UNIVERSITY OF MANITOBA

DATE: February 27, 2012 — MIDTERM

TITLE PAGE

DEPARTMENT & COURSE NO: MATH 1020 / FA 1020 — TIME: 1 hour

EXAMINATION: Math in Art — EXAMINER: Various

SURNAME: (Print in ink) ______________________________

GIVEN NAME(S):______________________________

STUDENT NUMBER: ______________________________

SIGNATURE: (in ink) ______________________________

(I understand that cheating is a serious offense)

☐ A01 TR - 10:00 S. Kalajdzievski

☐ A02 TR -11:30 D. Kalajdzievska

INSTRUCTIONS TO STUDENTS:

This is a 1 hour exam. **Please show your work clearly.**

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

This exam has a title page, 5 pages of questions and also 1 blank page for rough work. Please check that you have all the pages. You may remove the blank page if you want, but be careful not to loosen the staple.

The value of each question is indicated in the lefthand margin beside the statement of the question. The total value of all questions is 60 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. Use an unmarked ruler and a compass for the constructions, and give brief justifications.

Question	Points	Score
1	6	
2	7	
3	10	
4	6	
5	5	
6	20	
7	6	
Total:	60	

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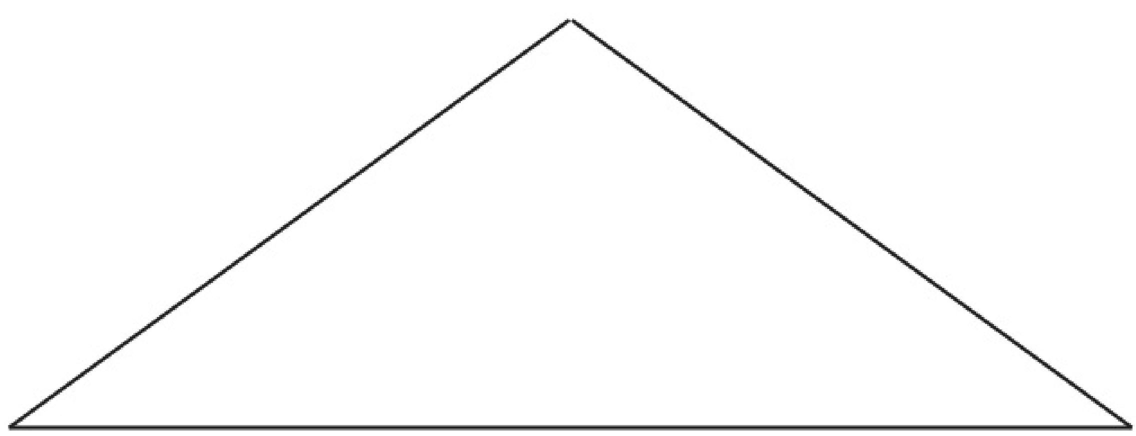
[2] 1. (a) The sequence of numbers $1, 1, 2, 3, 5, 8, 13, 21, 34, \ldots$ is called the **Fibonacci Sequence** and the next number in the sequence is **45**.

[4] (b) If $f_{25} = 75,025$ and $f_{27} = 196,418$, what is f_{26}?

Solution

$f_{27} = f_{26} + f_{25}$, *hence* $196418 = f_{26} + 75026$, *hence* $f_{26} = 121393$.

2. An obtuse golden triangle is given below:



[3] (a) Identify the sizes (in degrees) of the angles of the triangle.

[4] (b) Subdivide the triangle into an obtuse golden triangle and an acute golden triangle by constructing a single line.

Solution (a) The angles are 36, 36 and 108 degrees.

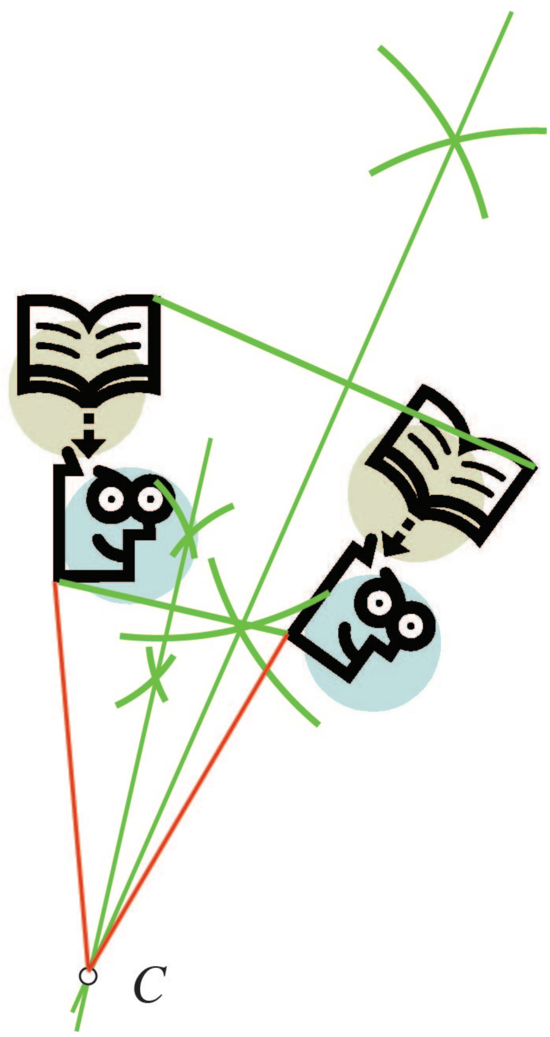
(b) This is solved on Page 20 in the textbook.

[10] 3. *Using an unmarked ruler and a compass, subdivide the lines below into 3 equal parts. Describe your steps briefly in words.*

Solution

This is done in class; see page 11 in the textbook.

[6] 4. *The object to the left in the figure below is obtained from the other by rotation. Use an unmarked ruler and a compass to construct the center of the rotation and identify the angle of rotation.*



The green lines indicate how to find the center of the rotation: bisect two line segment joining points that correspond under the rotation. The red rays give us the angle (counterclockwise).

[3] 5. (a) *There are 3 possible shapes that will create a regular, monohedral tiling of the plane. List and give a brief description of each three.*

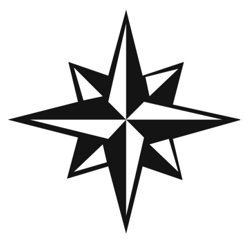
Tilings with an equilateral triangle, with a square, or with a regular hexagon.

[2] (b) *Choose one of the shapes and draw a tiling below.*

See page 78 in the textbook.

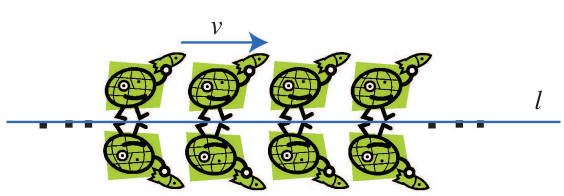
6. *Find the group of symmetries for each of the 3 objects shown below. If you claim there is a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line(s) of reflection. If there are translational symmetries show or describe the vectors of translation. Also, if there is a glide reflection, be sure to state so.*

[6] (a) *For this figure disregard the colouring (ie, assume the figure is all one colour)*



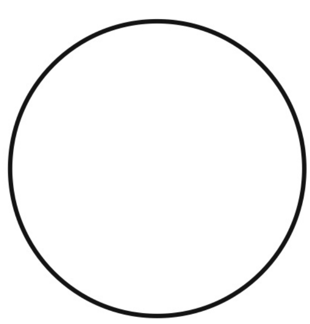
$\{id, rot(O,90), rot(O,180), rot(O,270)\}$ *If you added four reflections no points were deducted.*

[7] (b) *Assume this figure extends unboundedly in both directions.*



$\{id, tran_v, tran_{2v}, tran_{3v}, ..., tran_{-v}, tran_{-2v}, tran_{-3v}, ..., ref_l * tran_v, ref_l * tran_{2v}, ref_l * tran_{3v}, ..., ref_l * tran_{-v}, ref_l * tran_{-2v}, ref_l * tran_{-3v}, ...\}$ *where for typesetting reasons i am using * to indicate composition. .*

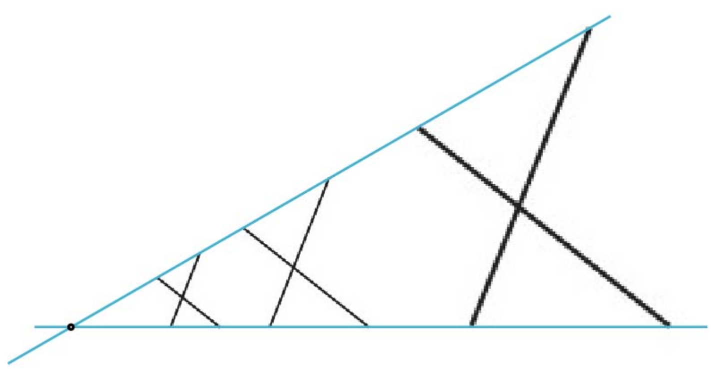
[7] (c) *A perfect circle (HINT: You may want to begin by finding the center of the circle.):*



The construction of the center of the circle is given on page 9 in the textbook. The group of symmetries of the circle consists of all rotations centered at the center of the circle, and all reflections with respect to lines passing through the center of the circle.

[2] 7. (a) *One of the X's below is obtained from the other by applying a central similarity of stretching factor $\alpha = 2$. Locate precisely and label the centre of the central similarity.*

[4] (b) *Construct the image of the larger X under the central similarity found in part (a).*



The blue lines indicate what should be done to find the center of the central similarity. The image of the larger of the two given X-s (now the middle one) is obtained by pushing each point twice further from the center (double the distances).