UNIVERSITY OF MANITOBA

DATE: April 17, 2014 — FINAL EXAMINATION
TITLE PAGE

COURSE: MATH/FA 1020 — TIME: 2 hours
EXAMINATION: Math in Art — EXAMINER: M. Davidson, S. Kalajdzievski

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FAMILY NAME: (Print in ink) _____

GIVEN NAME(S): (Print in ink) _____

STUDENT NUMBER: _____

SEAT NUMBER: _____

SIGNATURE: (in ink) _____
(I understand that cheating is a serious offense)

❑	A01	8:30–9:45	TR	M. Davidson
❑	A02	11:30–12:45	TR	S. Kalajdzievski

INSTRUCTIONS TO STUDENTS:

This is a 2 hour exam. **Please show your work clearly.**

A compass and straight edge (ruler) are required for this exam.
A simple, non-programable calculator is permitted.

No texts, notes, or other similar aids are permitted. There are no cellphones or electronic translators permitted.

This exam has a title page and 8 pages of questions. Please check that you have all the pages.

The value of each question is indicated in the lefthand margin beside the statement of the question. The total value of all questions is 70 points.

Answer all questions on the exam paper in the space provided beneath the question. If you need more room, you may continue your work on the reverse side of the page, but CLEARLY INDICATE that your work is continued.

Question	Points	Score
1	6	
2	8	
3	8	
4	8	
5	6	
6	8	
7	9	
8	8	
9	9	
Total:	70	

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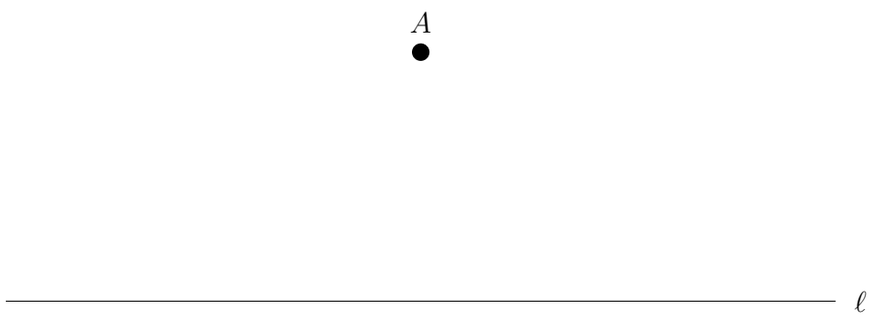
[6] 1. Construct a line that passes through A and intersects the line ℓ at 30°.



[8] 2. Find the golden cut of the line segment AB.

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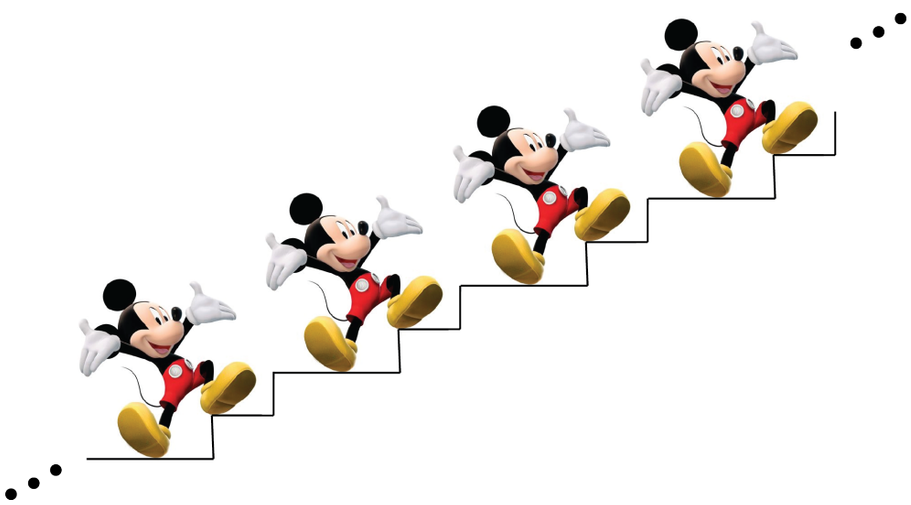
[8] 3. (a) Find the group of symmetries of the frieze pattern shown below (recall that the dots indicate that the pattern extends without end both to the left and to the right, as indicated).



(b) Draw an object having exactly 5 symmetries.

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[8] 4. In the Figures 1 and 2 below we are shown the first two steps of the construction of a fractal F. Notice that the third largest square in Figure 2 (Which has sides parallel to the outside square) is half the size of the largest (outside) square in Figure 2.

(a) In the square below, labelled Figure 3, is a copy of Figure 2. Sketch the next step of the construction of F in that figure. Use a ruler and a compass, but you do not have to precisely construct the squares and the circles.

(b) Recall that the fractal F is the result of iterating (repeating) the above procedure infinitely many times. Confirm that F is indeed a fractal by identifying the center and the stretching factor ($\alpha \neq 1$) of a central similarity f that sends F within itself.

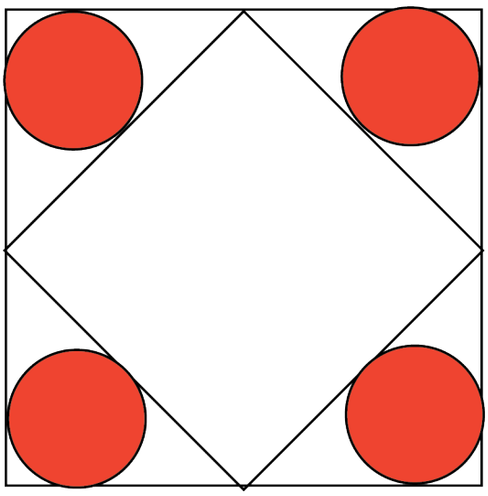


Figure 1

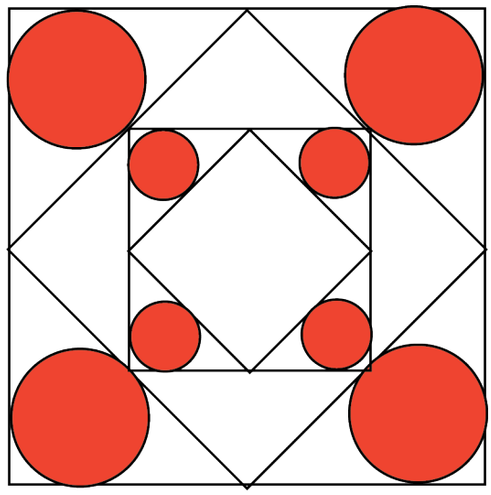


Figure 2

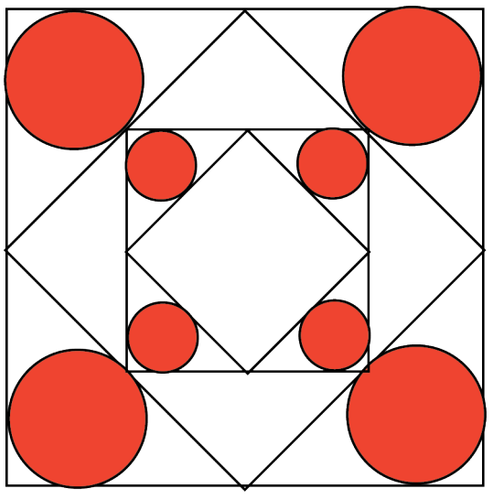
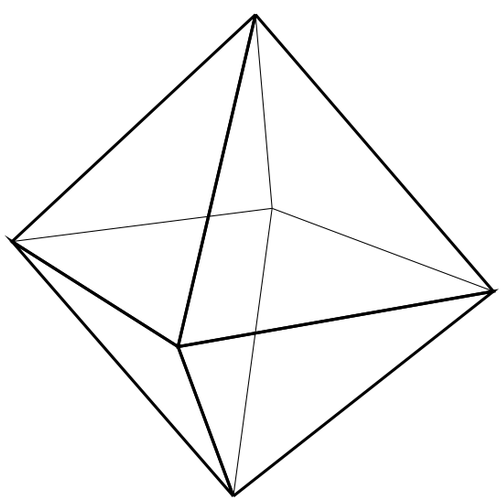
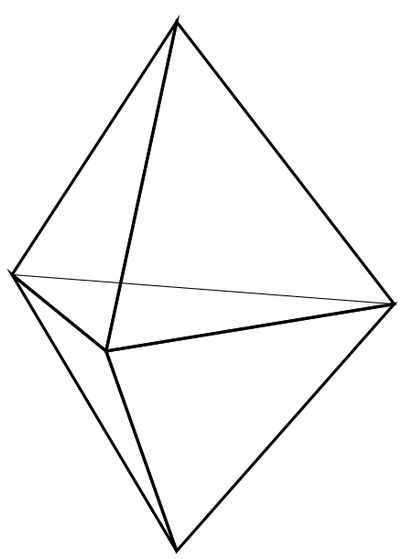


Figure 3

[6] 5. (a) Below is a drawing of an Octahedron. Calculate its Euler Characteristic.



(b) Below is a drawing of a solid known as a triangular dipyramid (it is a solid that is achieved by attaching two tetrahedrons together on a face). Explain why this is not one of the Platonic solids.



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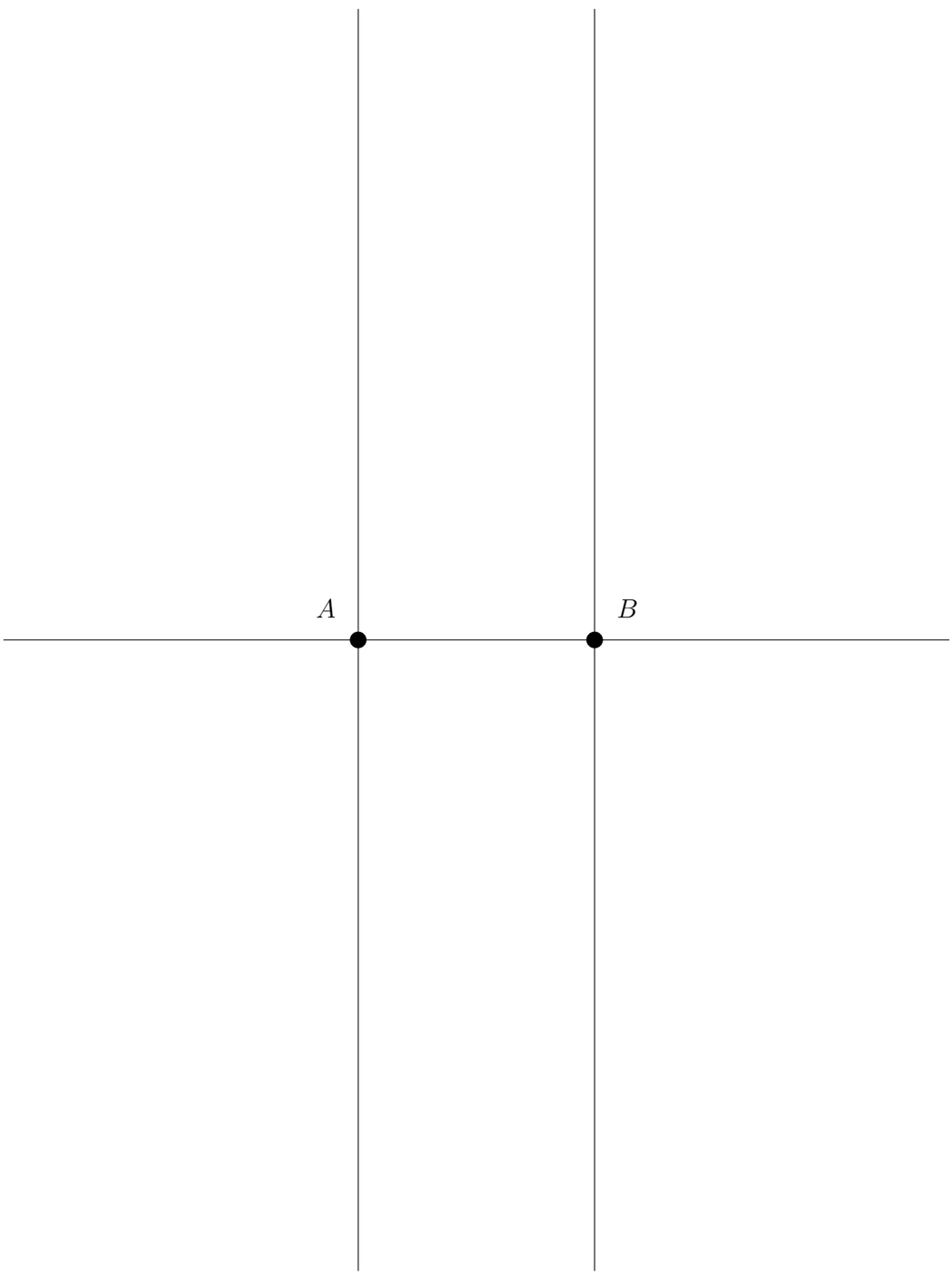
[8] 6. Below you are given three lines, two of which are parallel, and the third is perpendicular to them, and meets them at points A and B. Sketch the hyperbola that contains points A and B by constructing 8 more points that lie on the hyperbola.



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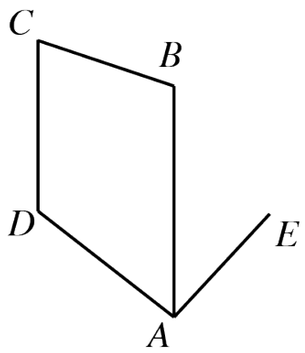
[9] 7. In the figure below, we are given a partial 2-point perspective drawing of a cube: are are given the face $ABCD$ and an additional edge AE.

(a) Find the horizon and the 2 vanishing points. (You may assume that the horizon is horizontal)

(b) Complete the 2-point perspective drawing of the cube.

(c) Subdivide the square $ABCD$ into 4 smaller squares of equal size.



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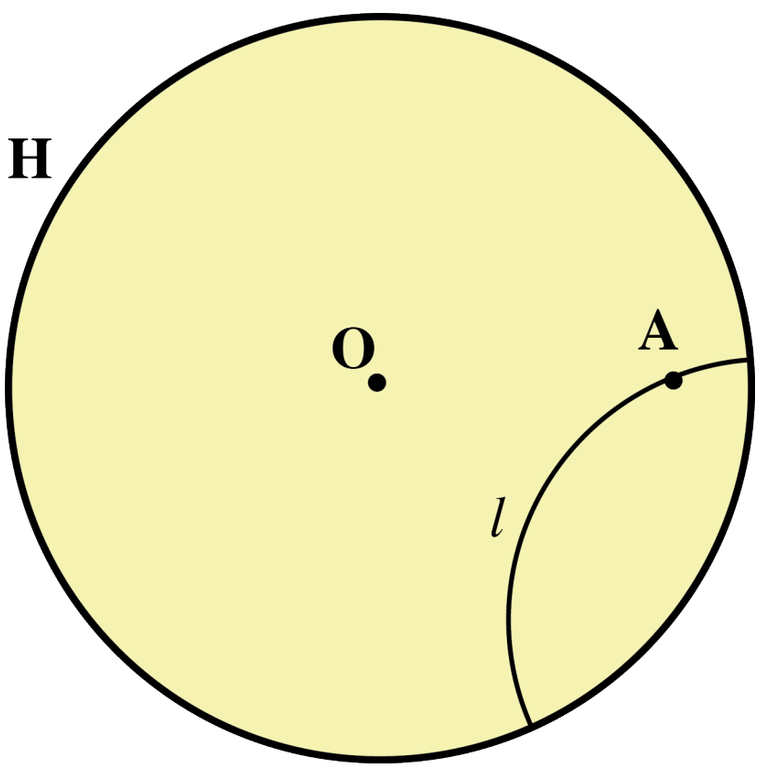
[8] 8. In the figure below we are shown a hyperbolic line ℓ and a point A on ℓ. The point O is the center of the horizon H of the Poincare model.

(a) Construct two hyperbolic lines that are parallel to ℓ.

(b) Construct two hyperbolic lines that intersect ℓ at the point A.

Briefly list the steps of your constructions.



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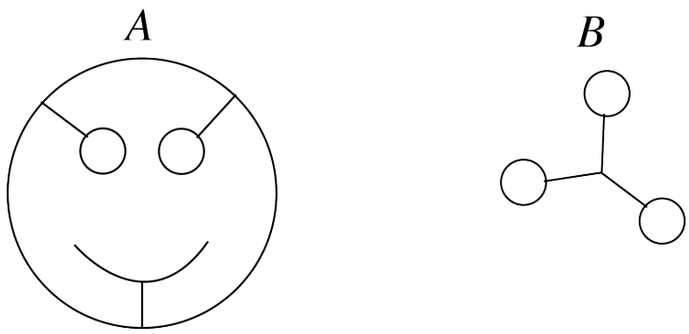
[9] 9. (a) In the figure below we are shown two objects, A and B. Is A homotopic to B? If yes, then show at least 3 frames of the animation showing how A could be deformed to B. Explain in words if needed. If no, give a brief explanation as to why they are not.



(b) Figure 2 shows a torus. What is the genus of this torus? What is its Euler characteristic?