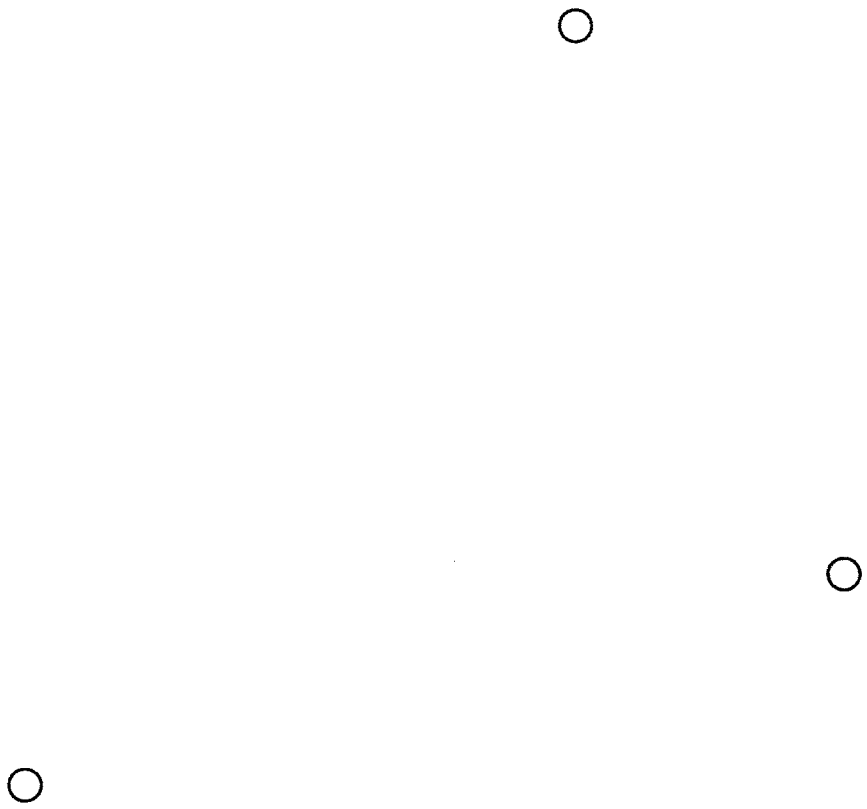
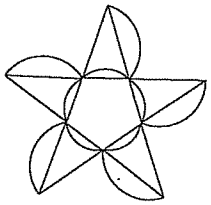
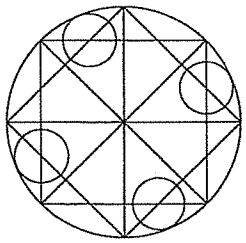
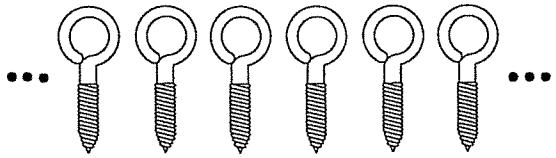
5. Three points given below lie on a circle but unfortunately the circle itself got erased. Reconstruct the circle (in other words, find the centre and the radius of the circle).



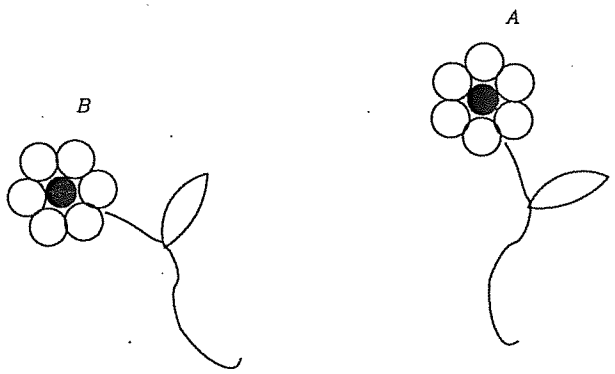
Give a brief description of your method for finding the centre of the circle.

8+2 = 10

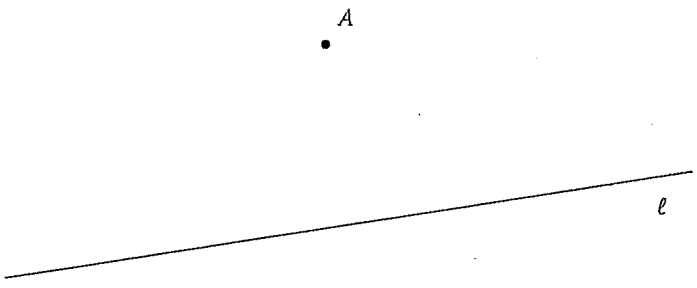
[10] 5. Find the group of symmetries for each of the three objects shown below. Be sure to indicate **in the object** any **centers of rotation**, **lines of reflection** or **vectors of translation**. If you are indicating a rotation, be sure to include to **angle of rotation**.

OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

[6] 4. (a) In the diagram, if flower B is the image of flower A under a rotation, find the center (label it C) and angle (label it θ) of this rotation .



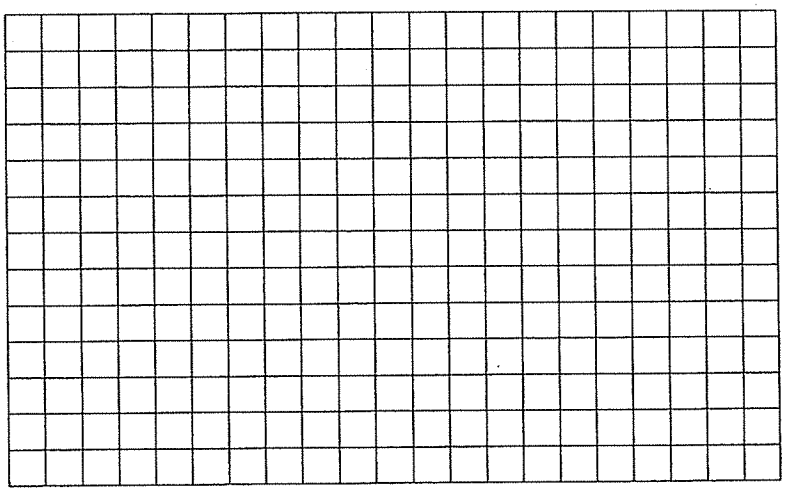
[4] (b) Find the image of the point A under the symmetry $f = \text{refl}(\ell)$.



[3] 3. (a) What are the Fibonacci numbers? (Give a definition)

[3] (b) Given that $f_{14} = 377$ and $f_{16} = 987$ find f_{15}.

[4] (c) In the rectangular grid below, use squares of side lengths corresponding to the Fibonacci numbers to construct an approximation of the golden spiral.



[6] 2. (a) Construct a golden rectangle having (shorter) side as given.

[4] (b) Using the above, construct two golden obtuse triangles of different sizes.

UNIVERSITY OF MANITOBA

DATE: February 25, 2010 — MIDTERM

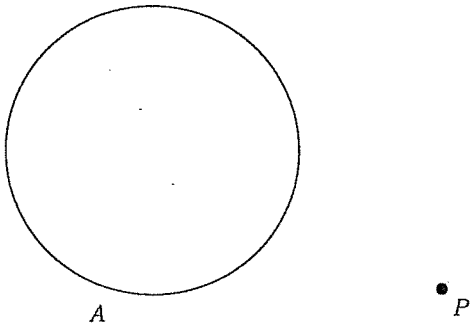
PAGE: 1 of 5

COURSE: MATH 1020 — TIME: 70 minutes

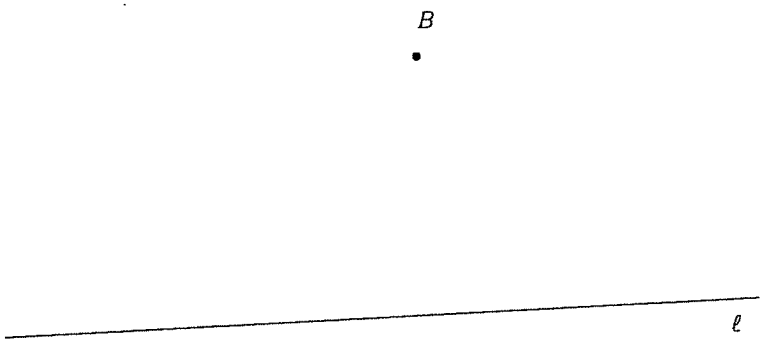
EXAMINATION: Math in Art — EXAMINER: M. Davidson

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.

[6] 1. (a) Find (construct) the center of the circle A given below. Construct a circle centered at point P that touches circle A in exactly one point.



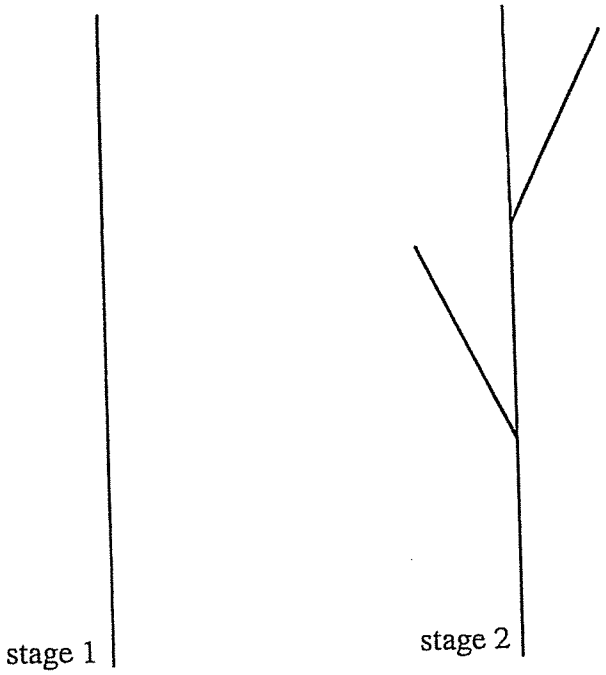
[4] (b) Draw a line that passes through the point B and intersects that line ℓ at an angle of 60 degrees.



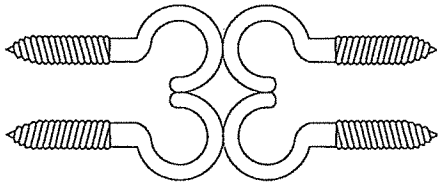
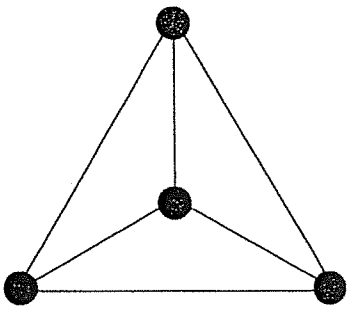
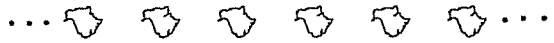
FA/MATH 102- Mathematics in Art
Mid-Term Test, 19 October, 2006

time 70 minutes

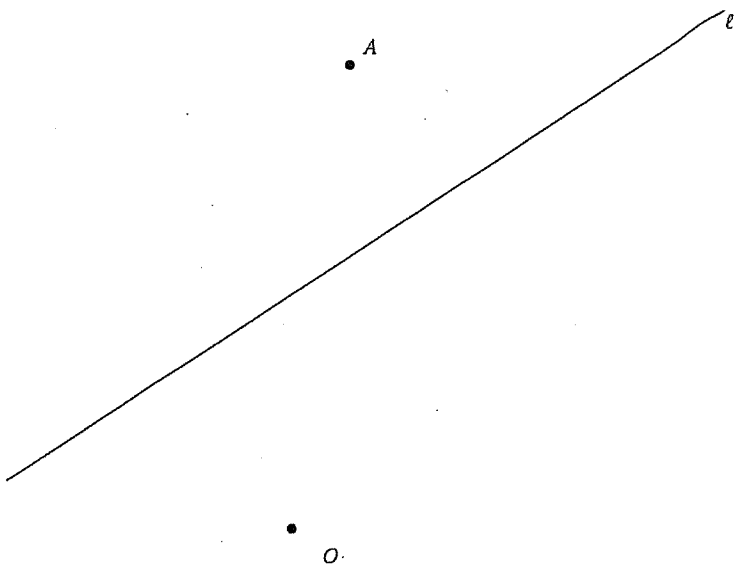
4. Study the algorithm given by the first three stages of a fractal tree shown below and draw the next two stages of the fractal. Demonstrate self-similarity by circling a portion of your final sketch which is similar the entire tree in the previous stage. 10



[10] 6. Find the group of symmetries for each of the three objects shown below. Be sure to indicate in the object any centers of rotation, lines of reflection or vectors of translation. If you are indicating a rotation, be sure to include to angle of rotation.

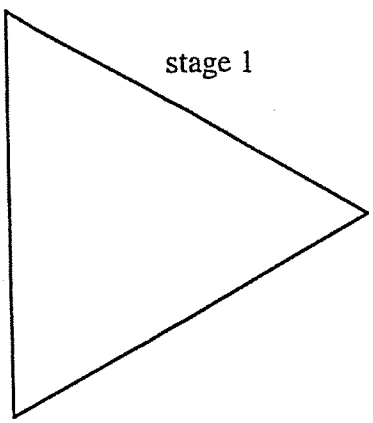
OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

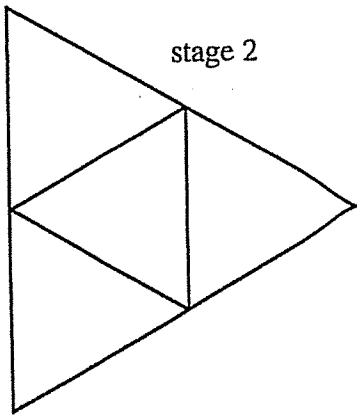
[5] 5. (a) Given the diagram below, we define $f = refl(\ell)$ and $g = rot(O, 60°)$. Find the image of A after first applying f, then applying g.

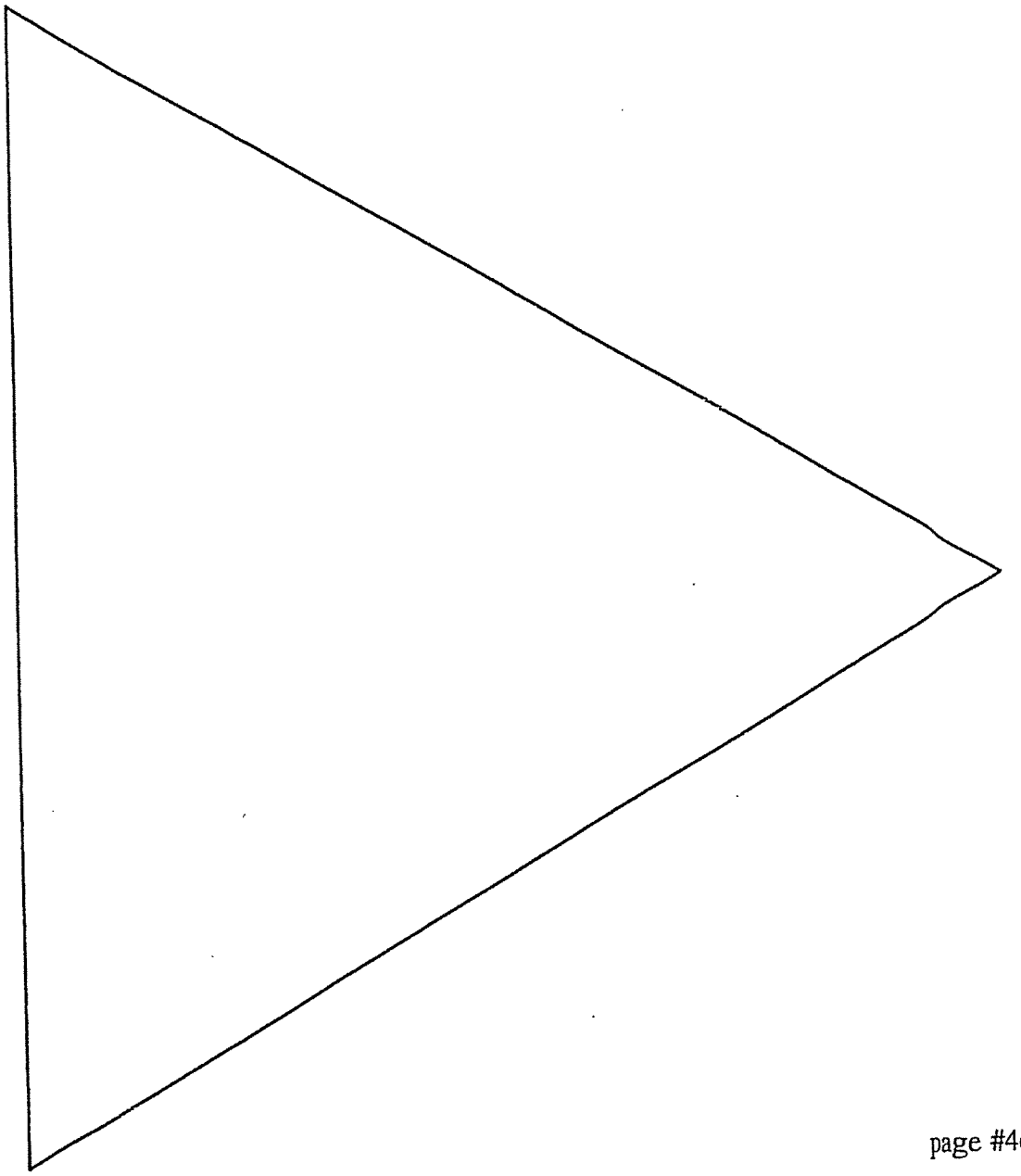


[3] (b) Give a reasonable accurate drawing of an object that has exactly 5 symmetries (including Id). List the symmetries.

4. Following the algorithm for drawing a Sierpinski triangle suggested by the first two stages given here, draw next two stages (of the fractal) in the big triangle given below. Demonstrate the principle of self-similarity of the fractal by circling a porion of your final artwork which is similar to the whole design. (In making the design, you may shade those regions that are to be removed)







3. Explain how each of the following is related to the golden ratio ϕ.

[2] (a) golden rectangle

[2] (b) golden acute triangle

[2] (c) regular pentagon

(d) [bonus/2] Fibonacci numbers

[3] 4. (a) What are the Fibonacci numbers? (Give a definition)

[3] (b) Given that $f_{13} = 233$ and $f_{15} = 610$ find f_{14}.

[6] 2. (a) Construct the golden cut of the line segment below.

[4] (b) Construct a golden obtuse triangle on the line below. (Note, this is the same length as the line given above). Divide it into a smaller golden obtuse triangle and a golden acute triangle. Label the smaller triangles.

UNIVERSITY OF MANITOBA

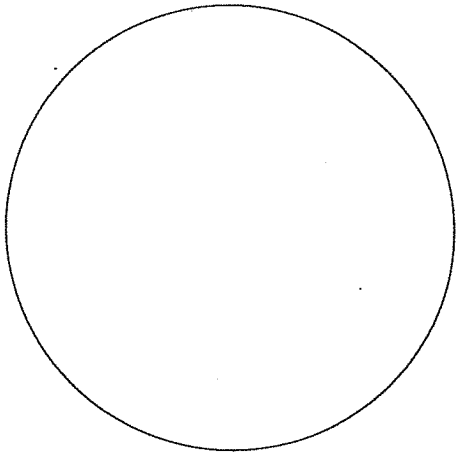
DATE: October 22, 2009 — MIDTERM

COURSE: MATH 1020 — TIME: 70 minutes

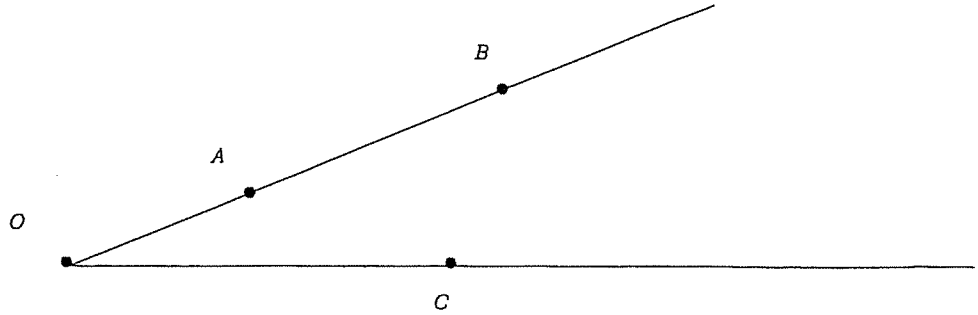
EXAMINATION: Math in Art — EXAMINER: M. Davidson

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.

[5] 1. (a) Find (construct) the center of the circle given below. Construct a hexagon in the circle.



[5] (b) Given the diagram below; If OA has length 1, OB has length n and OC has length m, find the point D on OC such that OD is length mn.



054/136. 102 Math In Art Mid-Term Exam, 20 October 2005

Dr. R. Padmanabhan/Prof T. Lysenko

Time 75 minutes

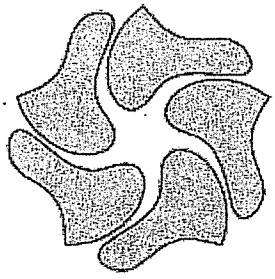
NAME _____ Student Id#_____

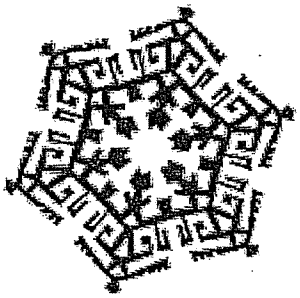
I understand that cheating is a crime

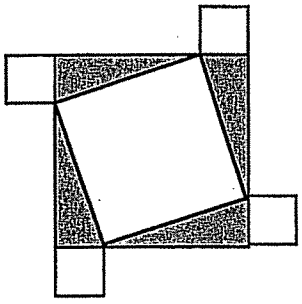
---

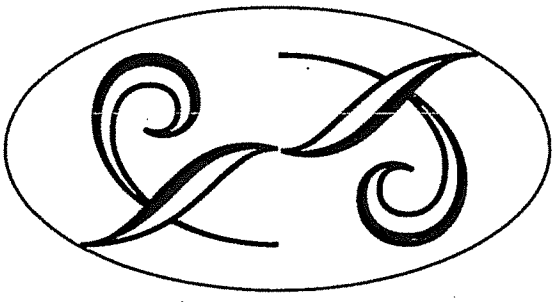
1. For each of the following designs given below, identify all the symmetries of the design.

15



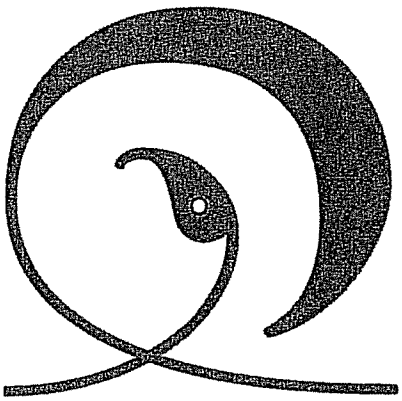


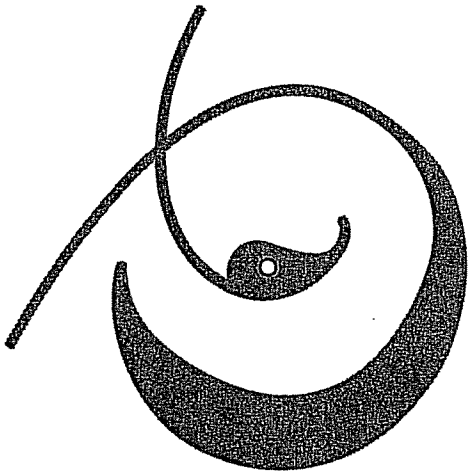




6. The image B is obtained from A by rotating A around a specific centre C and by a specific angle of θ degrees. Find the centre C and θ, the angle of rotation. Give a brief description of your method.

A





B

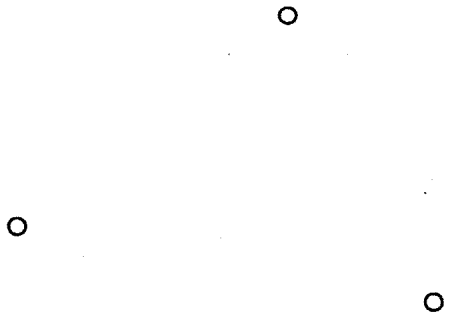
FA/MATH 1020 Math In Art, Mid_Term Exam, Oct 18, 2007

NAME_____ STUDENT ID#_____

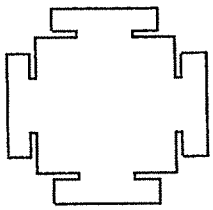
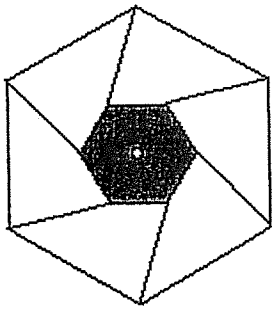
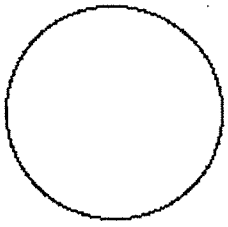
Time 75 minutes

1. You are given a line segment AB. Divide this line segment into five equal parts by using ruler and compass. Give a brief description of your method.

2. Three points given below lie on a circle but unfortunately the circle itself got erased. Reconstruct the circle using the ruler and compass techniques. Find the centre and the radius of the circle)



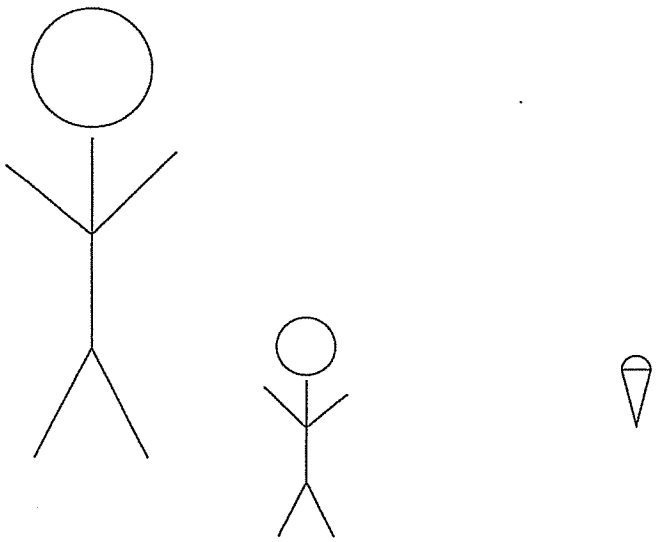
6. For each of the following designs given below, identify all the symmetries of the design.

Design D	Symmetries of D
	
N	
MOM	
	
 a circle	

[9] 4. (a) What are the Fibonacci numbers? (Give a definition)

(b) Given that $f_{24} = f_{23} + 17711$ and $f_{21} = 10946$, find f_{23}. (Here, f_n denotes the n-th Fibonacci number.)

[10] 5. In the following picture, the larger man (stick-figure) is the image of the smaller man under a central symmetry with a dialating factor of 2. Find (construct) the center of the central symmetry and sketch the image of the ice cream cone (by constructing the image of at least two points on the cone)



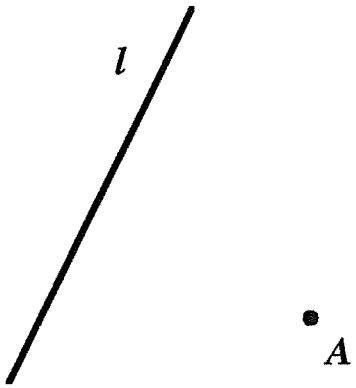
136.102 Math in Art
Midterm Exam
February 21, 2006

MT2

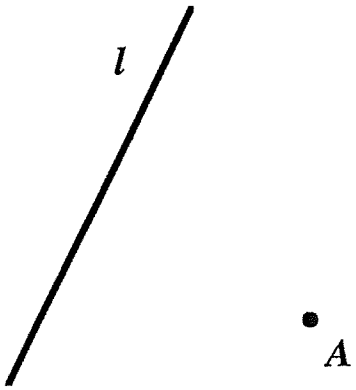
Name:_____ Student Number _____

Important: **"Construct" means "construct using an unmarked ruler and a 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.**

1. (a) Construct the line passing through the point A and parallel to the given line l.



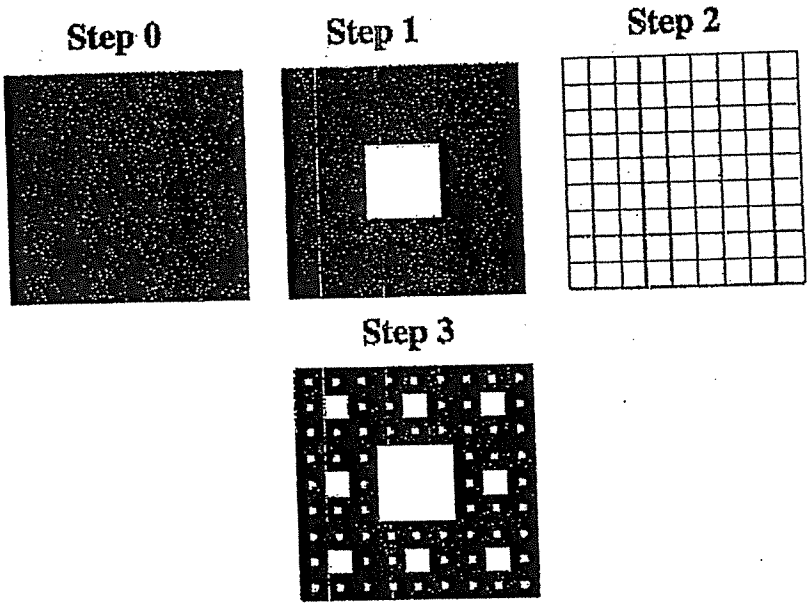
(b) Construct a line passing through the given point A (in the illustration shown below) and intersecting the given line l at the angel of 45°.



2. (a) Construct a regular pentagon over the given line segment (as one of the sides of the pentagon).

(b) Construct an angle of 144°.

[7 points] 5. (a) You are shown some of the first few steps of a procedure generating fractal: the initial figure (Step 0), the figure we get after 1 iteration (Step 1), and the figure we get after 3 iterations (Step 3). Shade with a pencil within the grid shown below Step 2 the object we get after performing 2 iterations.

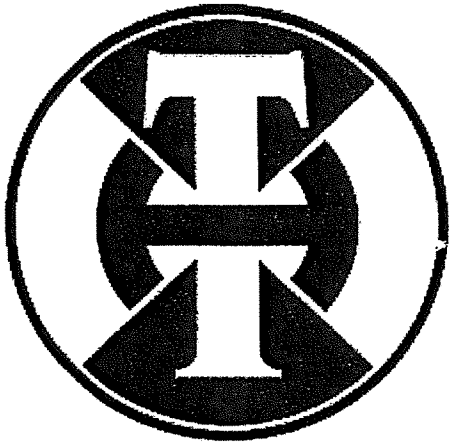


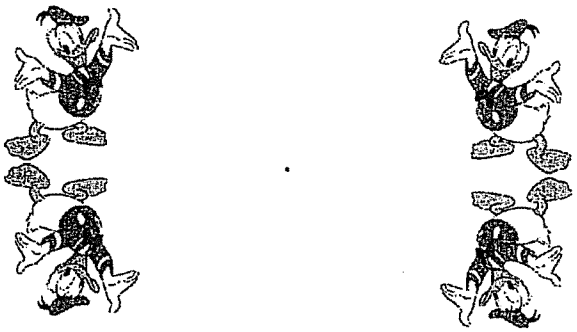
(b) After iterating (repeating the above steps) infinitely many steps we get a fractal F. That fractal is self-similar with respect to a central similarity centered at a point A and with a stretching factor α. Indicate in the figure shown below Step 3 above the position of the point A and write down the value of α. (You only need to indicate where A is, and fill the blank in $\alpha =$ _____.)

3. (a)What are Fibonacci numbers? (Write down the definition.)

(b) It can be verified that $f_{25} = f_{24} + 28657$ and that $f_{22} = 17711$ (no need to check that). Find f_{24}.
(In this question, as usual, f_n is the n-th Fibonacci number in the list of Fibonacci numbers.)

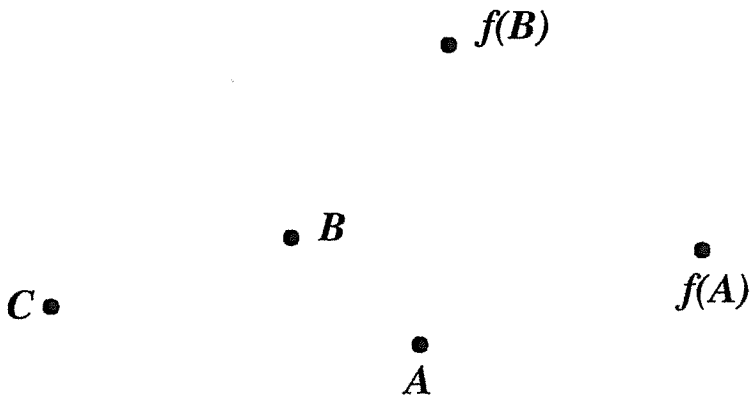
4. Find the group of symmetries for each of the three objects shown below. If you claim a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line of reflection. If there are translational symmetries show or describe the vectors of translation.

OBECT	THE GROUP OF SYMMETRIES
	



[This is a Frieze pattern (the pattern with ducks extends without end both to the left and to the right).]

5. Suppose the point $f(A)$ is the image of the point A and the point $f(B)$ is the image of the point B under the central symmetry f. Find (construct) the center of the central symmetry f and then construct the image $f(C)$ of the point C (as shown in the illustration) under the central symmetry f.



MT 1

Math 1020 Math in Art
Midterm Exam, February 28, 2008

Name: _____ Student Number: _____

1.	max=7	
2.	max=6	
3.	max=9	
4.	max=11	
5.	max=7	

Important: **"Construct" means "construct using an unmarked ruler and a 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.**

[7 points] 1. (a) Construct (using an unmarked ruler and a compass) an angle of 30° with a corner at O and over the given semi-line.

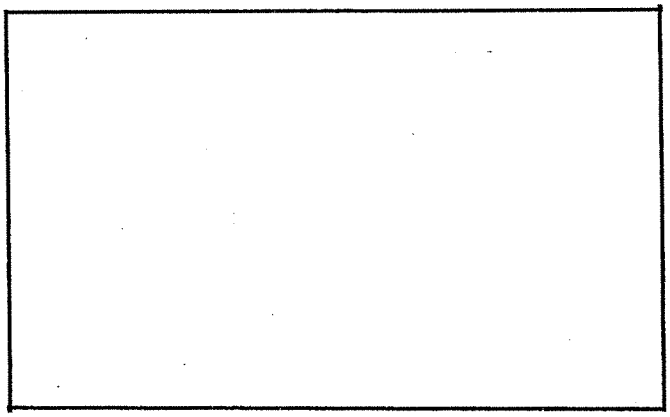
(b) Bisect the angle constructed in part (a) of this exercise.

(Do not forget to briefly describe your steps.)

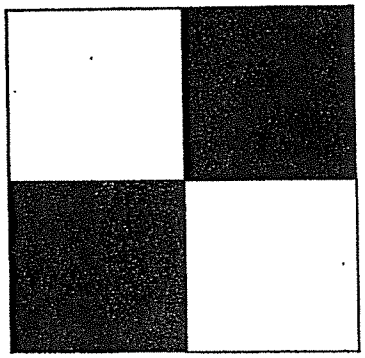
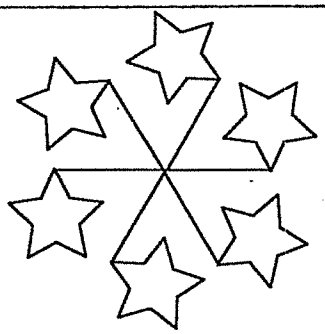
[6 points] **2.** Construct one of the two golden cuts of the line segment given below.

[9 points] **3.** (a) Construct a golden rectangle with the line segment given below representing the base of the rectangle (so that it is one of the larger sides of the rectangle).

(b) Construct a golden spiral within the golden rectangle shown below.



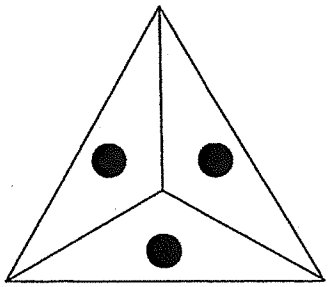
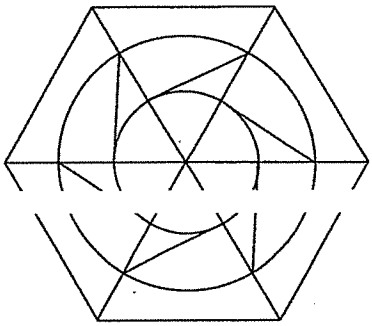
[11 points] **4.** Find the group of symmetries for each of the three objects shown below. If you claim a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line of reflection. If there are translational symmetries show or describe the vectors of translation, drawing **precisely** at least one of them. [In all three cases the object is defined by the (black or gray) coloured points.]

OBECT	THE GROUP OF SYMMETRIES
	
	
.....  ..... [This is a Frieze pattern and it extends without end both to the left and to the right.	

[10 points] 5. We know that the point $f(A)$ is obtained from the point A by applying to it a central similarity f of stretching factor $\alpha = \frac{1}{2}$.

(a) Construct the center O of the central similarity f.
(b) Construct the image of the line segment CB under the central similarity f.

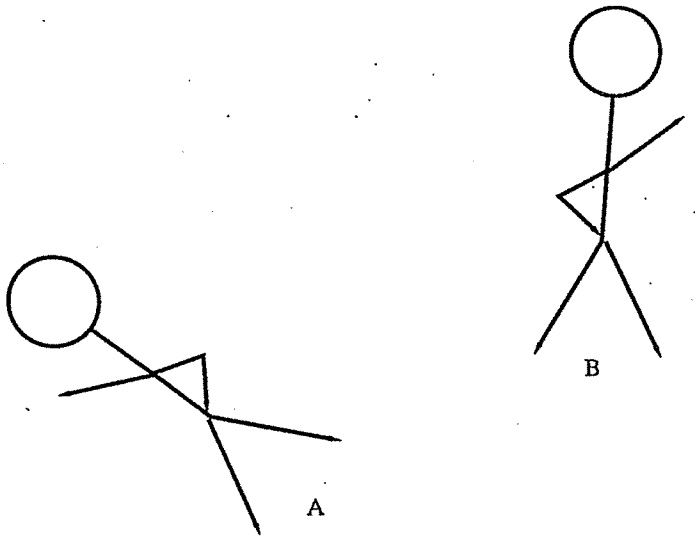
[10] 5. Find the group of symmetries for each of the three objects shown below. Be sure to indicate in the object any centers of rotation, lines of reflection or vectors of translation. If you are indicating a rotation, be sure to include to angle of rotation.

OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

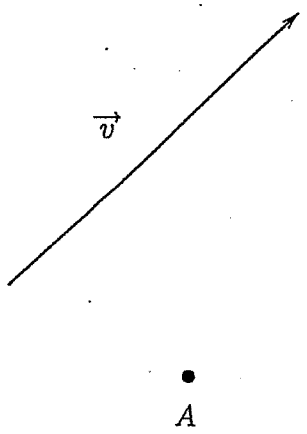
FA/MATH 1020 Mathematics in Art
Mid-Term Exam, 28 February 2008.

7. Study the algorithm given by the first two stages of a fractal design given below and draw the next two stages of the fractal. Demonstrate the self-similarity property of the fractal by circling a portion of your final sketch that is similar to the entire design of the *previous* stage.

[5] 4. (a) Item B is the image of Item A under a reflection. Construct ℓ, the line of reflection.



[5] (b) Find $f(A)$, the image of the point A under the symmetry $f = tran(\overrightarrow{v})$.



[7] **6.** In the two figures below (Figure 1 and Figure 2) we show the first two steps in the construction of a fractal.

(a) Draw the figure representing the next step in the construction of the fractal. (The dot in the middle of the large circle in Figure 1 represents the center of that circle. You do NOT need to precisely construct the circles and the lines in the next step.)

(b) The final fractal **F** will be constructed after infinitely many steps (the first few of them are described in Figures 1, 2 and in the correct solution to question (a) here). Find a central similarity of stretching factor not equal to 1 that will send the fractal **F** into itself. (To get full marks here, you need to indicate in the figure you draw in part (a) where the center of the central similarity is, and you need to state a specific number for the stretching factor of that central similarity.)

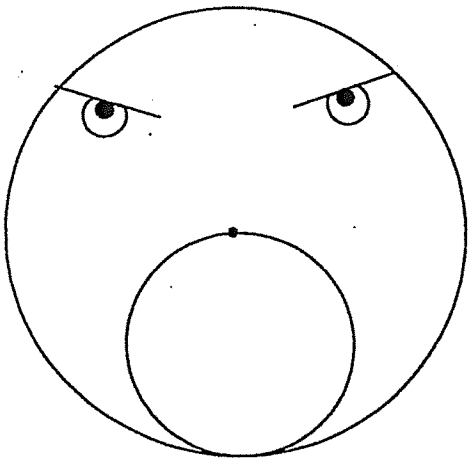


Figure 1.

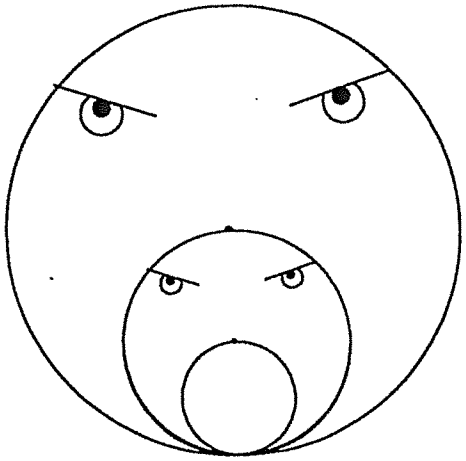


Figure 2.