NASA's Terra satellite flew over the Deepwater Horizon rig's oil spill in the Gulf of Mexico on Saturday, May 1 and captured the above natural-color image of the slick from space. The oil slick resulted from an accident at the Deepwater Horizon rig in the Gulf of Mexico. NOAA's estimated release rate of oil spilling into the Gulf is 200,000 gallons per day since April 20 when the accident occurred.

Problem 1 – Using a metric ruler, calculate the scale of this image in kilometers/mm.

Problem 2 – What is the approximate area of this oil leak in A) square kilometers? B) square meters?

Problem 3 - The estimated quantity of oil covering this area is about 2 million gallons. If one gallon of oil has a mass of 3.0 kg, what is the surface density, S, of oil in this patch in A) Gallons/meter^2? B) kg/meter^2?

Problem 4 – The density of crude oil is about D=850 kg/m^3. From your estimate for S, what is the approximate thickness, h, of the oil layer covering the ocean water?

Problem 5 - Suppose that an average 'oil' molecule has a length of about 5 nanometers. About what is the average thickness of this oil layer in molecules if the molecules are lined up end to end?

Problem 1 – Using a metric ruler, calculate the scale of this image in kilometers/cm.

Answer: The '25km' legend mark on the Terra image is 1.7 cm long, so the scale is

25 km / 1.7 cm = **15 km/cm**.

Problem 2 – What is the approximate area of this oil leak in A) square meters? B) square meters?

Answer: The oil spill is about 6 cm in diameter or 6cm x 15 km/cm = 90 km in diameter. A) As a circle, the area is $A = \pi (45 \text{ km})^2 = 6{,}358 \text{ km}^2$ or to 1 significant figures **$A = 6{,}000 \text{ km}^2$**.

B) $A = 6{,}000 \text{ km}^2 \times (1{,}000 \text{ m}/1 \text{ km})^2$ so **$A = 6.0 \times 10^9 \text{ m}^2$**.

Problem 3 - The estimated quantity of oil covering this area is about 2 million gallons. If one gallon of oil has a mass of 3.0 kg, what is the surface density, S, of oil in this patch in A) Gallons/meter^2? B) kg/meter^2?

Answer: Mass = 2 million gallons x (3 kg/1 gallon) = 6 million kg. Then

A) $S = 2 \text{ million gallons} / 6.0 \times 10^9 \text{ m}^2$ so **$S = 0.0003 \text{ gallons/m}^2$**.

B) $S = 6 \text{ million kg} / 6.0 \times 10^9 \text{ m}^2$ so **$S = 0.001 \text{ kg/m}^2$**.

Problem 4 – The density of crude oil is about D=850 kg/m^3. From your estimate for S, what is the approximate thickness, h, of the oil layer covering the ocean water?

Answer: $h = S/D$ so $h = (0.001 \text{ kg/m}^2)/(850 \text{ kg/m}^3) =$ **1.0×10^{-6} meters** (or 1 micron)

Problem 5 – Suppose that an average 'oil' molecule has a length of about 5 nanometers. About what is the average thickness of this oil layer in molecules if the molecules are lined up end to end?

Answer: Assuming that these cylindrical molecules are stacked up vertically along their maximum length, the layer is about 1.0×10^{-6} meters/5.0×10^{-9} meters = **200 molecules thick**.