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NAME:

Key

- [3] (4/5 Class) Identify one key difference between Flatland the book and Flatland the movie. Explain why you think the movie makers made this change.

There are lots and lots of differences?

Actual difference (+) why the change (+)

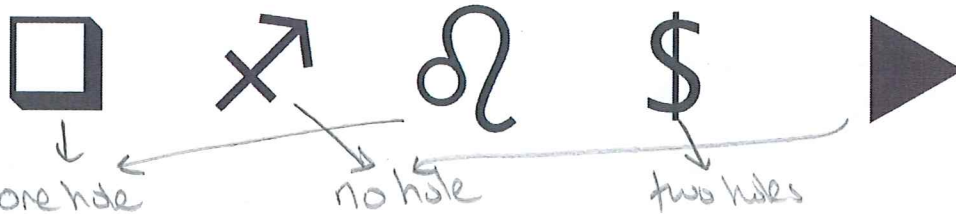
clarity (1.5) start (1.5)

- [3] (Weeks §1) Explain how A Square used red and blue string to motivate his fellow flatlanders into making a map of Flatland.

true (+)  
motivated (+)  
clarity (1.5)  
start (1.5)

A Square took one color and traveled around Flatland but surprisingly came back to where he started. A Square took the second color and traveled around Flatland another way (east-west instead of north-south) and again came back to where he started. Interestingly the two strings only crossed at the spot where he started, this made all the flatlanders curious about their world.

- [4] (HW3 #4) Group the following images into sets that have the same topology.



- [2] (TED Video) Provide two non-decorative or artistic uses for origami from "the real world".

There are lots of examples?

start (1.5)  
each one (1.5)  
clarity (1.5)

- heart shirt
- modeling airbags
- getting large objects into space

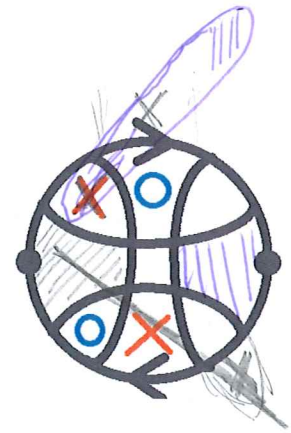
5. [3] (Weeks §3) A tic-tac-toe board being played on a projective plane is shown to the right. The game was started by  $X$  and now it is  $X$ 's turn.

What is  $X$ 's best move? Justify your choice.

Note: multiple answers!

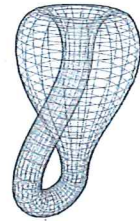
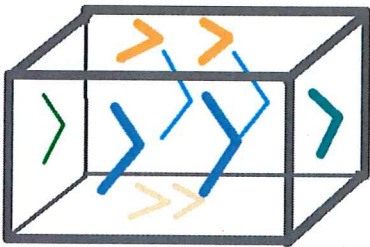
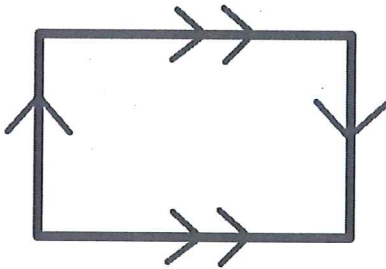
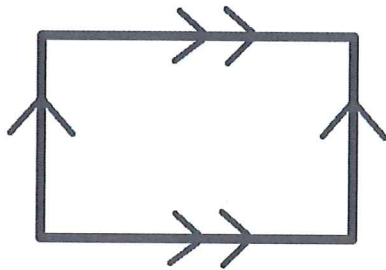
The shaded region is the best move (+1) since  $X$  will then win the game (+1)

or  
The region with vertical lines (+1) since  $X$  would win the game (+1)

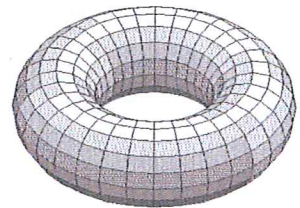


gluing work (+1)

6. [6] Match the items on the left to items with the same topology on the right.



3D flat torus

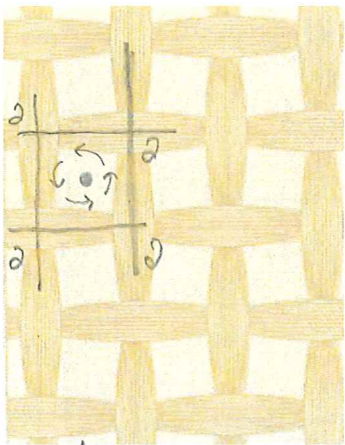


7. [3] (Weeks §3) Find a closed homogeneous 1 manifold.

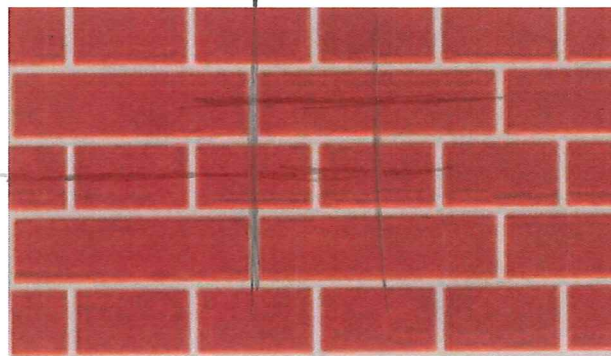
a circle



8. [4] (HW2 #1) Find the signature for each of the following.



4 \* 2  
 $\frac{3}{4} + 1 + \frac{1}{4}$  cost \$2 (+1)

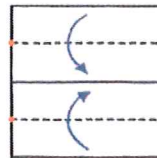


\* 2 2 2 2 (+1)  
 $1 + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}$  cost \$2 (+1)

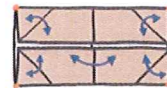
9. [2] (4/19 Class) Examine the Origami instructions to the right. What is the meaning of the circled instruction?

turn over

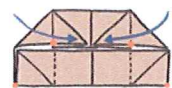
### F.W.'s Origami Wombat



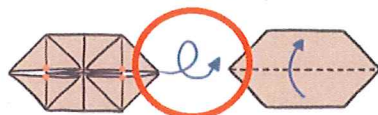
Crease the paper along the middle. Fold the top and bottom edges in to meet the crease.



Crease this shape up the middle. Fold all the corners over creasing them, and then unfold them again.



Bring the corners down while folding where I've made dotted lines. This will create four new points that meet in the middle.



Flip this shape over so that you are looking at the smooth side.

Fold the shape along the middle so that you bring the bottom edge up to meet the top edge.



This is the body of the wombat. Now it's time to give it some legs!



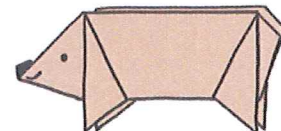
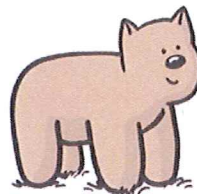
Fold the triangles that meet in the middle down so that they now extend down past the bottom of the body.



On one end of the wombat fold the point up for the nose. On the other end fold the point to.



Now fold the nose over one more time. Then use the marker to color it in and to add eyes and a mouth.



He's almost as cute as the real thing!

10. [5] (HW3 #1) Identify all possible signatures of a two dimensional tiling that includes only red symbols and the symbols \*32. Be sure to explain clearly how you know you have found all the possibilities!

start (+) (5)

Symbol	Cost (\$)	Symbol	Cost (\$)
○	2	* or ×	1
2	$\frac{1}{2}$	2	$\frac{1}{4}$
3	$\frac{2}{3}$	3	$\frac{2}{6}$ or $\frac{1}{3}$
4	$\frac{3}{4}$	4	$\frac{3}{8}$
5	$\frac{4}{5}$	5	$\frac{4}{10}$ or $\frac{2}{5}$
6	$\frac{5}{6}$	6	$\frac{5}{12}$
...	...	...	...
n	$\frac{n-1}{n}$	n	$\frac{n-1}{2n}$

(4.5) Recall that the signatures of a tiling must have a total cost of \$2 where each symbol's price is given in the table to the right.

(5) Notice that the cost of 32 is  $1 + \frac{1}{3} + \frac{1}{4}$  or  $\frac{19}{12}$ .

Thus there is only  $2 - \frac{19}{12}$  or  $\frac{5}{12}$  remaining.

(4.5) Certainly \*326 is a signature since the total cost is \$2.

(15) We have only to show that no other red symbols could add to  $\frac{5}{12}$ . Note that the red 2 has the lowest cost and the cost increases as the symbol increases. So the cost of 7, 8, 9, 10, etc is greater than  $\frac{5}{12}$ . Thus we need only consider the red symbols 2, 3, 4 and 5.

(4.5) Below is a list of all possible combinations of 2's, 3's, 4's + 5's showing that no combination can make up  $\frac{5}{12}$

Symbol	Cost
2	$\frac{1}{4}$
<del>22</del>	$\frac{1}{2} > \frac{5}{12}$
3	$\frac{1}{3}$
<del>33</del>	$\frac{2}{3} > \frac{5}{12}$
4	$\frac{3}{8}$
<del>44</del>	$\frac{3}{4} > \frac{5}{12}$
<del>55</del>	$\frac{5}{4} > \frac{5}{12}$

arithmetic (4.5)

Clarity (1)

$$\frac{24}{11} = \frac{35}{35}$$

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