UNIVERSITY OF MANITOBA

DATE: December 12, 2009 — FINAL EXAMINATION
PAPER # 182\183 — 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: _____

SEAT 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.

No texts, notes, or other similar aids are permitted. There are no calculators,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	10	
2	10	
3	9	
4	8	
5	7	
6	9	
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.

[10] 1. (a) Construct the division of the line segment into 3 segments of equal lengths.

(b) Construct a golden rectangle having the given segment as one of its (shorter) sides.

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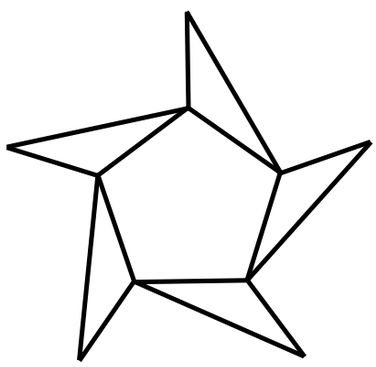
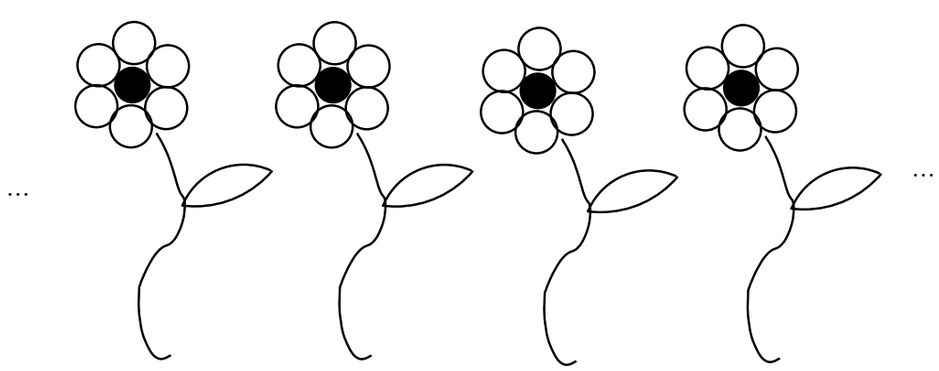
[10] 2. (a) List the symmetries of the following object:



(b) List the symmetries of the following object (it is a frieze pattern, it continues indefinitely on either side):



(c) Draw an object that has exactly 6 symmetries (including the identity).

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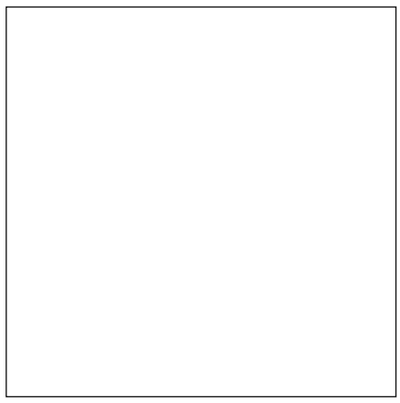
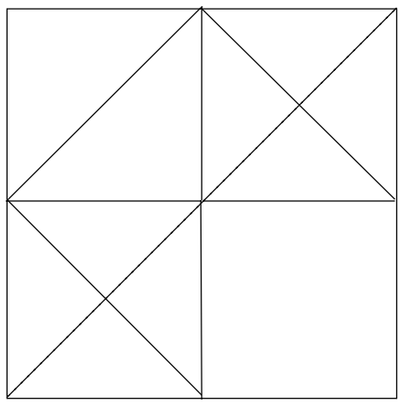
[9] 3. In the figures below labeled Step 1 and Step 2 we depict the first two steps in the construction of a fractal **F**.

(a) In the square labeled Step 3, draw the next step in the construction of the fractal.

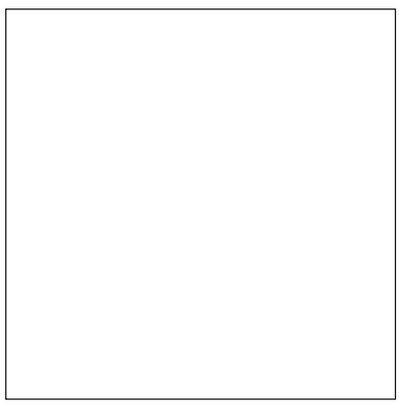
(b) The fractal **F** will be constructed after infinitely many steps. Find a central similarity (stretching factor not equal to 1) which maps **F** into itself. (To get full marks, you should indicate in Step 3 the point the is the center of the central similarity and you need to state a specific number for the stretching factor of the similarity.



Step 1



Step 2



Step 3

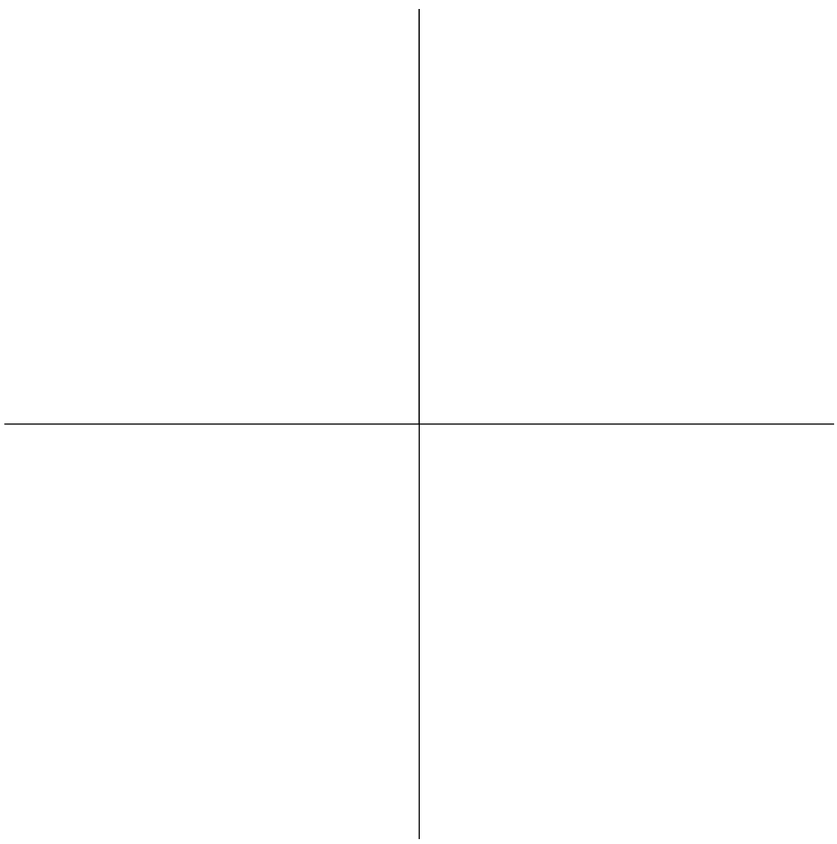
[8] 4. (a) Fill in the following table with the appropriate information about the Platonic solids.

Name of Solid	number of Faces	number of Edges	number of Vertices
	12		20
cube		12	
icosahedron		30	
tetrahedron			4
	8	12	

(b) The icosododecahedron is an Archimedean solid that has 12 pentagon faces and 20 triangle faces. How many edges and how many vertices does a icosododecahedron have?

(Hint: there is enough information given to calculate the number of edges. Use the Euler characteristic to find the number of vertices)

[7] 5. On the following axes, form a star by constructing the tangents a parabola in each corner. Each parabola should have 4 tangents. (You may wish to use the space at the bottom to find the appropriate divisions of the line. It is not necessary, however it will make your work neater.)



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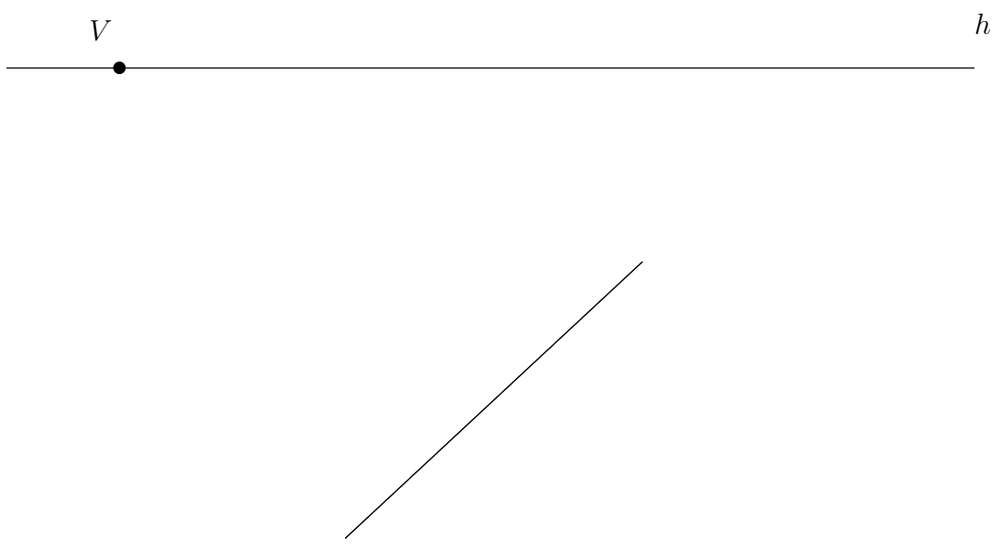
[9] 6. Below is depicted a portion of a drawing of a **square** in 2-point perspective. One side of the square is given, along with one of the vanishing points V (not the vanishing point associated with the given side), and the horizon line h.

(a) Indicate the 2^{nd} vanishing point with symbol V_2. Construct the other three sides of the perspective **square**.

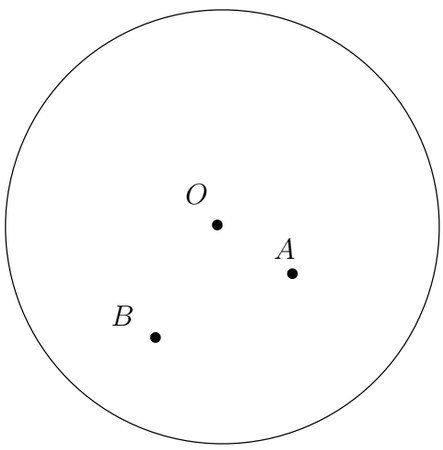
(b) Divide the square into 4 smaller squares (i.e. a 2×2 grid).



[9] 7. Below is a hyperbolic plane, having center 0.

(a) Construct the hyperbolic line, labeled h_1, that passes through the points A and B.

(b) Construct one hyperbolic line that intersects h_1, label it h_2, and one hyperbolic line that is parallel to h_1, label it h_3.



[8] 8. (a) Identify which letters and numbers are mutually homotopic in the following phrase:

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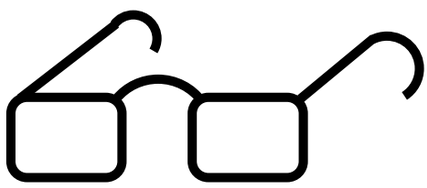
(b) Since I have 20\20 vision, I own a pair of glasses that have no lenses (depicted below). Note, they are just frames. We want to consider just the surface of these glasses frame.

What is the genus of the surface of these glasses frame?

What is the Euler characteristic of the surface of these glasses frame?



Frames of a pair of glasses
(A 3 dimensional object)