Instructions

1. Student are required to have a compass and an unmarked ruler. For the purposes of this exam, an unmarked ruler is any ruler which is used without reliance on the markings (I.e. a regular ruler is fine, as long as things are constructed and not measured). Students may have other geometry tools.

2. **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.

3. Calculators are permitted.

4. If a student does not have a printer, they can work on blank paper with reasonable hand drawn representations of any images included in the midterm.

5. Each question MUST be submitted separately, and in the appropriate place. Submissions later than 7:15pm will be considered late and will be penalized.

6. This midterm is open book.

   (a) Student may access their textbooks, notes, or UMLearn page during the midterm. No access to any other material is permitted.

   (b) Student may NOT copy by manual or electronic means from any work produced by any other person or persons, present or past, including tutors or tutoring services.

   (c) Students may NOT share questions or answers in whole or in part with anyone, including posting portions of the test/exam in publicly accessible locations.

   (d) Student may NOT consult external websites, online forums, search engines, etc. or any resource not appearing in the list of acceptable test materials above.

- Michelle.Davidson@umanitoba.ca

This honesty declaration document for the midterm for MATH/FA 1020. You may either print this declaration and sign it or copy everything below this paragraph on a blank sheet of paper.

Acceptable test materials: During the test or exam, students may use their lecture notes, the course textbook, workbooks, and any of the material that has been made available on the UM Learn site. No other materials are permitted.

Declaration: I, the undersigned, declare that all the work I will submit to fulfill the requirements for this course is **wholly my own work**. During the quiz/test/exam I **will not**:

1. copy by manual or electronic means from any work produced by any other person or persons, present or past, including tutors or tutoring services;

2. share questions or answers in whole or in part with anyone, including posting portions of the test/exam in publicly accessible locations;

3. copy from any source including textbooks and websites, or

4. consult external websites, online forums, search engines, etc. or any resource not appearing in the list of acceptable test materials above.

Students must not discuss or communicate the contents of any quiz, test or exam with any person except their **instructor** until **Saturday at noon following the assessment** for quizzes and tests and **24 hours** following the exam for the final exam.

By signing this document, I acknowledge that I have read and will follow the instructions for acceptable material during the quizzes, tests and exam.

I understand that penalties for submitting work which is not wholly my own, or distributing my work to other students, is considered an act of Academic Dishonesty and is subject to penalty as described by the University of Manitoba's Student Discipline Bylaw. These penalties that may apply range from a grade of zero for work, failure in the course, to expulsion from the University.

Name: _____

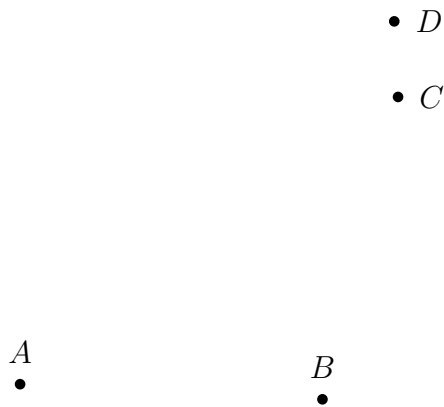**Student number**: _____

Date: _____

Signature: _____

[3]   1.   (a) Recall that two circles are concentric if they share a common centre. The points A and B are on a circle C_1 and the points C and D are on a circle C_2. If C_1 and C_2 are concentric circles, construct their common centre.

$\bullet\ D$

$\bullet\ C$

A
$\bullet$

B
$\bullet$

[5]   (b) Construct the point C between points A and B so that $AC = 2CB$.
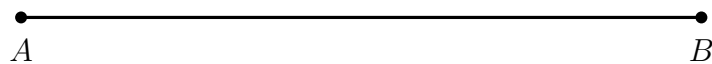
$\bullet$————————————————$\bullet$
A B

[2] 2. (a) The following is a regular pentagon. Use it in a meaningful way to construct an angle of 18°. (Students who cannot print this page may work from a sketch of a regular pentagon.)
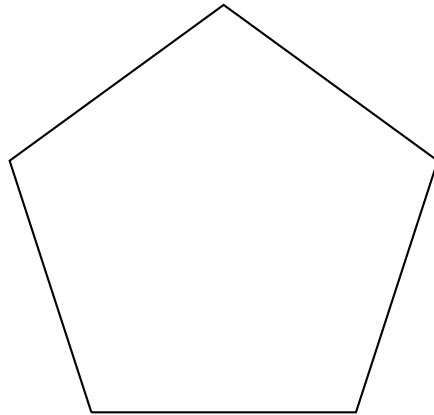
[5]   (b) Construct a rectangle with the base a units long, and height b units, such that $a = \phi b$ where ϕ is the golden ratio.

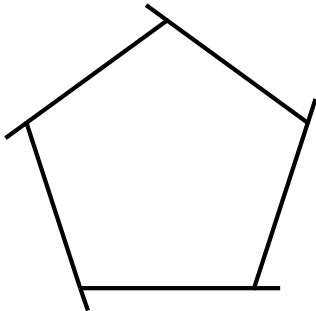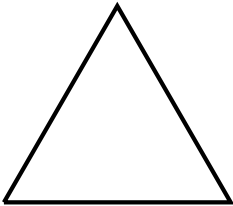[12]   3. Find the group of symmetries for each of the three objects shown below. If you claim there is a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line(s) of reflection. If there are translational symmetries, describe the vectors of translation, drawing **precisely** at least one of them.

OBJECT	SYMMETRIES
$\cdots$ G G G G $\cdots$ This is a Frieze pattern. It extends without end to the left and to the right.	

[2]   4.   (a)   The line ℓ, the vector $\mathbf{v}$ and the point A are shown; ℓ and $\mathbf{v}$ are parallel. Construct $tran_{\mathbf{v}} \circ ref_{\ell}(A)$.

ℓ

A •

$\mathbf{v}$
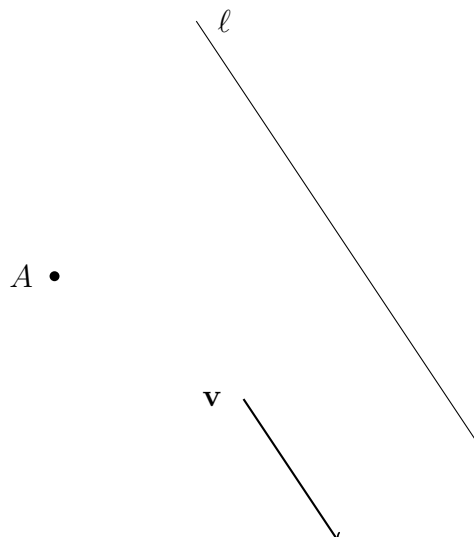
[4]   (b)   The points A and B are given in below. Let f be the symmetry $rot(A, -90°)$ and let g be the central similarity with centre B and stretching factor $\alpha = 0.5$. Construct $g \circ f(B)$.

●
A

●
B

5. In the two figures below we show the first two steps in the construction of a fractal.

   Note that in the second figure, the point B is the midpoint of the line segment AC.

   (a) Sketch the figure representing the next step in the construction of the fractal.

   (b) The final fractal F is constructed after repeating the above steps infinitely many times. Describe a central similarity of a 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 drawing you do in part (a) where exactly the centre of the central similarity is, and you need to state a specific number for the stretching factor of that central similarity.)