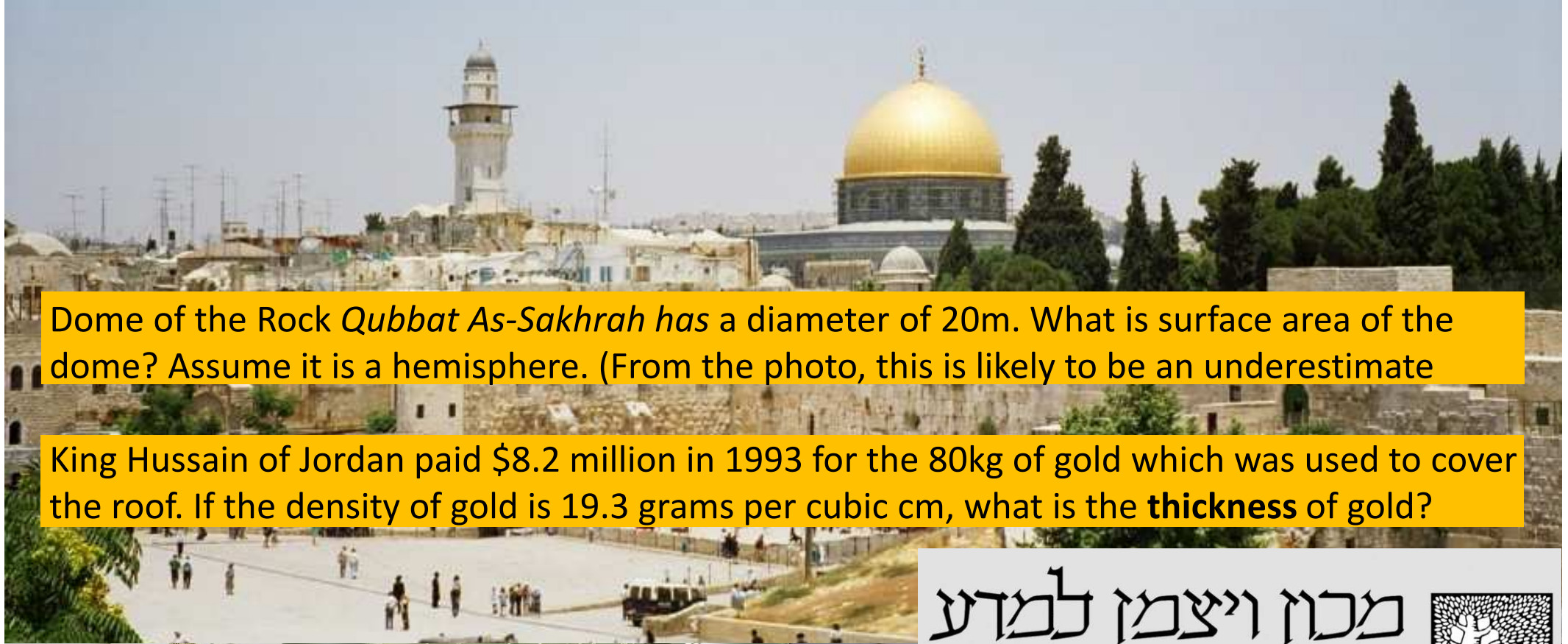
IOW area is approximately $\frac{1}{2} \times 21 \times 37 = 390 \text{ km}^2$

[According to Google, the 'official' area is 380 km^2]

$$390 \text{ km}^2 = 390 \times (1000 \text{ m})^2 = 3.9 \times 10^8 \text{ m}^2$$

$$\frac{3.9 \times 10^8 \text{ m}^2}{0.5 \text{ m}^2} = 7.8 \times 10^8$$

$$\frac{7.8 \times 10^8}{7.046 \times 10^9} = 11.1\%$$



Dome of the Rock *Qubbat As-Sakhrah* has a diameter of 20m. What is surface area of the dome? Assume it is a hemisphere. (From the photo, this is likely to be an underestimate

King Hussain of Jordan paid \$8.2 million in 1993 for the 80kg of gold which was used to cover the roof. If the density of gold is 19.3 grams per cubic cm, what is the **thickness** of gold?

מכון ויצמן למדע

WEIZMANN INSTITUTE OF SCIENCE



Dome surface area is $A = \frac{1}{2} \times 4\pi R^2$

$$R = 10\text{m}$$

$$A = 2\pi \times 100 = 628.3\text{m}^2$$

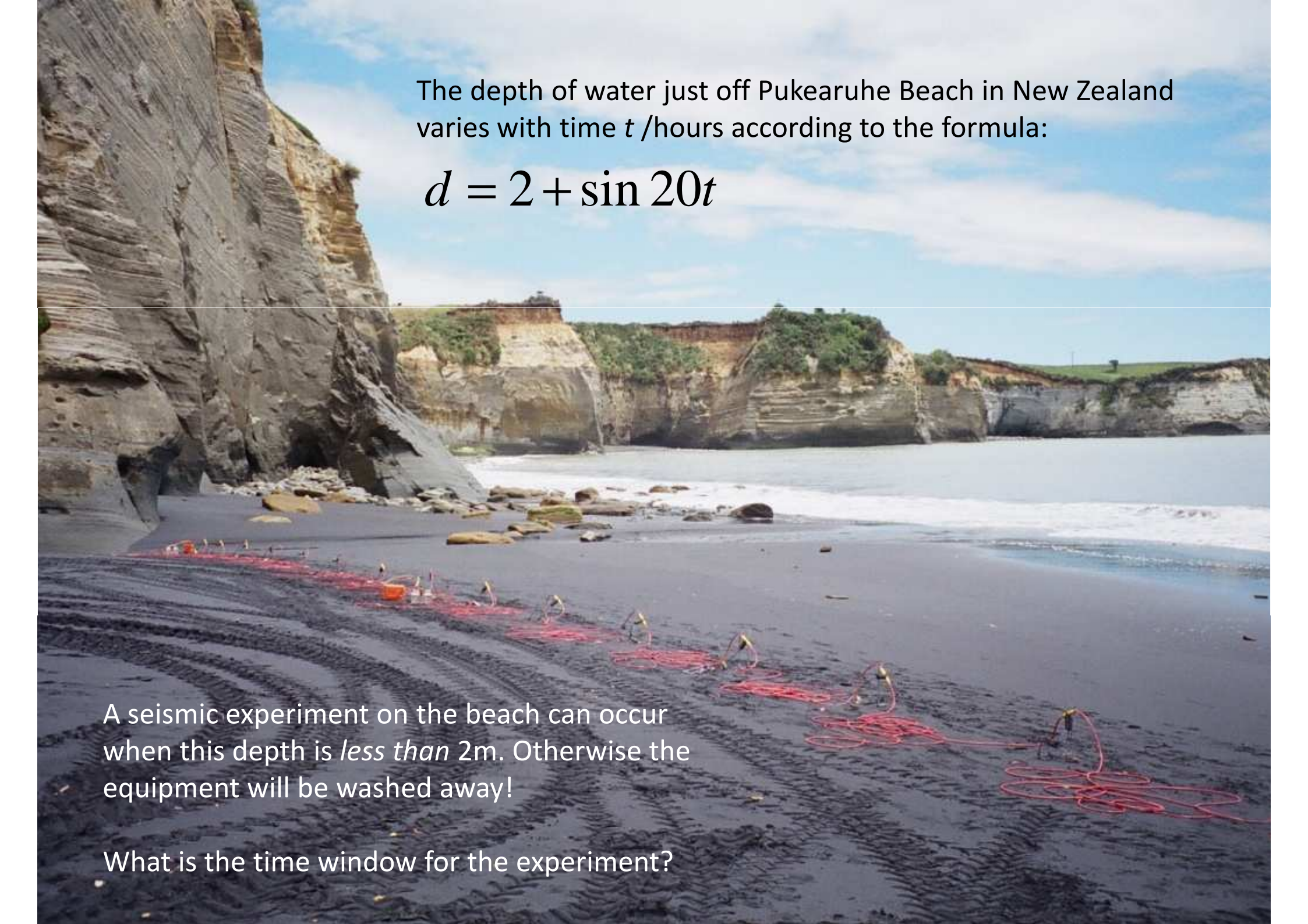
$$19.3\text{g/cm}^3 = \frac{19.3 \times 10^{-3}\text{kg}}{(10^{-2}\text{m})^3} = 1.93 \times 10^4\text{kg/m}^3$$

Volume of gold is $V_{\text{Au}} = \frac{80\text{kg}}{1.93 \times 10^4\text{kg/m}^3} = 4.15 \times 10^{-3}\text{m}^3$

Thickness of gold is $t = \frac{4.15 \times 10^{-3}\text{m}^3}{628.3\text{m}^2} = 6.60 \times 10^{-6}\text{m}$

$$t = 6.6\mu\text{m}$$

[According to Google it is $2.3\mu\text{m}$, indicating the hemispherical area is an underestimate of the true area]



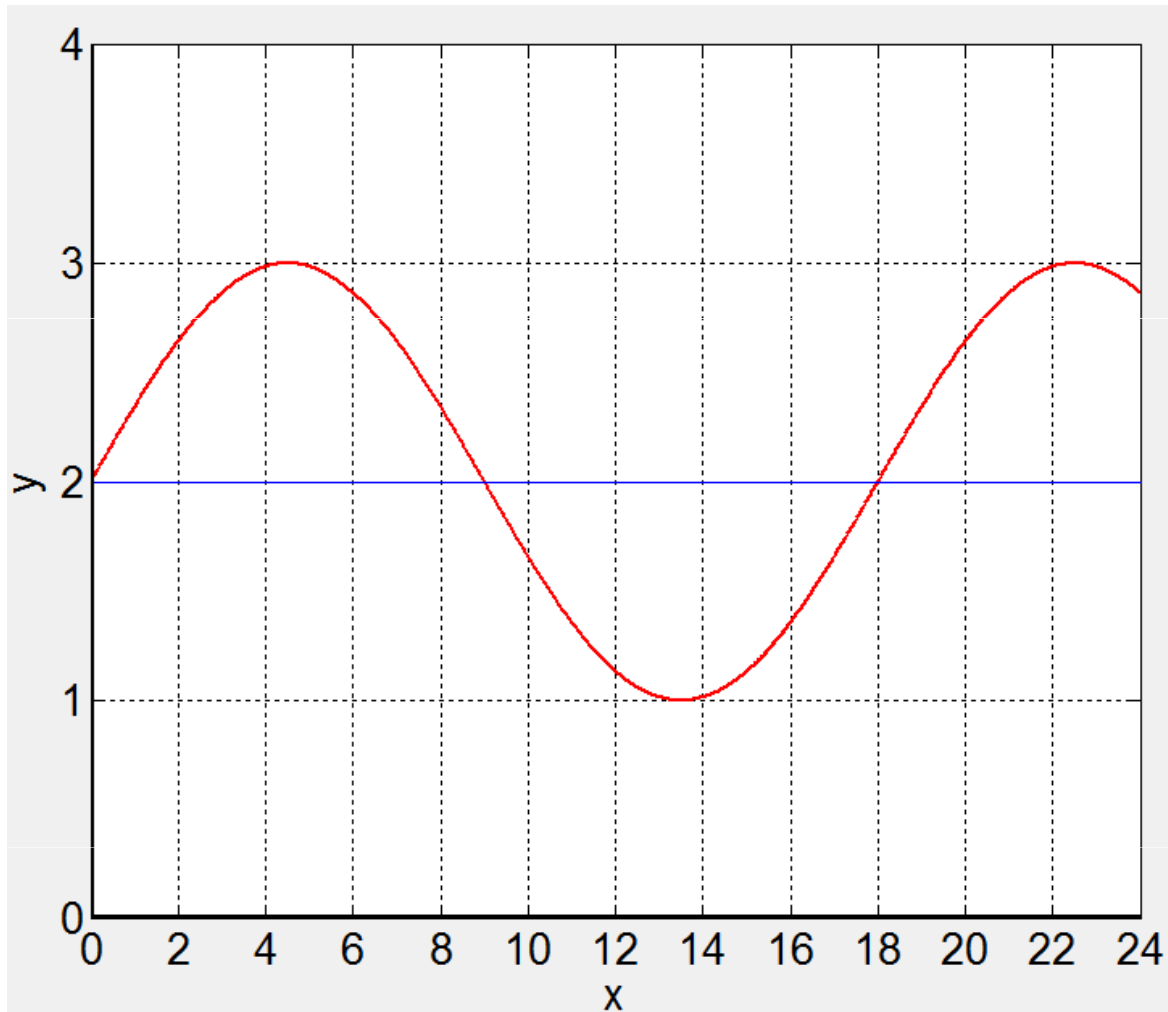
The depth of water just off Pukearuhe Beach in New Zealand varies with time t /hours according to the formula:

$$d = 2 + \sin 20t$$

A seismic experiment on the beach can occur when this depth is *less than* 2m. Otherwise the equipment will be washed away!

What is the time window for the experiment?

$$d = 2 + \sin 20t$$

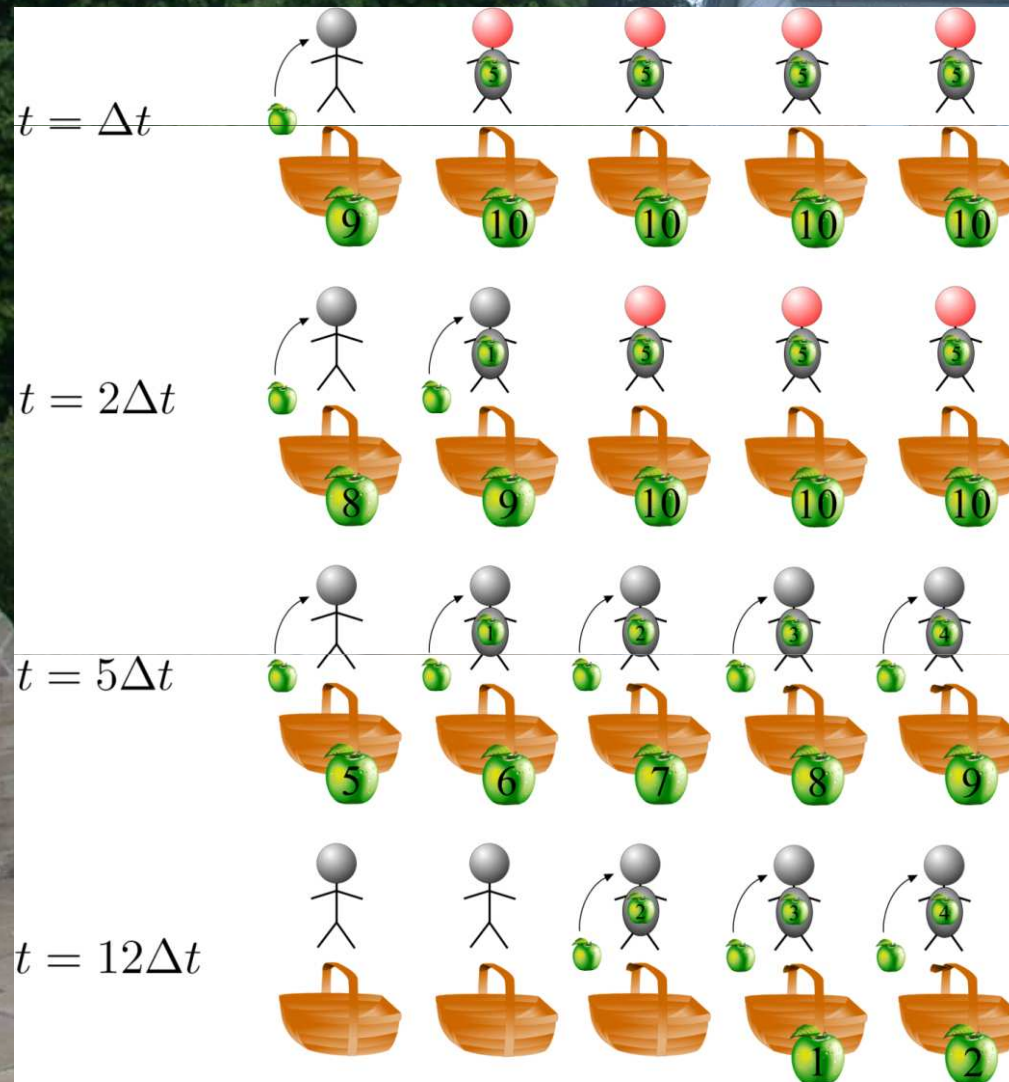


One period T hours of the tide
is when $20T = 360^\circ$

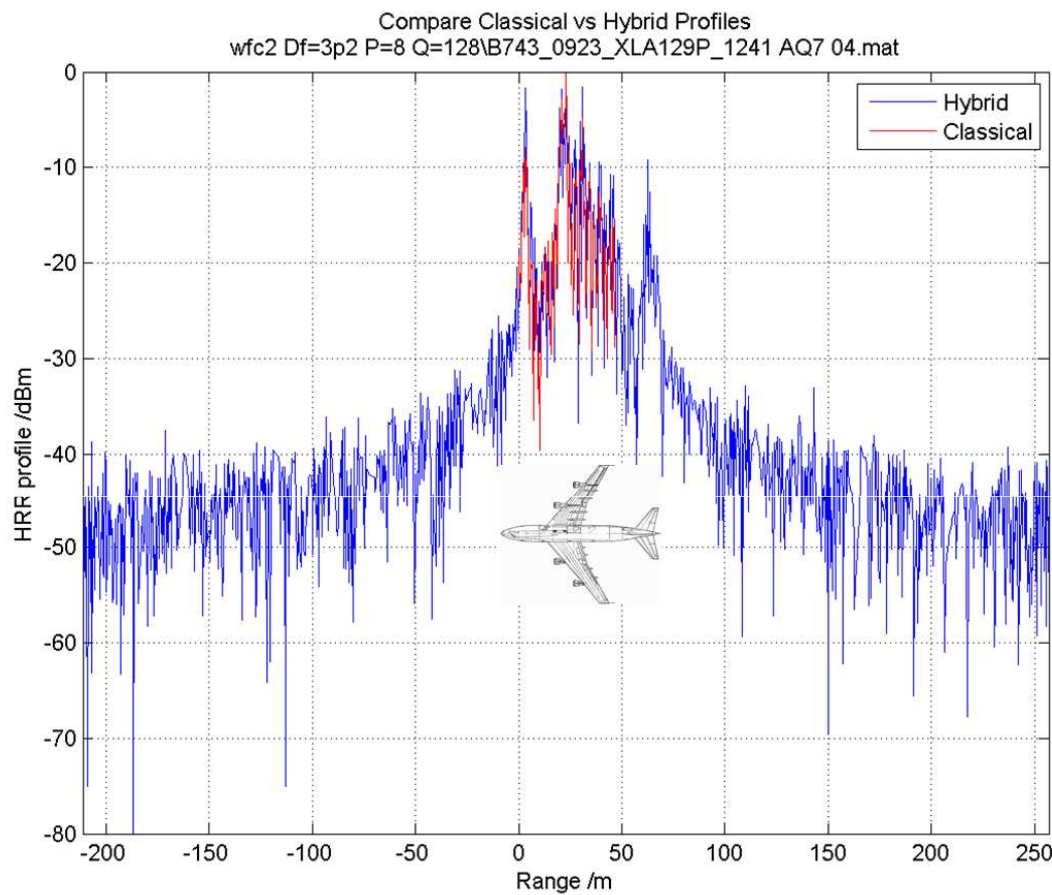
Therefore $T = 18$ hours

Time window for the experiment
is:

0900 till 1800



'Apples & baskets' model
of precipitation and
dissolution reactions in
porous media



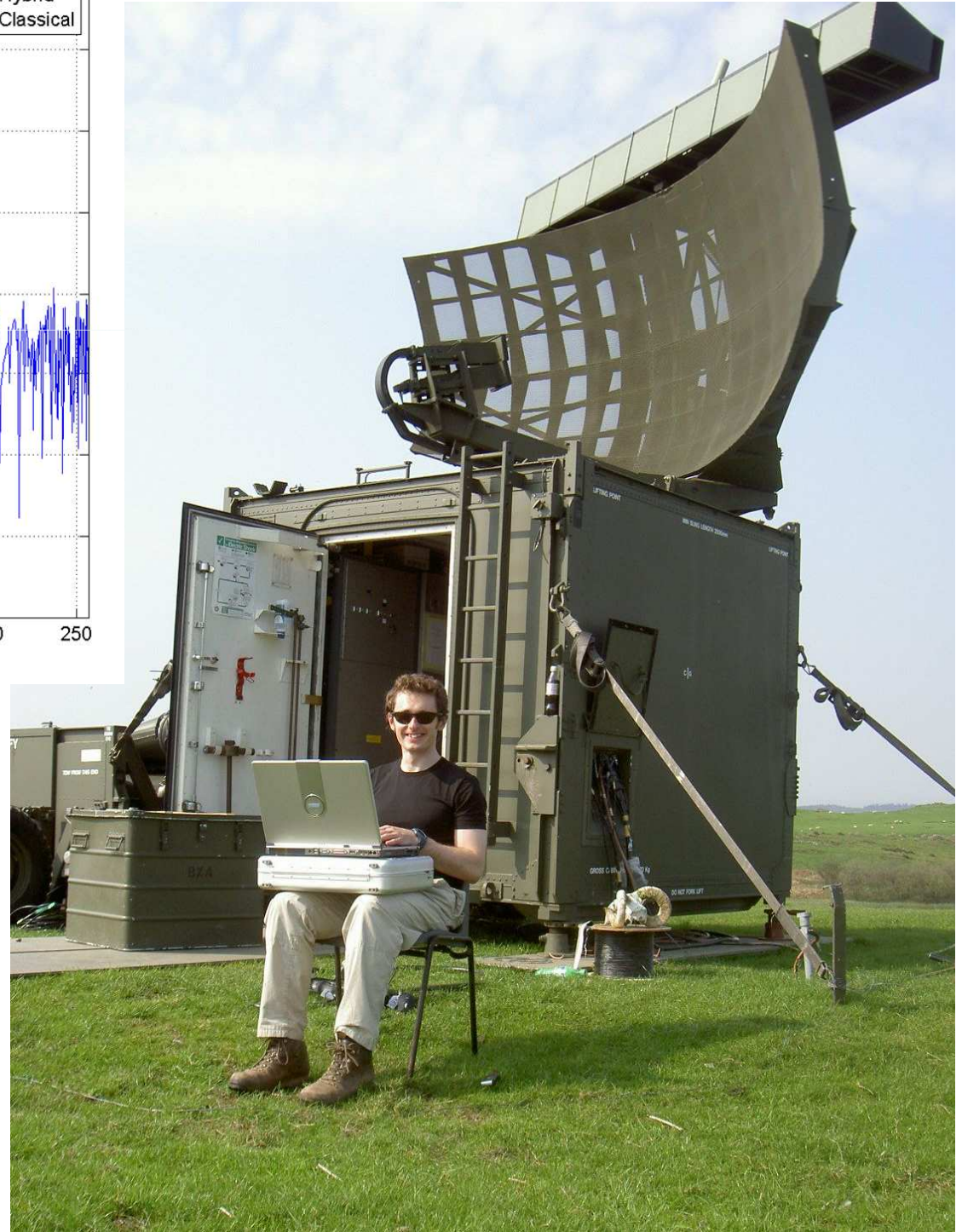
The *resolution* of a radar which transmits over frequency range of Δf is

$$\delta R = \frac{c}{2\Delta f}$$

What is the resolution in metres if

$\Delta f = 200 \times 10^6 \text{ Hz}$?

[The speed of light $c = 2.998 \times 10^8 \text{ ms}^{-1}$]

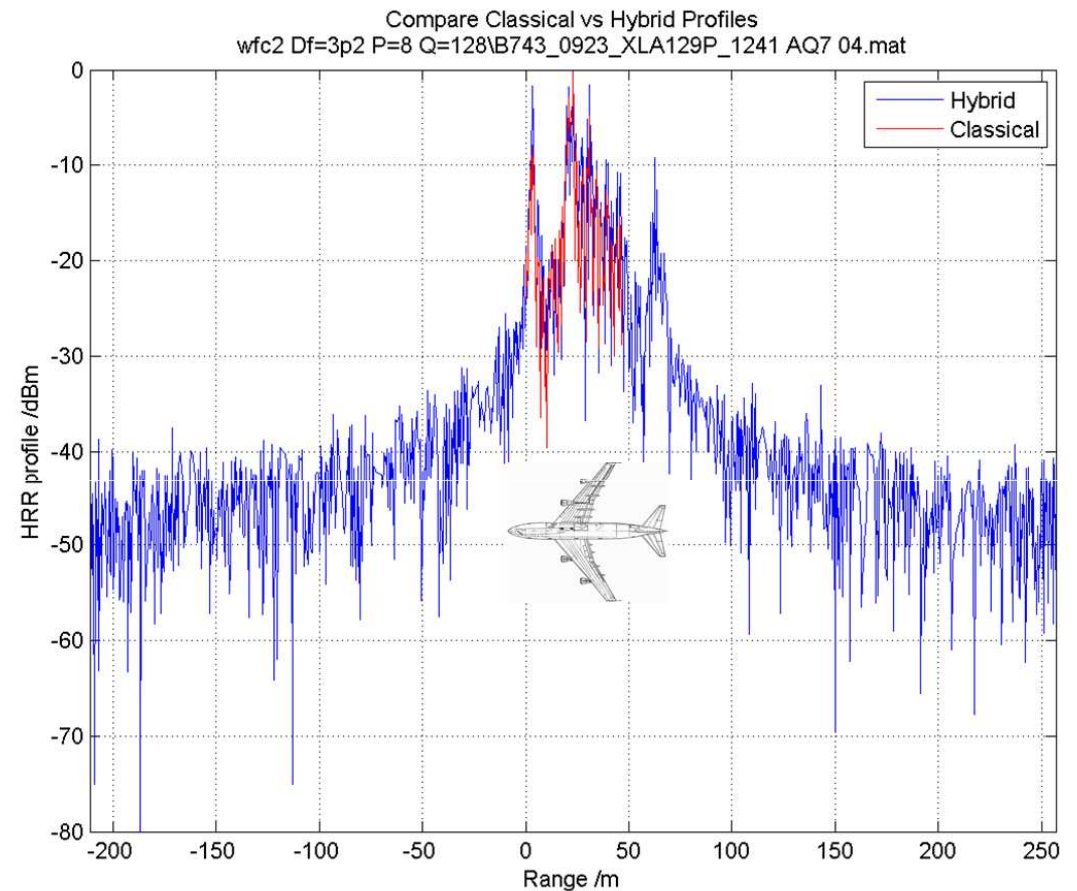


$$\delta R = \frac{c}{2\Delta f}$$

$$1\text{Hz} = 1\text{s}^{-1}$$

$$\delta R = \frac{2.998 \times 10^8 \text{ms}^{-1}}{2 \times 200 \times 10^6 \text{s}^{-1}}$$

$$\delta R = 0.75\text{m}$$



This means the radar could *resolve* aircraft features such as length, position of engines, tailfin etc!



HMS Daring - Type 45

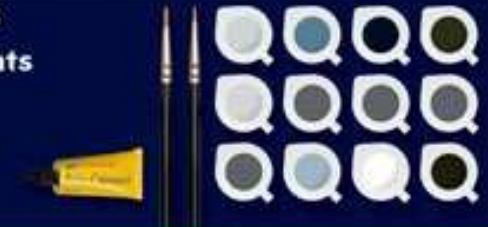


1:350 scale

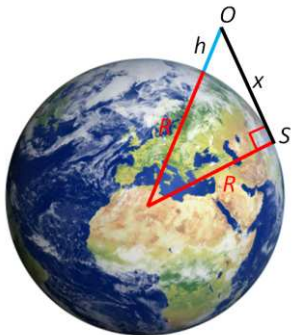
Model kit

• MAQUETTE A MONTER • MODELLBAUSATZ • MAQUETA PARA MONTAR

SET INCLUDES
12 Acrylic Paints
2 Brushes
1 Poly Cement



Official Licensed Product



Radius of the Earth $R = 6.378 \times 10^6 \text{ m}$

Distance to the horizon is approximately

$$d = \sqrt{2 \times \frac{4}{3} Rh}$$

If radar height $h = 30\text{m}$, how far away is the horizon?



HELICOPTER:

The on-board Merlin anti-submarine helicopter carries Sting Ray air-launched torpedoes, depth charges and Sea Skua missiles. Dubbed 'The Flying Frigate'. Top speed 190mph.

SAMPSON MULTI FUNCTION RADAR:

Can detect targets 250 miles away. Capable of simultaneously tracking 300 flying objects.

MISSILES: Can launch eight surface-to-air Aster 15 and Aster 30 missiles - capable of destroying enemy planes or missiles - in just 10 seconds.

HULL STRUCTURE: Made of 2,800 tonnes of steel, it is more than the weight of the Blackpool Tower. Approximately 40 tonnes of paint cover an area of 100,000 square metres of steel. Its shape is designed to minimise visibility to radar, so a Type 45 looks like a smaller ship on an enemy's screen. All angles and outside slopes are calculated to reflect radar beams away. Exhaust fumes are cooled to reduce detection by infra-red.

PHALANX MACHINE-GUN:

Radar-guided, it fires 75 rounds per second to knock down missiles or aircraft.

ENGINES: Two Rolls-Royce WR-21 gas turbine engines. Its onboard power plant can supply enough electricity to light a town of 80,000 people.

CREW QUARTERS:

She contains 220 berths, 26 sofa beds and has her own hospital facilities complete with operating table. She is fitted with 1 bath, 44 showers, 54 toilets and 100 wash basins.

FACTFILE: TYPE 45 DESTROYER

- Displacement: 7,350 tonnes
- Length: 500ft
- Crew: 190
- Speed: 27 knots
- Cost: £1billion

DEFENCE SYSTEM: Uses the state-of-the-art Sea Viper air-defence system to protect the ship and escorted vessels against multiple attacks from the most sophisticated enemy aircraft and missiles. Can operate close to shore to provide cover for ground forces, for instance during an amphibious landing.



<http://www.dailymail.co.uk/sciencetech/article-1233054/HMS-Dauntless-How-Britains-new-1bn-super-ship-isnt-working-order.html>

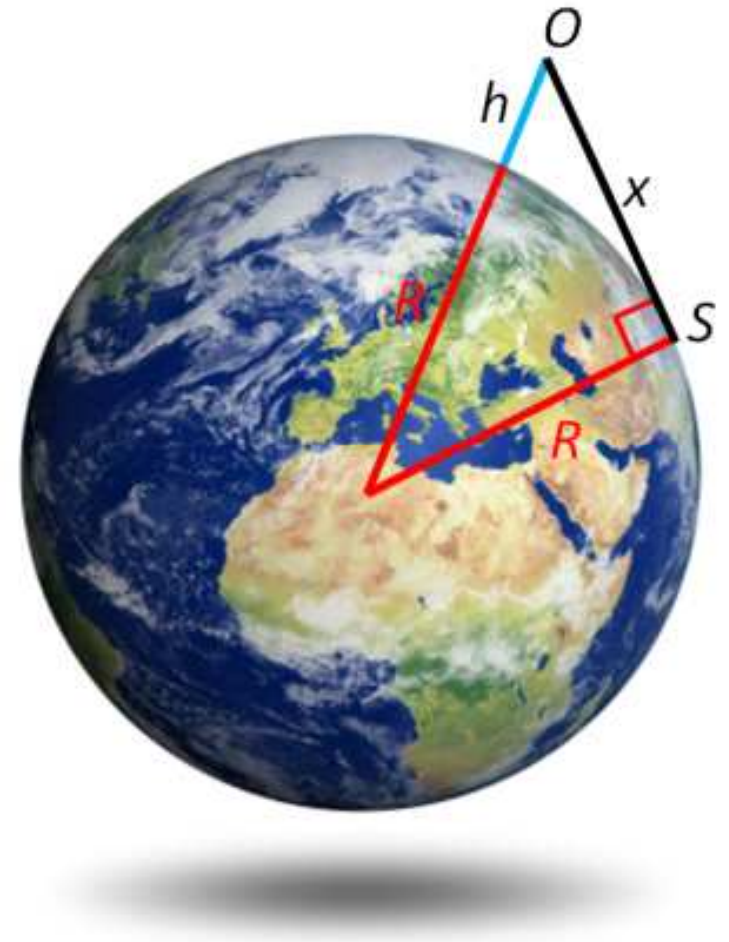
Radius of the Earth $R = 6.378 \times 10^6 \text{ m}$

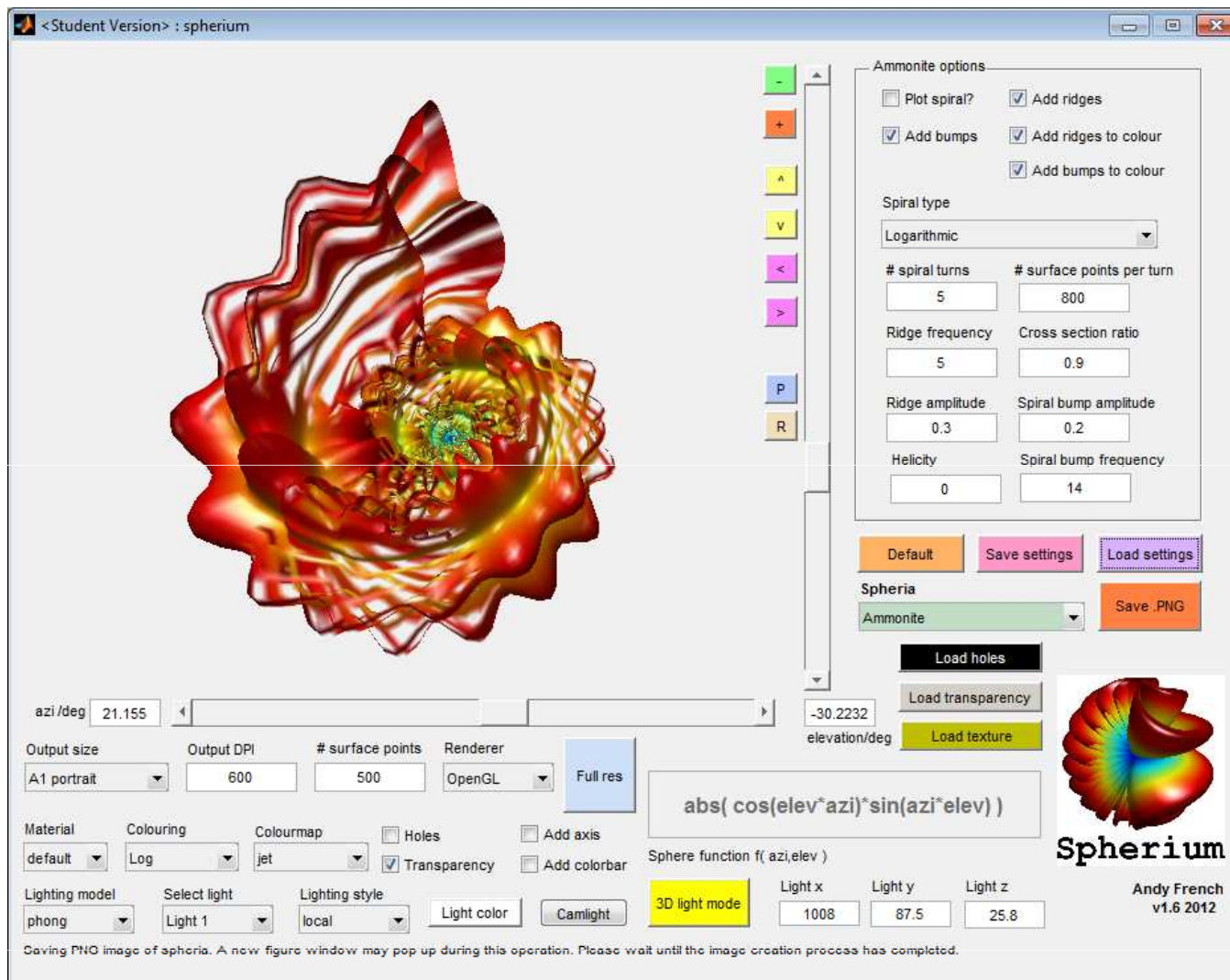
Distance to the horizon is approximately

$$d = \sqrt{2 \times \frac{4}{3} R h} \quad \text{If radar height } h = 30\text{m, how far away is the horizon?}$$

$$d = \sqrt{2 \times \frac{4}{3} \times 6.378 \times 10^6 \times 30} \text{ m}$$

$$d = 22.6\text{km}$$

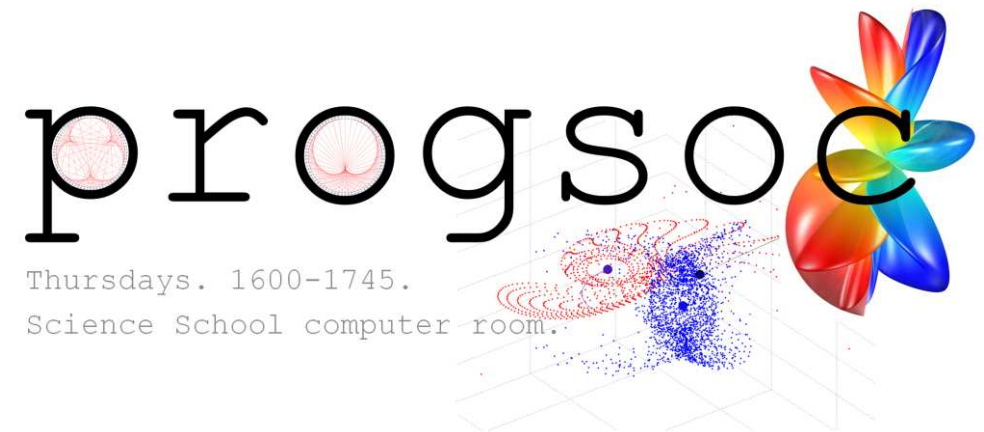




```
p=0;
for n=1:12
    for m=1:n
        p = p + m;
    end
end
```

What is p?

What has this number got to do with a popular festive carol?



The total number of presents in the carol “The Twelve Days of Christmas” is:

1 +
1 + 2 +
1 + 2 + 3 +
1 + 2 + 3 + 4 +
1 + 2 + 3 + 4 + 5 +
1 + 2 + 3 + 4 + 5 + 6 +
1 + 2 + 3 + 4 + 5 + 6 + 7 +
1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 +
1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 +
1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 +
1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 +
1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12

= 364

There is actually a formula for this type of sum. If n is the ‘number of days of Christmas’ and p is the total number of presents

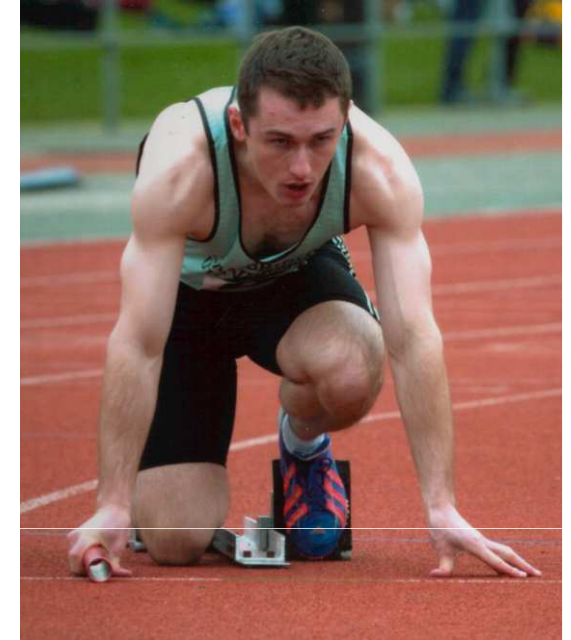
$$p = \frac{1}{6} n(n+1)(n+2)$$

e.g. $(1/6) \times 12 \times 13 \times 14 = 364$

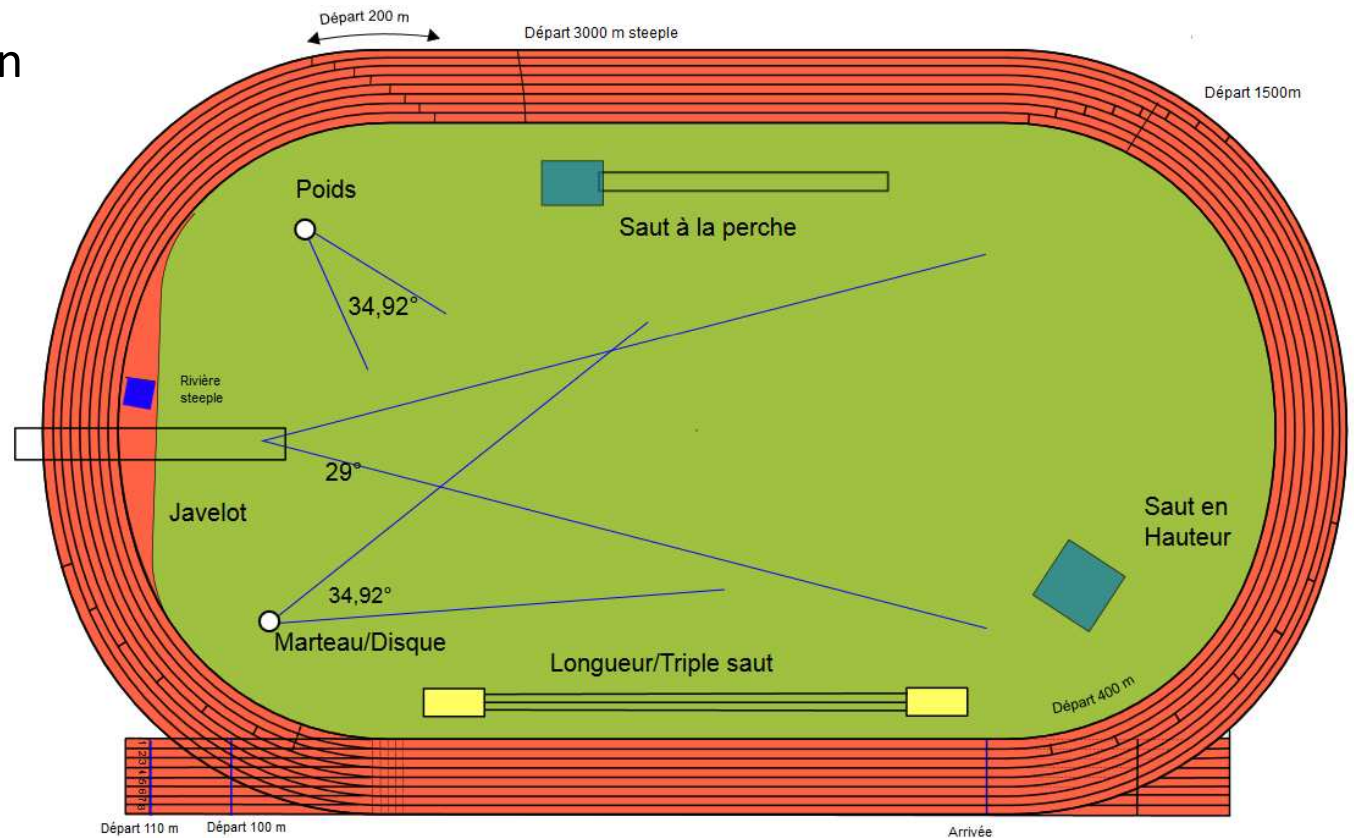
Note if Christmas *lasted all year*

$p = (1/6) \times 365 \times 366 \times 367 = 8,171,255$ presents!





How far behind Michael Johnson would a 400m runner be if he ran 50.0s?



Michael Johnson covers 400m in 43.18s at World Record pace (set on 26th August 1999, Seville and still holding in Dec 2013)

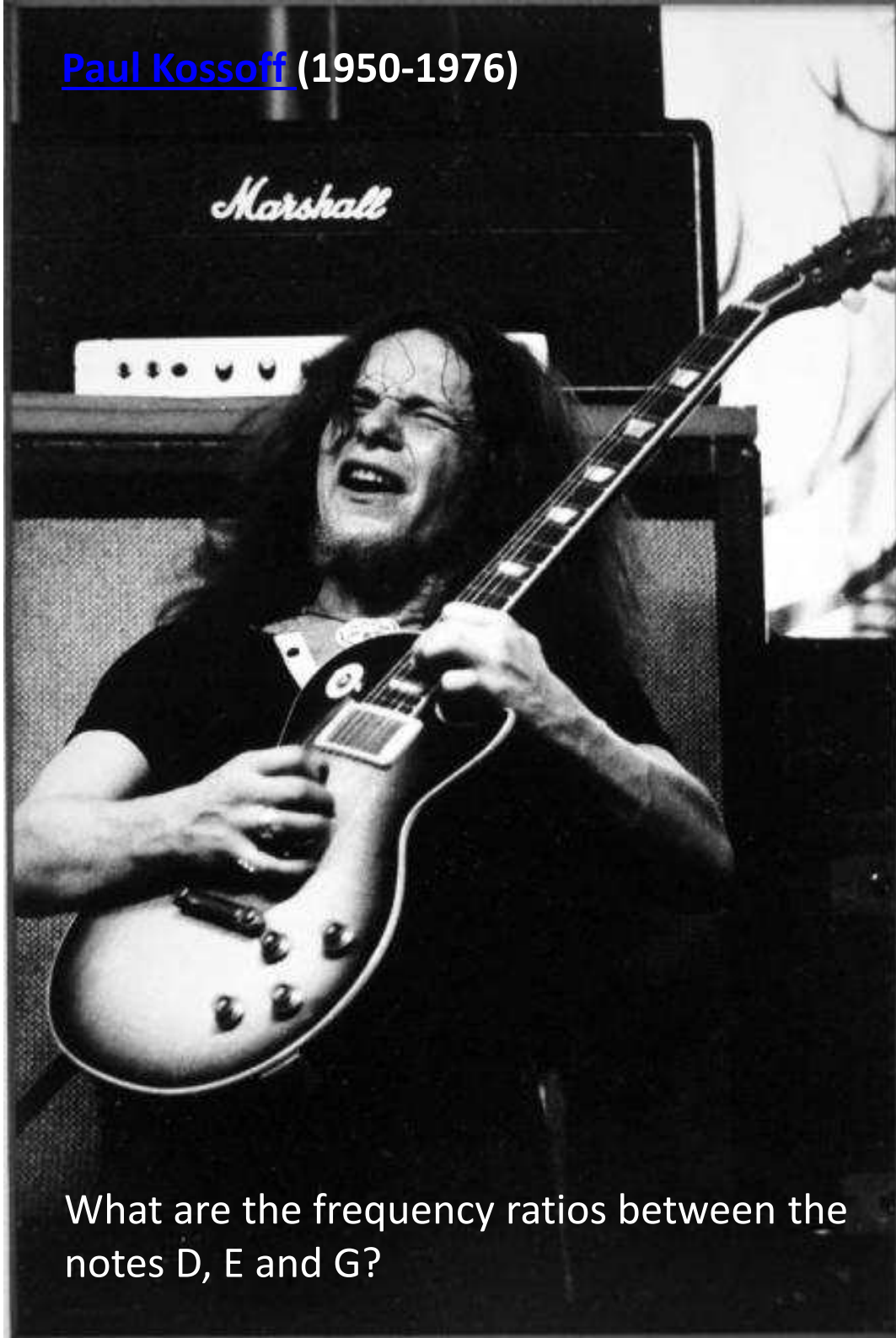
The other athlete covers the same distance in 50s at top speed, therefore he runs at an average speed of

$$400\text{m} / 50.0\text{s} = 8 \text{ ms}^{-1}$$

In 43.18s he will have covered $43.18 \times 8 = 345.44\text{m}$, so will be

54.56m behind Michael Johnson!

Paul Kossoff (1950-1976)



What are the frequency ratios between the notes D, E and G?

Unison (C)	$2^{\frac{0}{12}} = 1$
Minor second (C#)	$2^{\frac{1}{12}} = \sqrt[12]{2}$
Major second (D)	$2^{\frac{2}{12}} = \sqrt[6]{2}$
Minor third (D#)	$2^{\frac{3}{12}} = \sqrt[4]{2}$
Major third (E)	$2^{\frac{4}{12}} = \sqrt[3]{2}$
Perfect fourth (F)	$2^{\frac{5}{12}} = \sqrt[12]{32}$
Diminished fifth (F#)	$2^{\frac{6}{12}} = \sqrt{2}$
Perfect fifth (G)	$2^{\frac{7}{12}} = \sqrt[12]{128}$
Minor sixth (G#)	$2^{\frac{8}{12}} = \sqrt[3]{4}$
Major sixth (A)	$2^{\frac{9}{12}} = \sqrt[4]{8}$
Minor seventh (A#)	$2^{\frac{10}{12}} = \sqrt[6]{32}$
Major seventh (B)	$2^{\frac{11}{12}} = \sqrt[12]{2048}$
Octave (C)	$2^{\frac{12}{12}} = 2$

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$$f_D = 2^{\frac{2}{12}} f_C$$

$$f_E = 2^{\frac{4}{12}} f_C$$

$$f_G = 2^{\frac{7}{12}} f_C$$

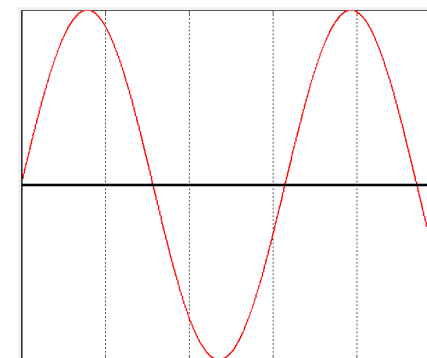
$$f_D : f_E : f_G$$

$$= 2^{\frac{2}{12}} : 2^{\frac{4}{12}} : 2^{\frac{7}{12}}$$

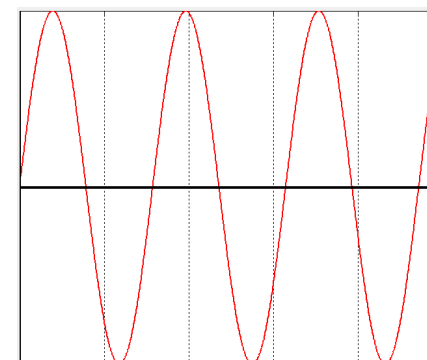
$$= 1 : 2^{\frac{2}{12}} : 2^{\frac{5}{12}}$$

$$= \boxed{1 : 1.122 : 1.335}$$

C



C + one octave



time



South face of
Annapurna 1, Nepal

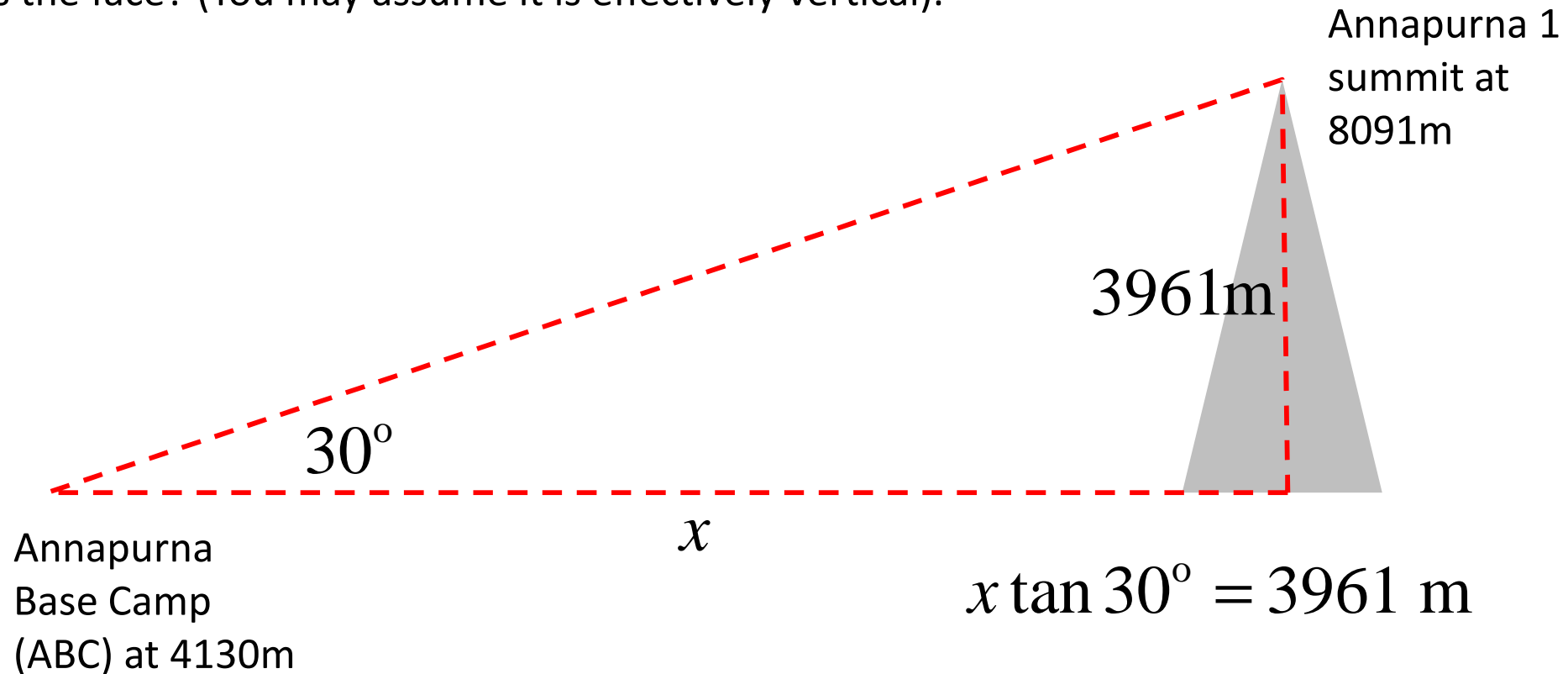
The height of Annapurna 1 is 8091m.

Base camp is at 4130m. If the summit is at an elevation of 30 degrees, how far away is the face? (You may assume it is effectively vertical).



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Base camp is at 4130m. If the summit is at an elevation of 30 degrees, how far away is the face? (You may assume it is effectively vertical).



$$x \tan 30^\circ = 3961 \text{ m}$$

$$\frac{x}{\sqrt{3}} = 3961 \text{ m}$$

$$x = \sqrt{3} \times 3961 \text{ m}$$

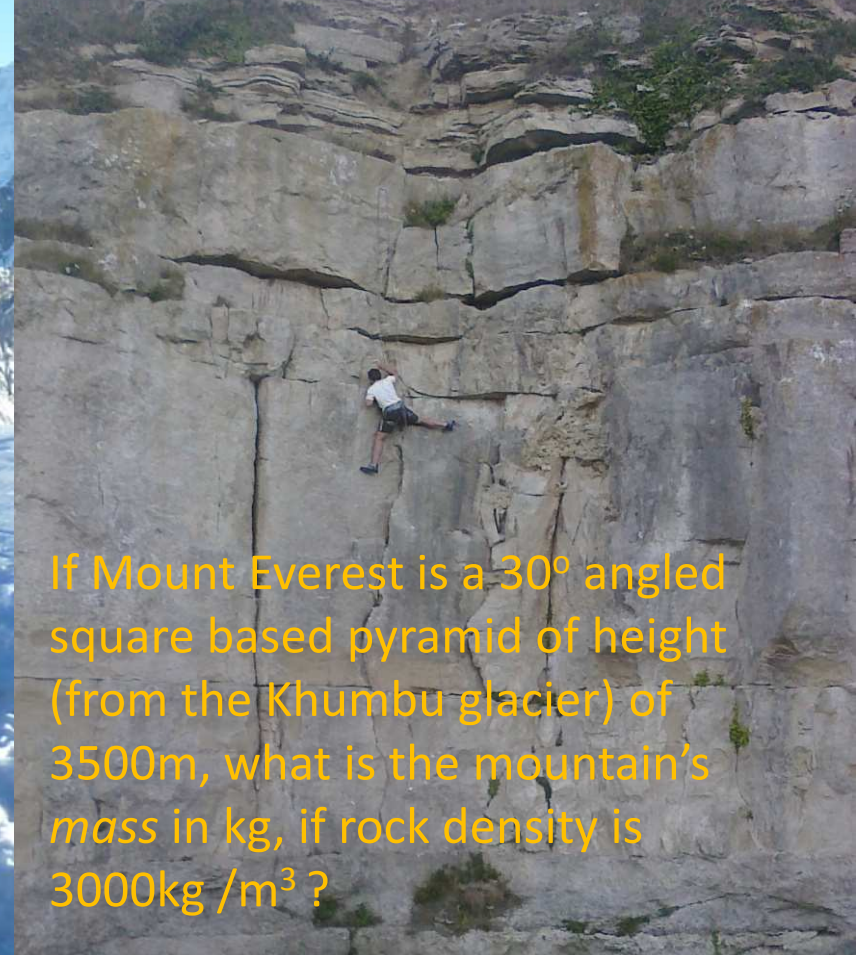
$$x = 6.9 \text{ km}$$

Maurice Herzog and Louis Lachenal, of a French expedition led by Maurice Herzog (including Lionel Terray, Gaston Rébuffat, Marcel Ichac, Jean Couzy, Marcel Schatz, Jacques Oudot, Francis de Noyelle), reached the summit on 3 June 1950.

Mount Everest



Mera Peak, 6476m



If Mount Everest is a 30° angled square based pyramid of height (from the Khumbu glacier) of 3500m, what is the mountain's mass in kg, if rock density is $3000\text{kg}/\text{m}^3$?

If Mount Everest is a 30° angled square based pyramid of height (from the Khumbu glacier) of 3500m, what is the mountain's *mass* in kg, if rock density is 3000kg/m^3 ?

$$3500 = r \tan 30^\circ$$

$$3500 = r \frac{1}{\sqrt{3}}$$

$$r = 3500\sqrt{3}$$

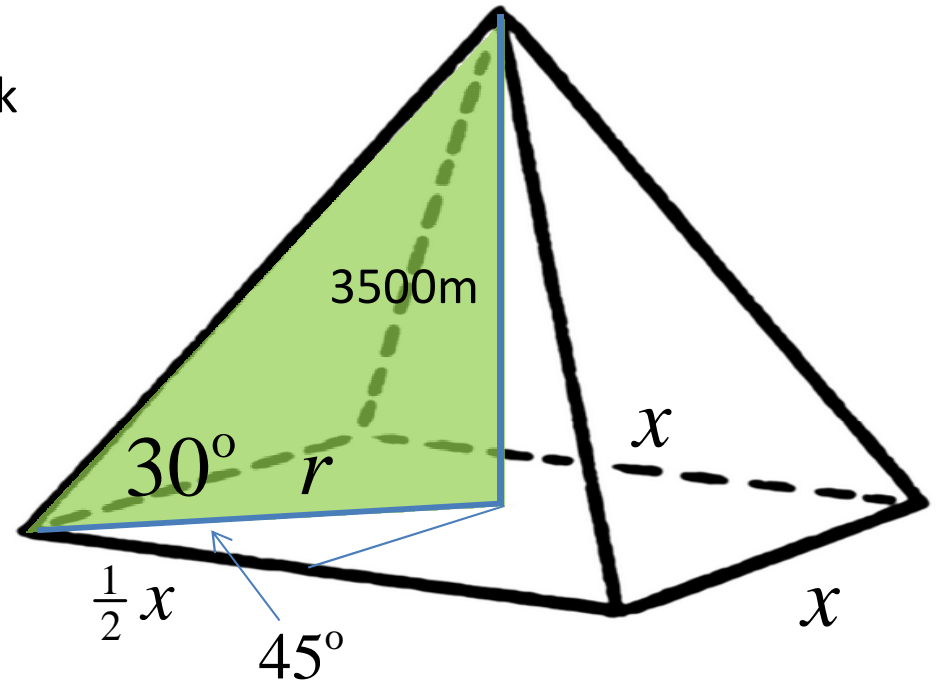
$$\frac{1}{2}x = r \cos 45^\circ$$

$$x = \frac{2r}{\sqrt{2}} = r\sqrt{2}$$

$$x = 3500\sqrt{3} \times \sqrt{2}$$

$$x = 3500\sqrt{6}$$

Volume of a pyramid is $\frac{1}{3}$ x base area x perpendicular height



$$V = \frac{1}{3} x^2 h$$

$$V = \frac{1}{3} \times 3500^2 \times 6 \times 3500$$

$$V = 2 \times 3500^3 \text{ m}^3$$

$$M = 3000\text{kgm}^{-3} \times 2 \times 3500^3 \text{ m}^3$$

$$M = 2.57 \times 10^{14} \text{ kg}$$

Grisedale tarn, Lake District



George the Bear. Mallory Challenge 2013, Scafell Pike



Indus river, near Basgo



Campsite near the Matho La, Ladakh.



Winchester College / Lotus Flower Trust Ladakh 2013
with the Nuns of Saboo Ayu, near Leh.

