

INSTRUCTIONS

- I. You have two hours to complete the paper. You must submit your paper within 20 minutes of completing it. If you have difficulties uploading, you place your solutions in the emergency folder and email your instructor to alert them that it is there.
- II. If you can print the question papers and work on those, please do. Otherwise you may work on your own (preferably plain white) paper.
- III. Student are expected to answer all questions. Any question without a submitted answer will receive a grade of zero.
- IV. Each question needs to be submitted in a separate file, so you need a new page for each question. You can submit more than one page for a question if your solution does not fit on one page.
- V. During the exam, students may use their lecture notes, the course textbook, and any of the material that has been made available on a University of Manitoba site dedicated to this course (such as UMLearn). Students may also have a calculator and geometry tools. No other materials are acceptable.
- VI. The value of each question is indicated in the left hand margin beside the statement of the question. The total value of all questions is 62 points.
- VII. **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.
- VIII. Unless instructed otherwise, you must show work (calculations, intermediate steps, etc) to receive full credit.
- IX. If you have a question during the exam, you should email your course instructors (email addresses given below), or ask on the Webex meeting.

Instructors

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COURSE: MATH 1020

DURATION: 120 minutes

DATE & TIME: April 26, 2020, 6:00–8:00

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This honesty declaration must be submitted with the exam. Failure to submit may result in a grade of zero (0) on the assessment. You may either print this declaration and sign it or copy everything below this paragraph out by hand on a blank sheet of paper. Please have this prepared **before** the assessment begins.

Acceptable test materials: During the test or exam, students may use their lecture notes, the course textbook, lab worksheets, and any of the material that has been made available on a University of Manitoba site dedicated to this course (such as UMLearn).

Declaration: I declare that all the work I will submit to fulfill the requirements for this assessment is **wholly my own work**. 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 any other students in this course, including posting portions of the assignment in publicly accessible locations,
3. copy from any source including textbooks and web sites, or
4. look for answers on any other website, online forum, search engines, etc. or any other resource.

Students must not discuss or communicate the contents of the test or exam with any person, other than their instructor, until **24 hours after** the end of the exam.

By signing this document, I acknowledge that I have read and will follow the instructions for acceptable material during the test/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: _____

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COURSE: MATH 1020

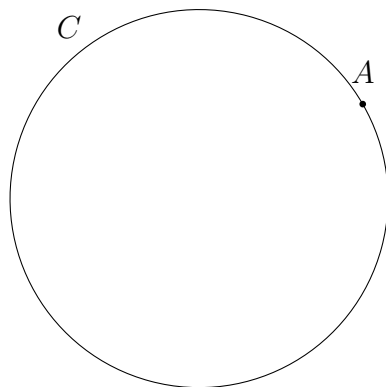
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[3] 1. (a) Construct an angle of 75° . (Hint: $75 = 45 + 30$)

[4] (b) Given the circle C and the point A , construct the tangent to C at A .



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- [4] 2. (a) We are given a line segment AB . Construct a line segment CD that is $\frac{1}{\phi}$ times the length of AB .



- [4] (b) We know the 30^{th} and 33^{rd} Fibonacci numbers, and we want to find the 31^{st} and 32^{nd} . Given that $f_{30} = 832040$ and $f_{33} = 3524578$, find f_{31} and f_{32} . Show all your work, display all steps in the solution.

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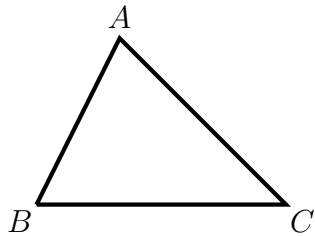
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- [7] 3. Denote by f the central similarity centred at the point O and having stretching factor 2. Denote by g the rotation about O by 180° ($g = \text{rot}(O, 180^\circ)$).
- (a) Construct $f(ABC)$. (I.e. construct the image of the triangle ABC under f .)
 - (b) Construct $g \circ f(ABC)$.

$O \cdot$



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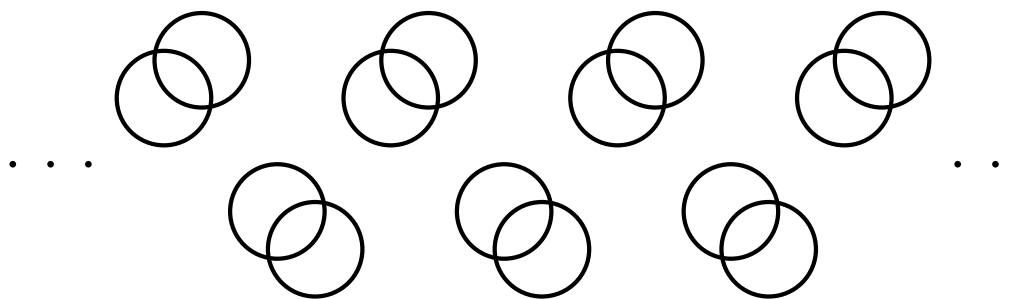
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- [3] 4. (a) Use a compass to draw a design made only of circles so that the design has exactly 4 symmetries. Identify these 4 symmetries. (While you may need a straightedge to demonstrate symmetries if there are lines of reflection, these lines will not be considered part of the object.)

- [4] (b) Identify two symmetries of the following frieze pattern that are neither a translation nor the identity symmetry.



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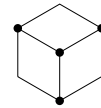
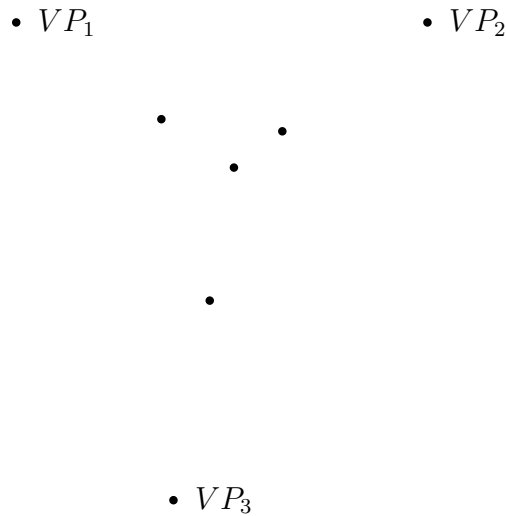
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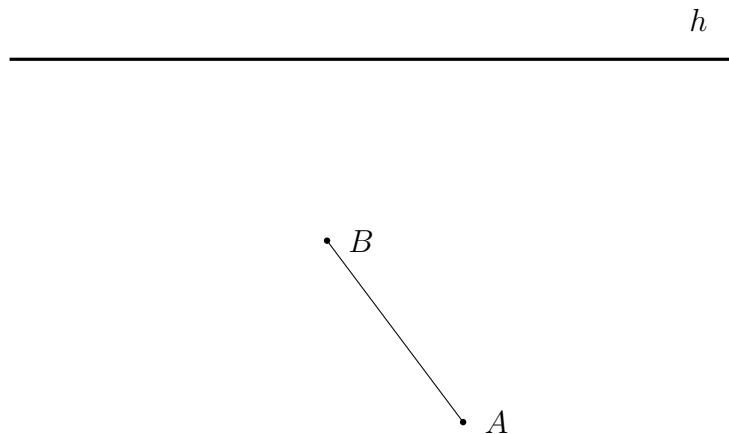
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- [3] 5. (a) In the figure below, you are given four vertices of a box drawn in three-point perspective. The three vanishing points VP_1 , VP_2 , and VP_3 are also given. Draw (construct) the rest of the box in three point perspective, include all edges as if the box were see-through.



Example of how vertices relate to box

- [5] (b) The picture below shows the line segment AB (on the ground) and the horizon h . Subdivide AB into 5 equal parts (in perspective).



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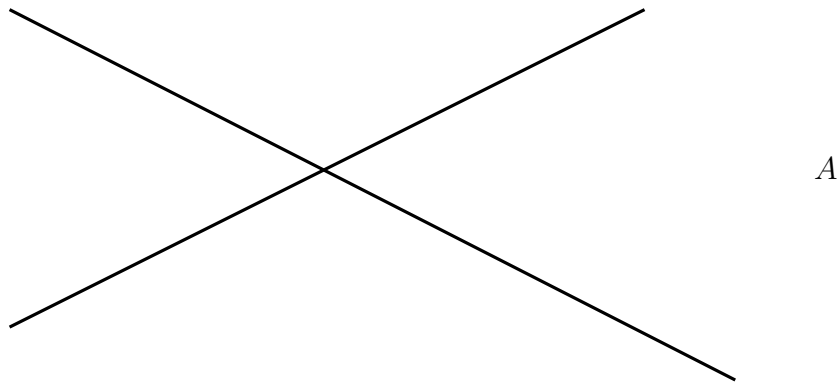
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- [6] 6. (a) Construct at least 6 tangents outlining one half of a hyperbola. The starting setup for this construction is given; the work should be done between the lines in area A .



- [3] (b) A polyhedron has a total of 10 faces, all of them are hexagons. How many edges will this polyhedron have?

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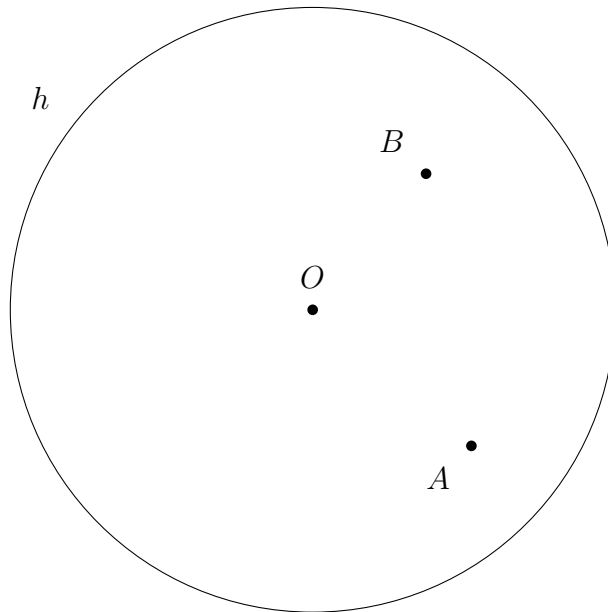
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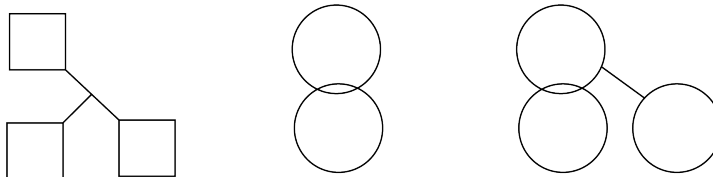
7. In the Poincare model of the hyperbolic geometry show below, h is the horizon. We are given the points A and B .

[2] (a) Construct any two parallel hyperbolic lines.

[6] (b) Choose a point C within h and construct the hyperbolic triangle ABC .



- [4] 8. (a) Given the following three objects, choose the two that are homotopic and show that they are homotopic by drawing at least three intermediate sketches indicating a continuous deformation of one into the other. (Place an X over the one that is not homotopic to the others).



- [4] (b) Consider the surface shown below. Find the Euler characteristic of this surface. Justify!

