UNIVERSITY OF MANITOBA

DATE: June 27, 2014 — FINAL EXAMINATION
TITLE PAGE

COURSE: MATH\FA 1020 — TIME: 2 hours

EXAMINATION: Math in Art — EXAMINER: M. Davidson

FAMILY NAME: (Print in ink) _____

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

STUDENT NUMBER: _____

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

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 **??** pages of questions. Please check that you have all the pages.

Run LaTeX again to produce the table

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

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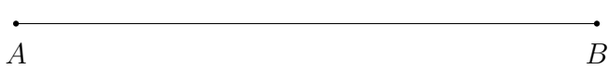
Important: "Construct" means "construct using an unmarked ruler and compass." The phrase "unmarked ruler" stands for any ruler that may be used only as a straight edge to draw straight line segments. When you use a compass, show the (intermediate) circular arcs you draw in your constructions (do not erase them).

[10] 1. (a) Construct the division of the following line segment into three segments of equal length. Briefly describe your steps.

(b) Construct the golden cut of the following line segment. Briefly describe your steps.



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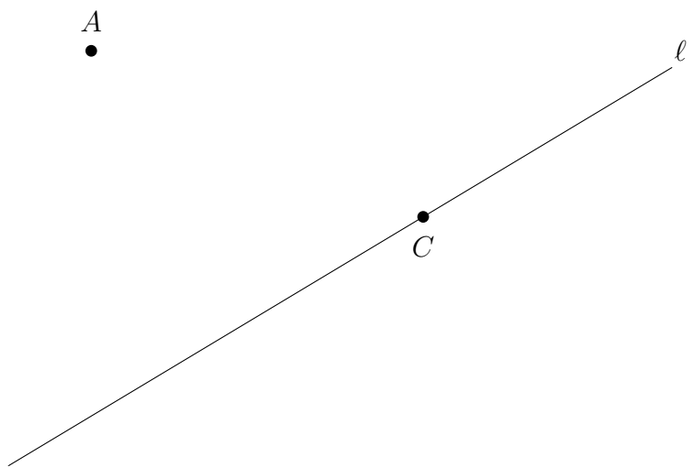
[10] 2. (a) Recall that a dilative reflection is the composition of a central similarity with a reflection. Construct the image of the point A under the dilative reflection having center C, with stretching factor $\alpha = \frac{1}{2}$, and line of reflection ℓ; label it $f(A)$.



(b) Draw (reasonably accurately) an object that has exactly 5 symmetries in its group of symmetries. List the group of symmetries.

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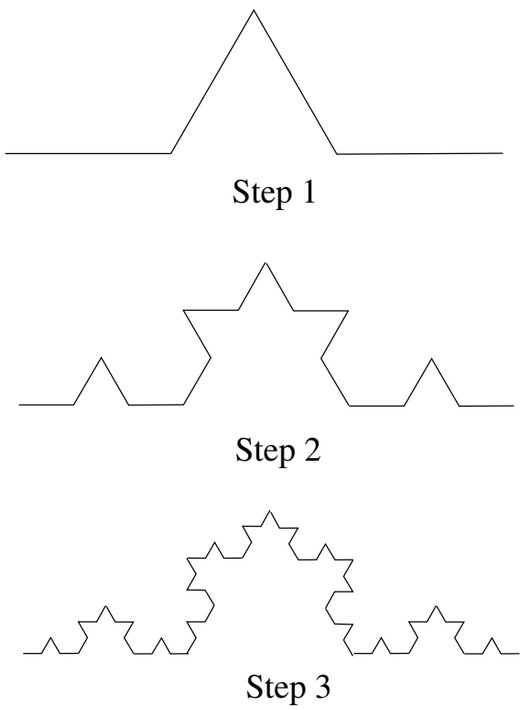
[6] 3. For each of the series of figures below, the first three steps in the iterative process of constructing a fractal are given. The fractal **F** will be constructed after infinitely many steps.

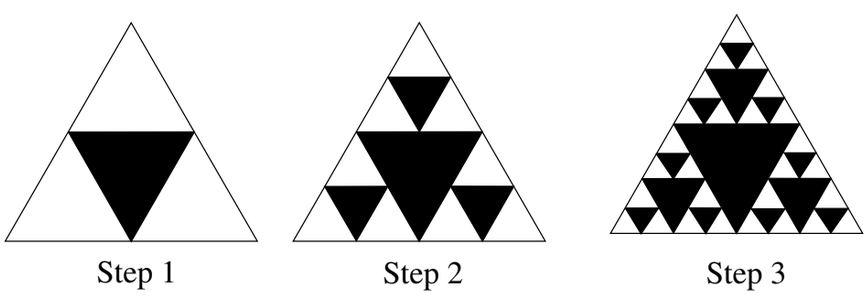
Find a central similarity (with stretching factor not equal to 1) which maps **F** into itself.

You should, in Step 3, indicate the point the is the centre of the central similarity, and state a specific number for the stretching factor of the similarity.

i.



ii.



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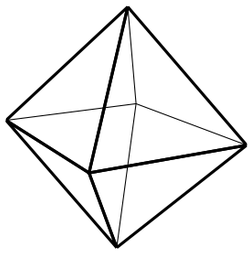
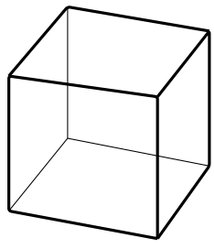
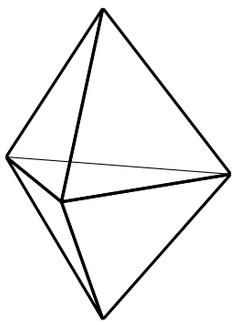
[9] 4. (a) For the solids Octahedron and Cube (depicted below), contrast and compare all of the features of each solid. Include the following: number and type of vertex, number and type of face, number of edges and Euler Characteristic.





(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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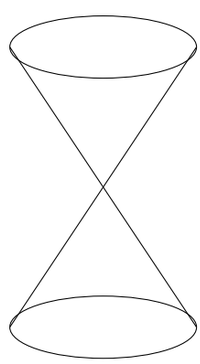
[10] 5. (a) For each of the four conics, give the name of the conic and indicate on the double cone how a cut would give that conic. You may use words to describe your cut as well.

i. Name of conic:

_____



ii. Name of conic:

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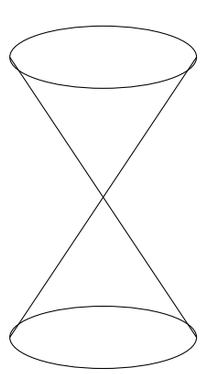

iii. Name of conic:

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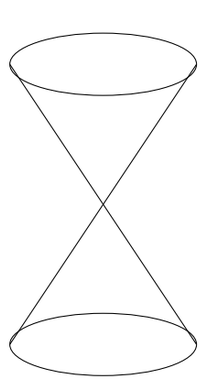

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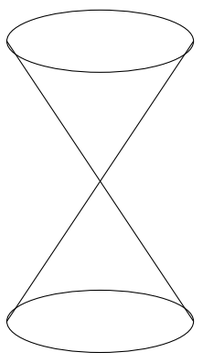
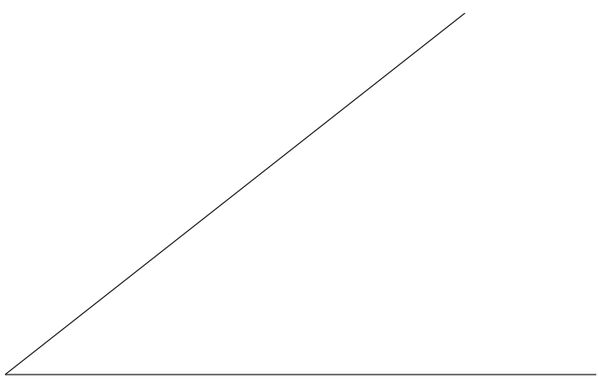
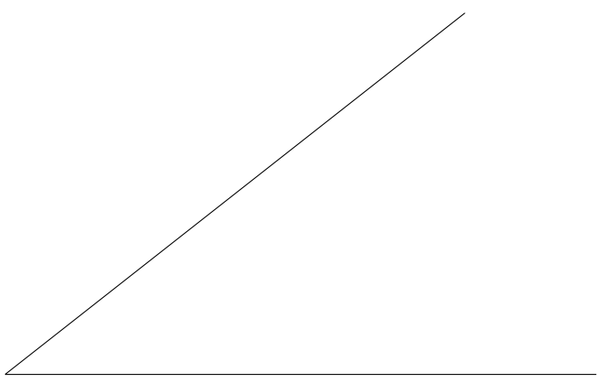
iv. Name of conic:



(b) On the following lines, construct parabolas using tangents. Use a larger spacing on the first, so that it will have fewer tangent lines than the second. Use as much of the given segments as your choice of spacing allows. What, if any, are the differences in the appearance of the parabolas?





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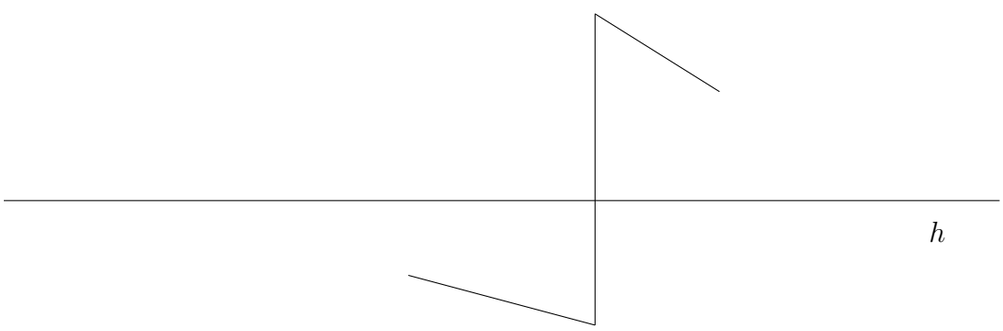
[8] 6. Depicted below is a portion of a drawing of a rectangular box in two point perspective. Three edges are given, one from each parallel class. The edge that is parallel to the drawing plane should be thought of as closest to the drawing plane. The horizon line h is given as well.

(a) Find the 2 vanishing points, and indicate them with the symbols V_1 and V_2.

(b) Complete the perspective drawing of the box; include all edges, as if you could see through the box.



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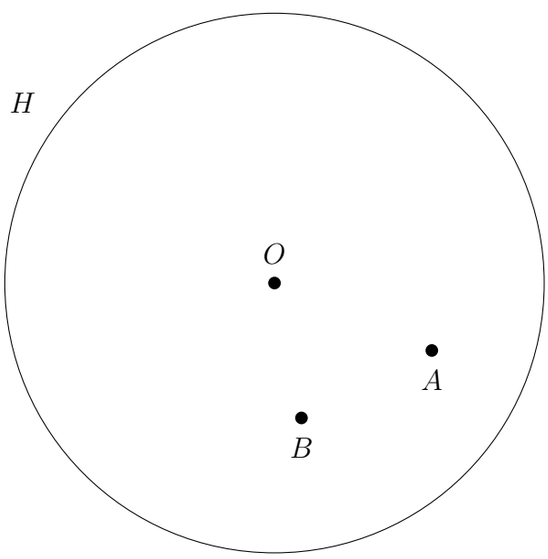
7. Below is a hyperbolic plane H, having center O.

[7] (a) Construct the hyperbolic line that passes through the points A and B.

[2] (b) Shade the hyperbolic triangle OAB.

Briefly describe your steps.



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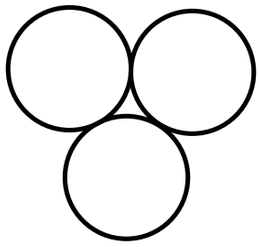
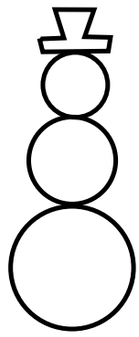
[4] 8. (a) Are the two figures below homotopic? If they are, draw three intermediate drawing in the homotopy (deformation) from one to the other. If not, give a reason why.





[4] (b) Consider the surface of the following 3-dimensional object (a torus).
What is the genus of the surface of this object?
What is the Euler characteristic of the surface of this object?
(Briefly justify your answers.)