UNIVERSITY OF MANITOBA

DATE: June 28, 2013 — 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 9 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	10	
2	14	
3	8	
4	8	
5	6	
6	7	
7	9	
8	8	
Total:	70	

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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). Use words to describe **BRIEFLY** what you have done.

[4] 1. (a) Construct an equilateral triangle having the given segment as one of its sides. Bisect one of the angles of the triange. What angle was created?

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[6] (b) Construct a golden acute triangle having as its base the given line segment.

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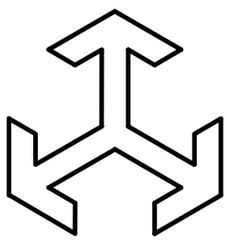
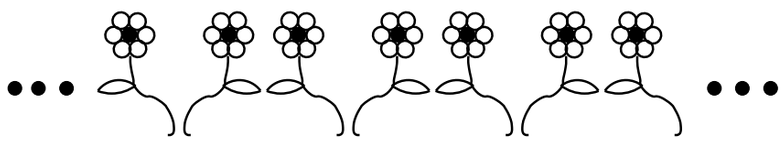
2. (a) List the symmetries of the following objects:

[4] i.

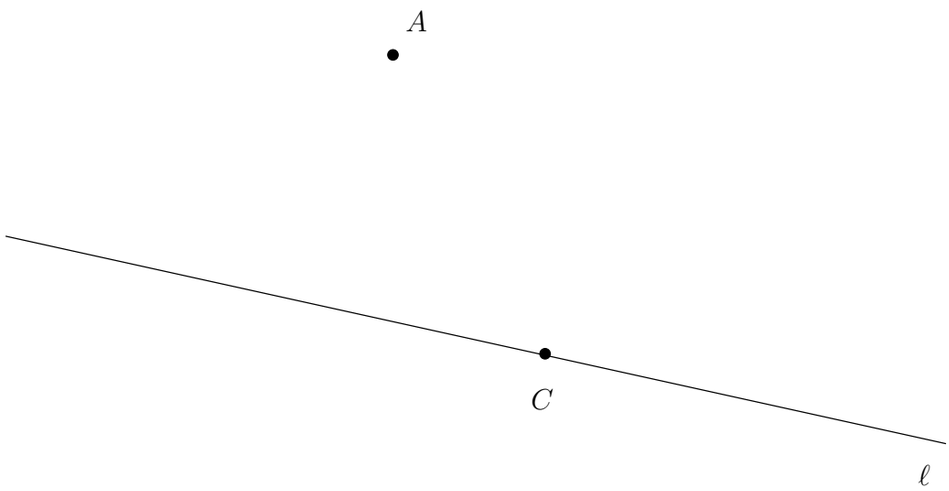


[4] ii.



This is a frieze pattern; it continues infinitely in both directions.

[6] (b) 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 $f(A)$.



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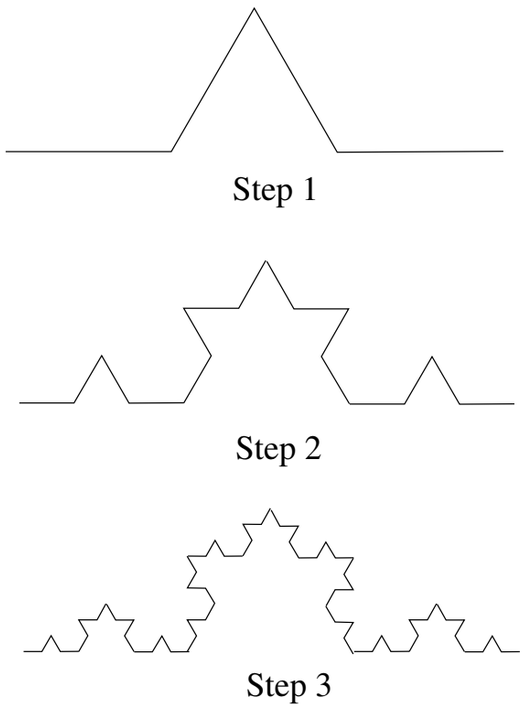
[4] 3. (a) Each of the series of figures below, the first three steps in the iterative process of constructing a fractal are given. The fractal **F** will be constructed after infinitely many steps.

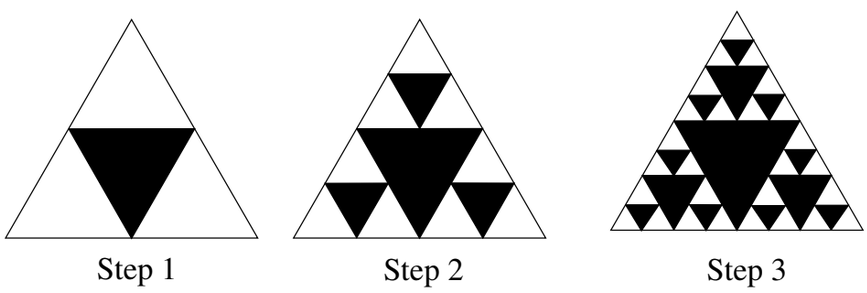
Find a central similarity (with stretching factor not equal to 1) which maps **F** into itself.

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

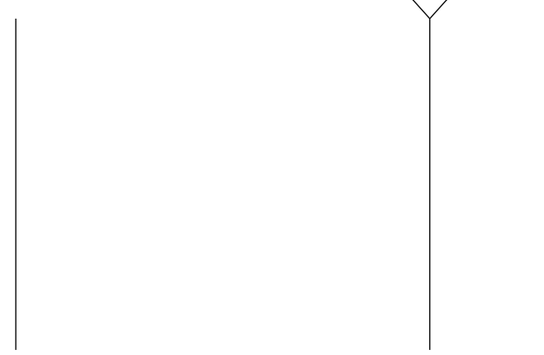
i.



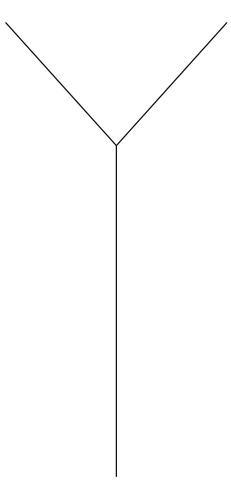
ii.



[4] (b) The following gives the first two steps in the construction of a fractal tree. Notice that the 'branches' are half the size of the original line ('trunk'). Construct the next step in the iteration of the fractal on the diagram labeled Step 3. (Pay attention to the angle that the branches meet the trunk; how do you ensure that this angle is the same in all interations?)



Step 1 Step 2



Step 3

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[5] 4. (a) Fill in the following table with the appropriate information about the Platonic solids.

Solid	Faces (F)	Edges (E)	Vertices (V)	type of face	faces per vertex
tetrahedron					
cube					
octahedron					
dodecahedron					
icosahedron					

[3] (b) The truncated cuboctahedron is an Archimedean solid that has as its faces 12 squares, 8 hexagons and 6 octagon. (An octagon has 8 sides.) How many edges and how many vertices does a truncated cuboctahedron have?

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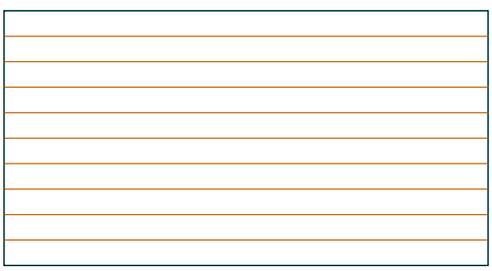
[6] 5. Construct sixteen (16) lines tangent to the the ellipse that would fit in the given rectangle. (You should construct both the top and the bottom of the ellipse.)

Assume that the horizontal lines are equally spaced, they indicate the appropriate fractions (less than 1) that should be used in the construction.

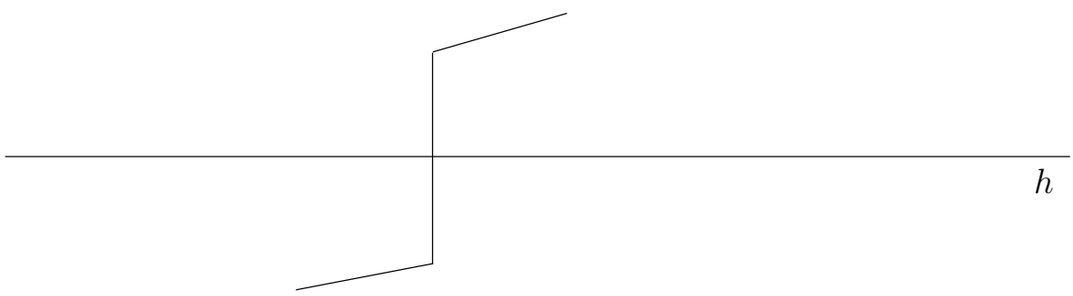
You may estimate the location of non integers (rather than constructing them).



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 farthest from the drawing plane. The horizon line h is given as well.

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

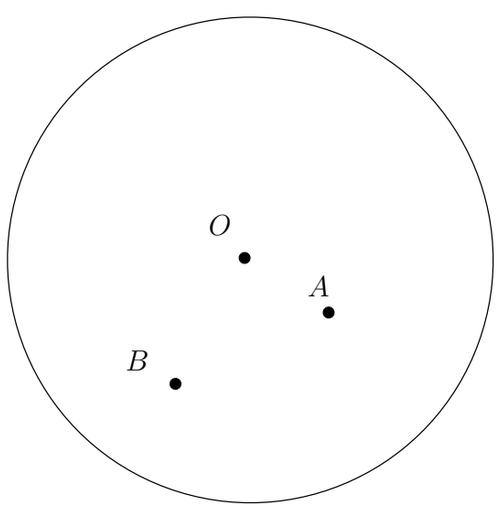
[5] (b) Complete the perspective drawing of the box, include all edges, as if you could see through the box.



7. Below is a hyperbolic plane, having center 0.

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

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



[4] 8. (a) Sort the letters/numbers of the following into homotopic groups.

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[4] (b) Consider the surface of the following 3-dimensional object (which can be thought of as a wall with some bricks removed, indicated by black background.)

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.)