Problem 1A - With a millimeter ruler, determine the scale of this image in meters/mm (round to the nearest hundredth). How many meters does 1 mm represent (round to nearest hundredth)? Show your work and circle the final answer. (3 points)

NOTE: The white bar representing 500. meters should be between 10.5 cm and 16 cm long. If it is not, resize the image until it fits within that range.

Given: White bar is 500. m on the lunar surface

White bar = 13.3 cm = 133 mm
Scale = 500. meters/ 133 mm
= 3.7593985 meters/ mm
Round to the nearest hundredth
The scale of the image in meters/mm is 3.80 meters/mm

Problem 1B --What is the total area of this image in square-kilometers? Be aware of the units shown and the final units required. Be sure to show all your work and include units in all calculations, your final answer should contain 3 sig figs. Circle your final answer. (3 points)

Measure the sides of the image
Horizontal length: 15.5 cm x 10 = 155 mm
Vertical length: 14.3 cm x 10 = 143 mm

Find the actual length of the horizontal and vertical sides

Horizontal length:
$(3.8\ meters/mm)(x\ meters/155mm) = (589\ meters(mm) = x\ meters(mm))$
$x = 589$
The horizontal length is 589 meters.

Vertical length:
$(3.8\ meters/mm)(x\ meters/143mm) = (543.4\ meters(mm) = x\ meters(mm))$
$x = 543.4$
The vertical length is 543.4 meters.

Convert to kilometer
589 meters = 0.589 km
543.4 meters = 0.5434 km

Find the area
$lw = a$
$(0.5434\ km)(0.589\ km) = a = 0.3200626\ km^2$
3 sig figs
$a = 0.320\ km^2$

The total area of this image is $0.320\ km^2$.

Problem 2A. – If a crater measured from the image is 2 mm across, how many meters across is the actual crater? Show your work, circle your answer and round to the nearest tenth. Put your answer in column 2 and then complete the rest of the column 2. (3 points)

Given: scale = 3.8 meters/mm

$$(3.8\ meters/mm)(x\ meters/2mm) = (7.6\ meters(mm) = x\ meters(mm))$$
$$x = 7.6$$

Round to the nearest tenth

The actual crater is 7.6 meters across

Column 1	Column 2	Column 3	Column 4	Column 5
Crater Diameter (mm)	Crater Diameter (meters, round to nearest tenth)	Approximate number of craters close to the size	Prob 2D. Areal Crater Density (Ac) crater/km^2: (# craters [column 3] / total area [from problem 1])	Prob 3A. Average distance between craters in km. (calculate the square-root of the reciprocal of Ac)
2 mm	7.6 meters			
4 mm	15.2 meters			
6 mm	22.8 meters			
8 mm	30.4 meters			
10 mm	38 meters			

Problem 2B. – On the image, measure and count all the 2 mm craters, then all the 4 mm craters, etc. to complete column 3. (3 points)

Column 1	Column 2	Column 3	Column 4	Column 5
Crater Diameter (mm)	Crater Diameter (meters, round to nearest tenth)	Approximate number of craters close to the size	Prob 2D. Areal Crater Density (Ac) crater/km^2: (# craters [column 3] / total area [from problem 1])	Prob 3A. Average distance between craters in km. (calculate the square-root of the reciprocal of Ac)
2 mm	7.6 meters	~22 craters		
4 mm	15.2 meters	~7 craters		
6 mm	22.8 meters	~3 craters		
8 mm	30.4 meters	~1 crater		
10 mm	38 meters	~1 crater		

Problem 2C. – Do you think all the students will have the same numbers in column 3? Explain why or why not. (2 points)

I do not think that all students will have the same numbers in column 3 because of multiple different variables. First is the scale. The scale would be unique to each student because it relies on their image size, length of white line, etc. Another variable would be the number of craters counted. Each student may have approximated the number of craters and lengths differently.

Problem 2D. -- Divide the number of craters by the total area of the field (solved in problem 1), to get the Areal Cratee Density (Ac) craters/km2. Show all work, circle answers and round to the nearest tenth. Fill in the 4th column with answers. (3 points)

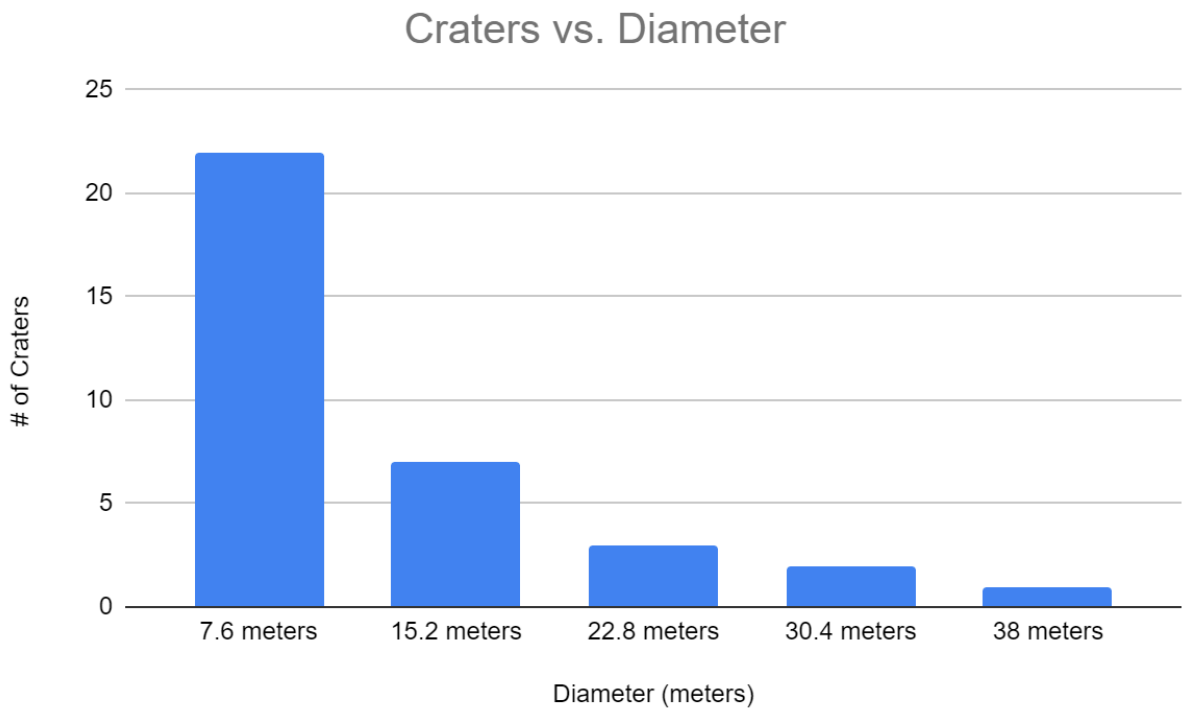
(# craters [column 3] / total area [from problem 1])

2 mm - 22 crater/0.320 km^2 =68.75 crater/km^2
4 mm - 7 crater/0.320 km^2 = 21.875 crater/km^2
6 mm - 3 crater/0.320 km^2 = 9.375 crater/km^2
8 mm - 2 crater/0.320 km^2 = 6.25 crater/km^2
10 mm - 1 crater/0.320 km^2 = 3.125 crater/km^2

Round to the nearest tenth

Column 1	Column 2	Column 3	Column 4	Column 5
Crater Diameter (mm)	Crater Diameter (meters, round to nearest tenth)	Approximate number of craters close to the size	Prob 2D. Areal Crater Density (Ac) crater/km^2: (# craters [column 3] / total area [from problem 1])	Prob 3A. Average distance between craters in km. (calculate the square-root of the reciprocal of Ac)
2 mm	7.6 meters	~22 craters	68.8 crater/km^2	
4 mm	15.2 meters	~7 craters	21.9 crater/km^2	
6 mm	22.8 meters	~3 craters	9.4 crater/km^2	
8 mm	30.4 meters	~2 crater	6.3 crater/km^2	
10 mm	38 meters	~1 crater	3.1 crater/km^2	

Problem 2E. -- Using Excel or Google sheets, create a bar graph of the numbers of craters at each diameter (use columns 2 and 3). Be sure to include axis labels and title. (5 points)



Problem 3A. -- The average distance between craters of a given size is found by taking the square-root of the reciprocal of Ac: Avg Dis = √(1/Ac). Show all work, circle answers and Round to the nearest hundredth. Fill in column 5 with answers. (3 points)

Avg Dis = √(1/Ac)

Use the Ac calculated from the previous problem

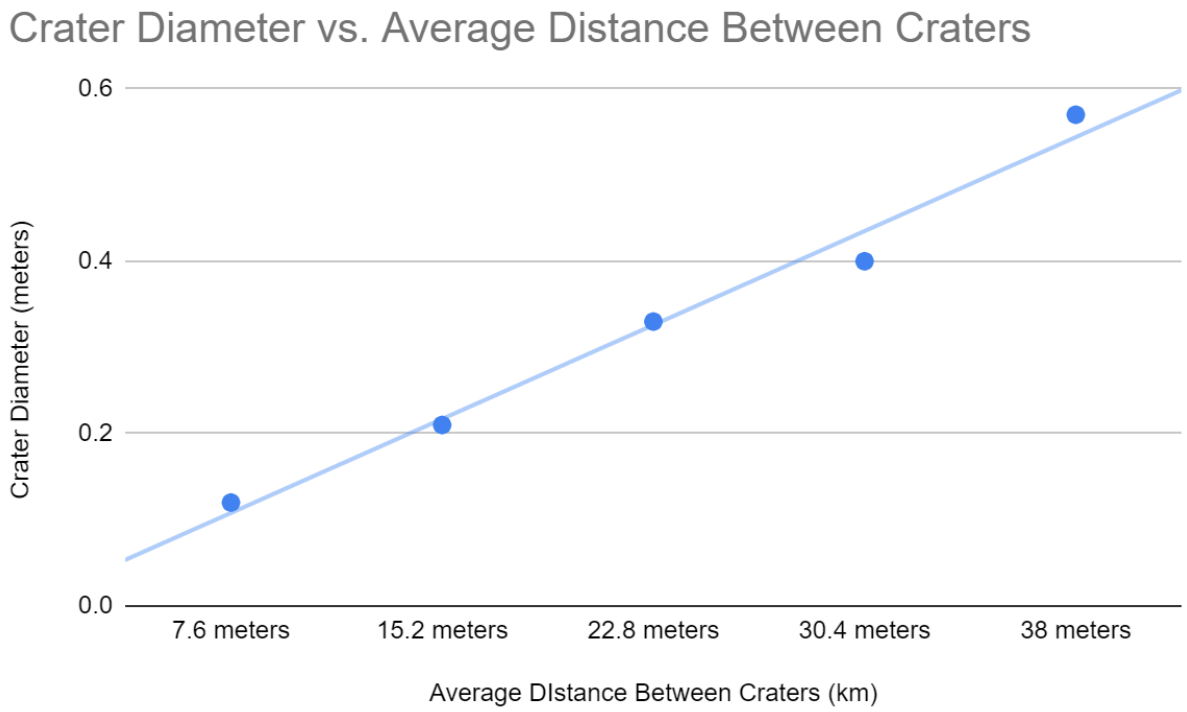
2 mm - √(1/68.8 crater/km^2) = 0.1205607055 km
4 mm - √(1/21.9 crater/km^2) = 0.2136869216 km
6 mm - √(1/9.4 crater/km^2) = 0.3261640365 km
8 mm - √(1/6.3 crater/km^2) = 0.3984095364 km
10 mm - √(1/3.1 crater/km^2) = 0.5679618342 km

Round to the nearest hundredth

Column 1	Column 2	Column 3	Column 4	Column 5
Crater Diameter (mm)	Crater Diameter (meters, round to nearest tenth)	Approximate number of craters close to the size	Prob 2D. Areal Crater Density (Ac) crater/km^2: (# craters [column 3] / total area [from problem 1])	Prob 3A. Average distance between craters in km. (calculate the square-root of the reciprocal of Ac)

2 mm	7.6 meters	~22 craters	68.8 crater/km^2	0.12 km
4 mm	15.2 meters	~7 craters	21.9 crater/km^2	0.21 km
6 mm	22.8 meters	~3 craters	9.4 crater/km^2	0.33 km
8 mm	30.4 meters	~2 crater	6.3 crater/km^2	0.40 km
10 mm	38 meters	~1 crater	3.1 crater/km^2	0.57 km

Problem 3B. -- Make a scatterplot (use columns 2 and 5) and show a trend line for the data. Be sure to include title and axis labels. (5 points)



Problem 3C. -- Interpolating, determine the approximate distance between craters with a diameter close to 25 meters. What is this approximate average distance? Answer should be rounded to the nearest hundredth and circled. (2 points)

Given: diameter = 25 meters

From the data, for every ~7 meter increase in diameter, the average distance (column 5) is ~0.09 km. So for 25 meters, $x = (0.09\ km/7\ meters)\ *\ 25\ meters = 0.3214285714\ km$

Round to the nearest hundredth

The approximate distance between craters with a diameter close to 25 meters is 0.32 km.

Problem 4. -- Approximately how large in diameter, in meters, is the largest crater on the image? Show your work and the answer should be to the nearest tenth. Circle Answer. (2 points)

Measure the distance in mm on the image

Crater diameter in mm = 3.8 cm

Convert into mm

3.8 cm = 38. mm

Use the scale factor which was calculated in problem 1

$$(0.38\ meters/mm)(x\ meters/38.\ mm) = (14.44\ meters(mm) = x\ meters(mm))$$

$$x = 14.44$$

Round to the nearest tenth

The largest crater's diameter in the image is 14.4 meters.

Problem 5. -- Name one other characteristic about a crater that might be important. Can this information be determined from the image? Explain your answer. If you use any sources for information, be sure to provide the title and weblink (does not have to be in APA). (2 points)

One other characteristic of a crater is its depth, which is essential. I don't think this information can be determined because of the poor quality of the image, which makes it near impossible to use the shadows to calculate it.

Problem 6. -- Using your data and your knowledge of the Artemis mission, explain whether you think this would be a good or poor place to locate the Artemis lander. Be sure to provide at least two points; either positive or negative or both. If you use any sources for information, be sure to provide the title and weblink (does not have to be in APA). (4 points)

I think this location would be a successful place to locate the Artemis lander because not many overly large craters are in this area. The largest crater on the map is approximately 14.4 meters in diameter, and the diameters of the rest of the craters are less than ~5 meters. I believe the lander will be able to withstand the landing process in all of the craters except the biggest one.

One reason this location could be challenging for the Artemis lander are clusters of small craters. Since the average distance between small craters of less than ~5 meters would be less than 0.12 km, it is very likely that most of them are located in close proximity to each other. The terrain from these clusters of small craters could be dangerous to land on.