TUDelft
Delft University of Technology

Faculty of the Built Environment & Architecture

3D modelling of the built environment (GEO1004) — 5 ECTS

Location: Faculty of Mechanical, Maritime and Materials Engineering (3mE) hall H
Date & time: 17 June 2022, 09:00–11:00
Responsible teacher: Ken Arroyo Ohori

1. The subject matter is in full accordance with the study guide.

2. This resit exam is worth 40% of the final mark for the course, which substitutes the marks previously awarded to the midterm (5%) and the final exam (35%).

3. The maximum grade for this course is 10.0. The minimum (unrounded) final mark to pass this course is 5.75, which will be rounded to 6.0. However, you need a weighted average of at least 50% in the combined exams (midterm + this one) to be able to pass the course.

4. All questions have equal weight in this exam.

5. Answer directly on these pages. If there is not enough space, use extra sheets and staple them at the end.

6. This is an open-book exam, only paper is allowed. No computer/phone/etc; a calculator is fine.

7. This final exam has 12 questions, and 13 pages.

8. Fill out your name and student ID.

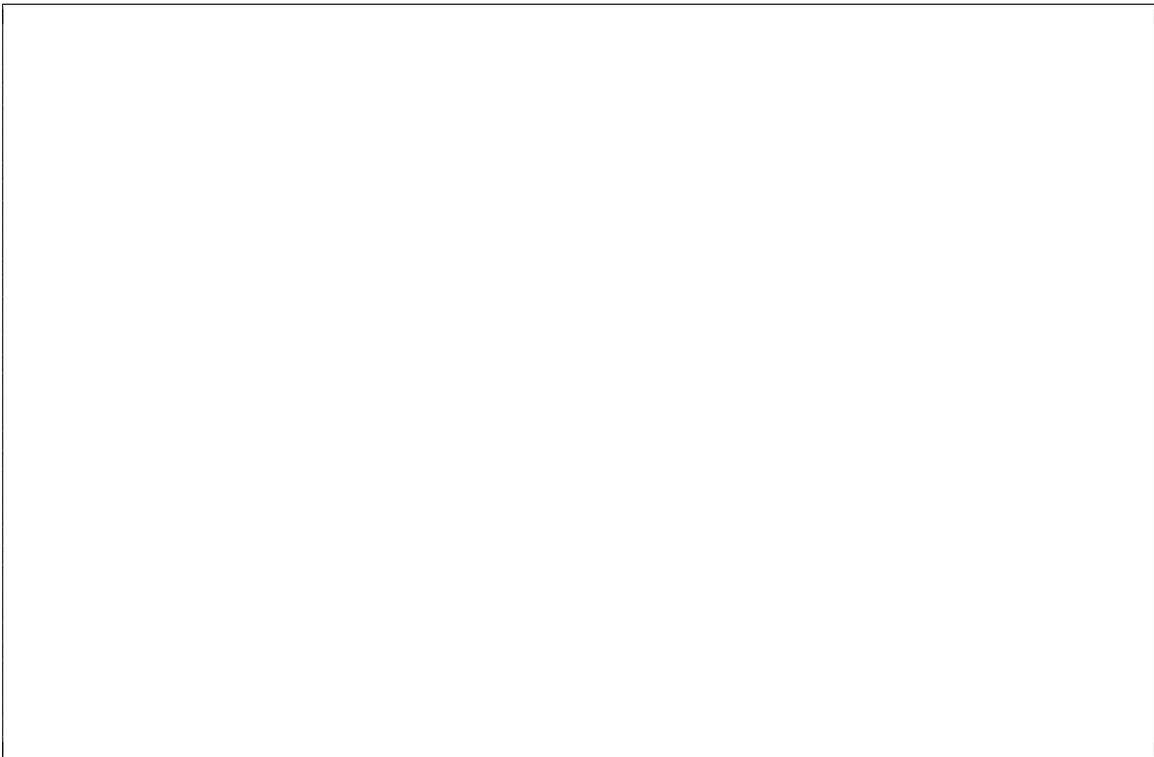9. You have 2 hours to do this exam.

Name: _____

Student ID: _____

Lesson 1.1

Using examples from your homework assignments, give an example of the use of Euclidean, Cartesian and point set geometry (⅓ point each).
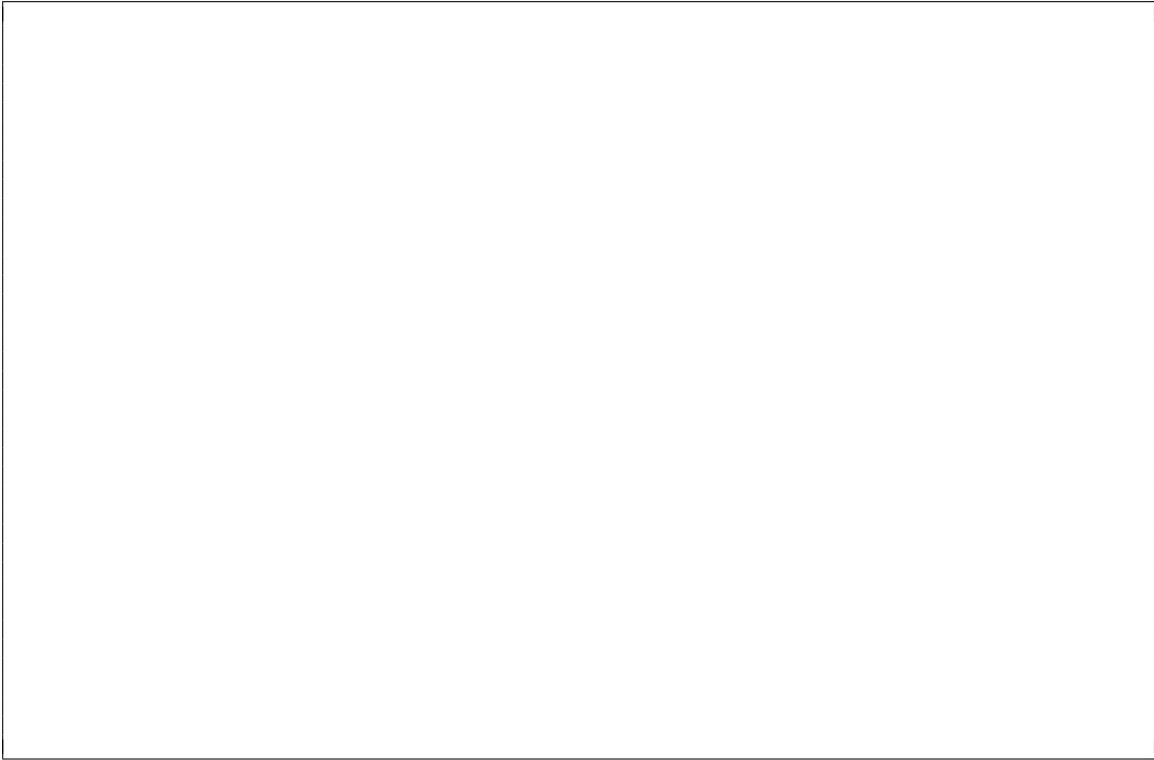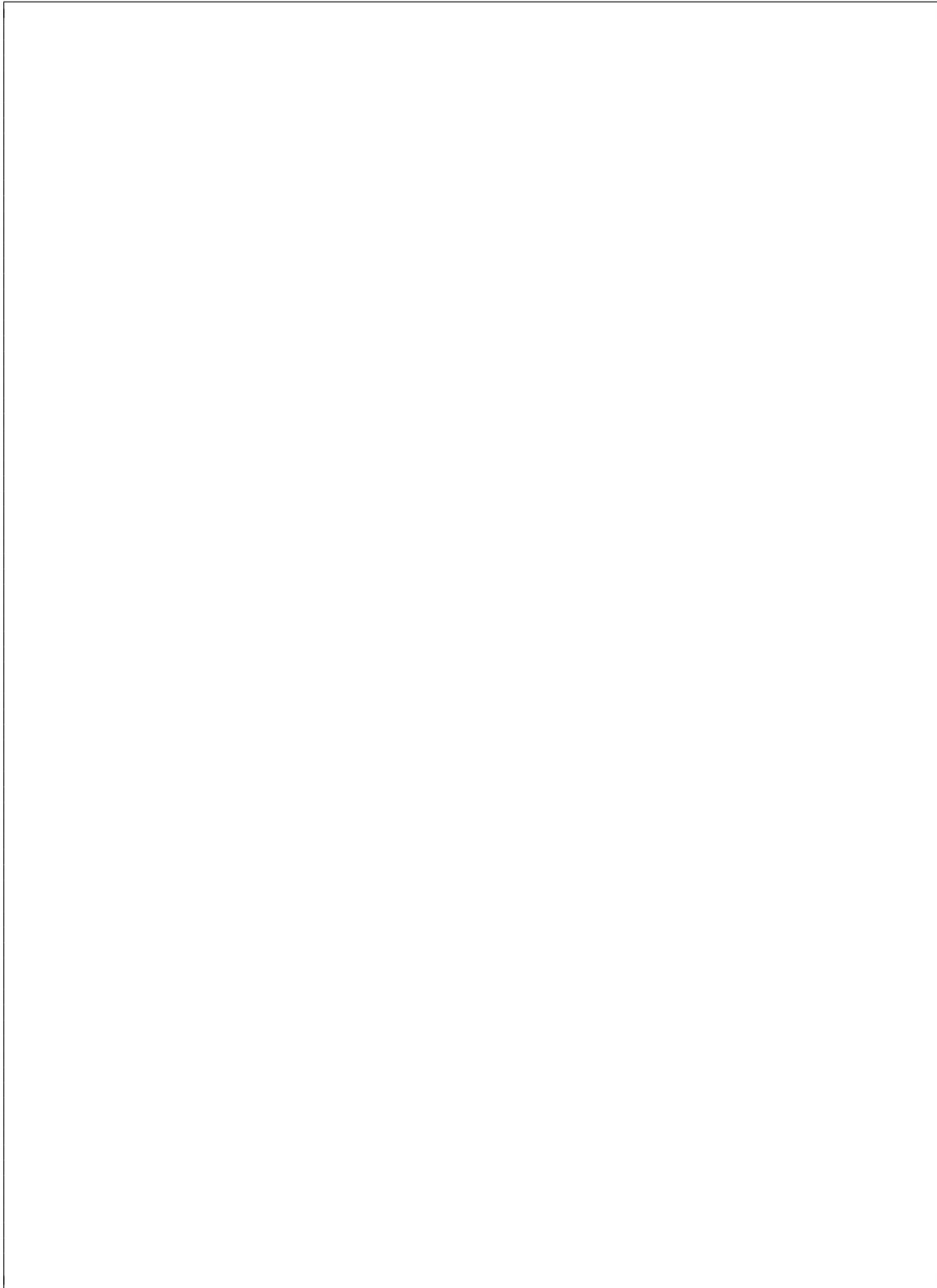
Lesson 1.2

Explain in your own words how boundary representation allows us to store 3D objects using 2D data structures.
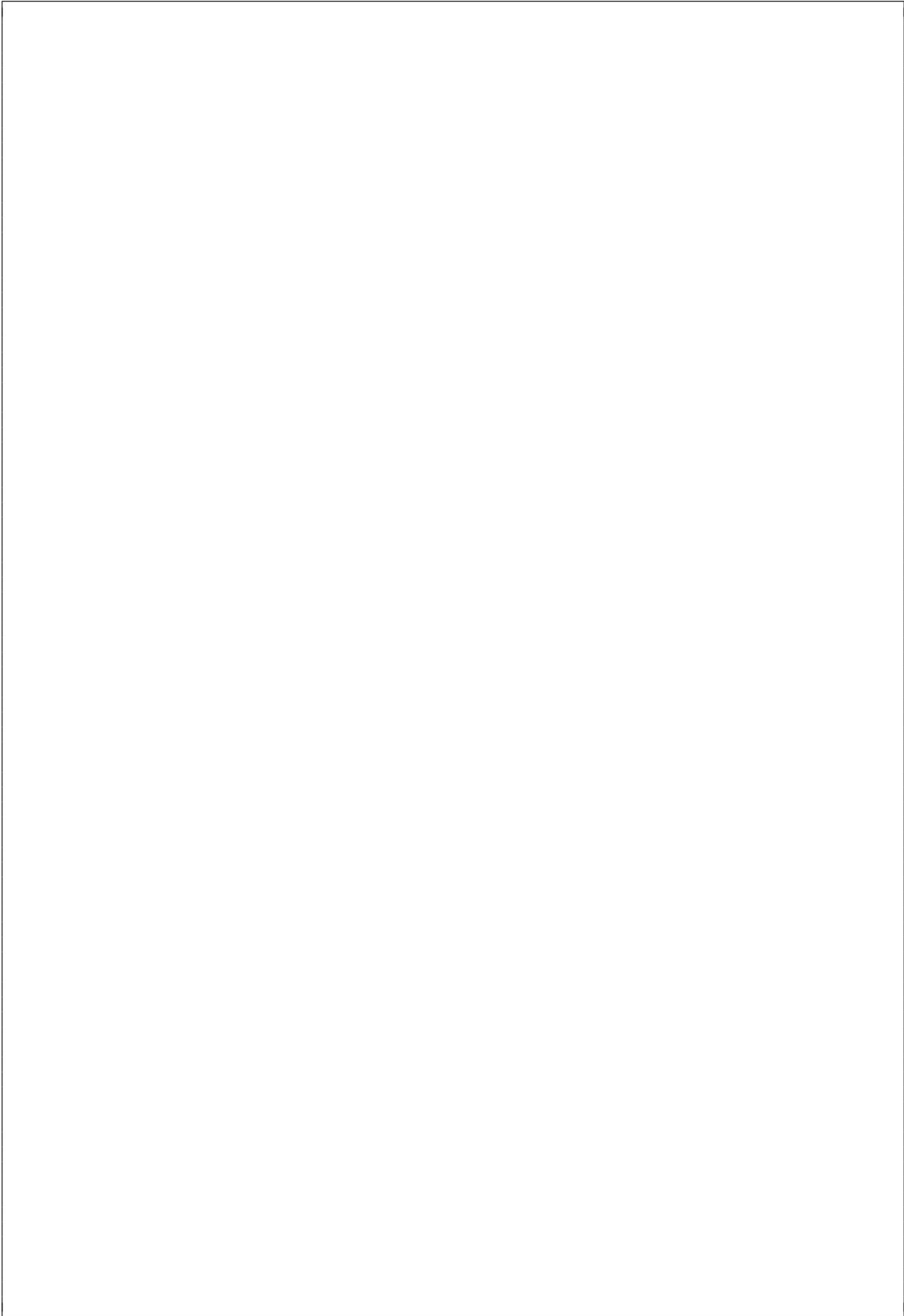
Lesson 2.1

In a 2D generalised map:

(a) What is the sequence of involutions that is necessary to obtain all the darts around an edge? (½ point)

(b) Draw an example map to demostrate it. (½ point)

Lesson 2.2

Consider a voxelised version of a tile of the 3D BAG. Using it as an example, explain how a sparse representation could help you store this model more efficiently.
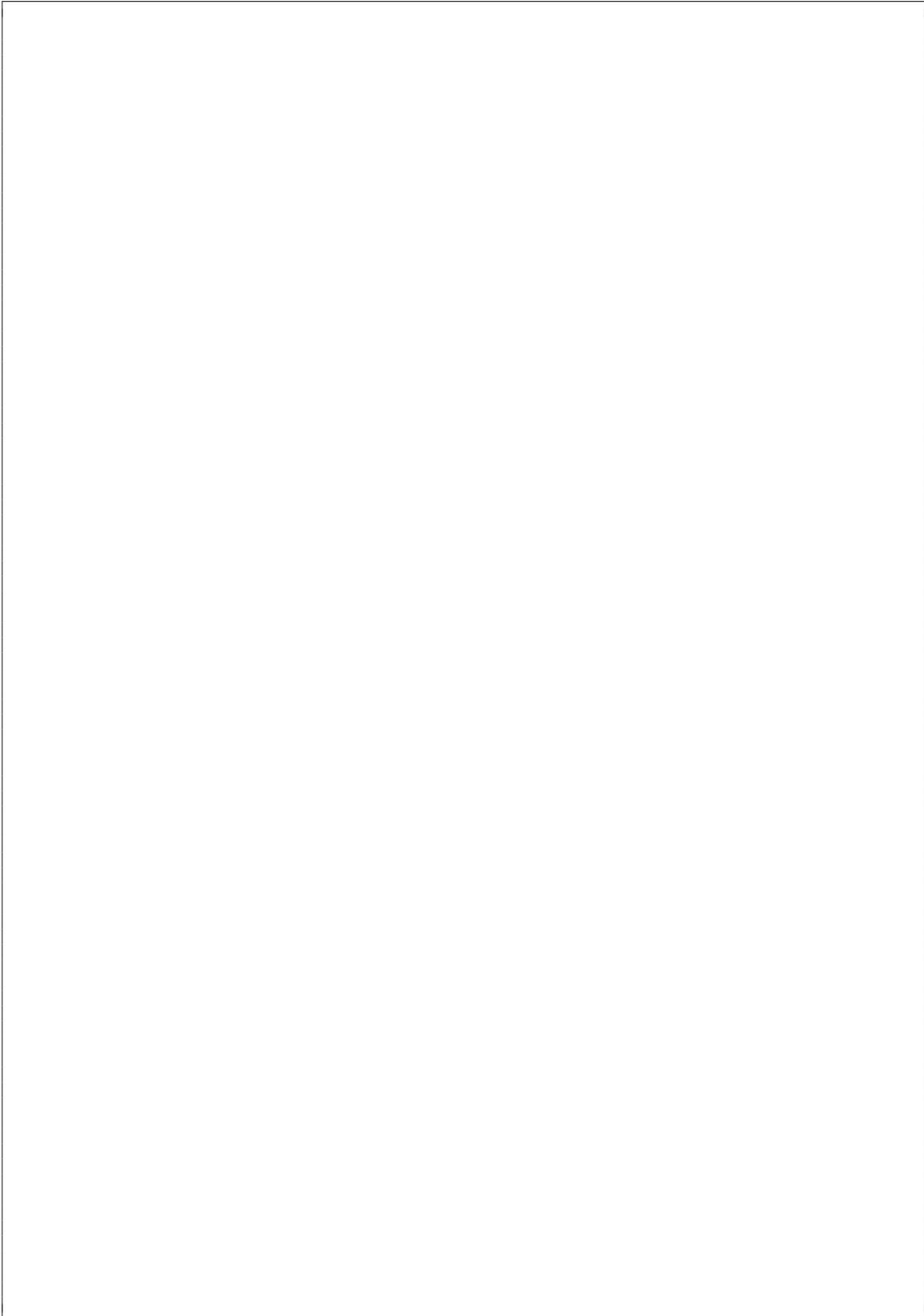
Lesson 3.1

Given a polyhedron (valid according to ISO19107), give 3 differences between: (1) the tetrahedralisation of the polyhedron; and (2) its Constrained Delaunay tetrahedralisation? (⅓ point each)
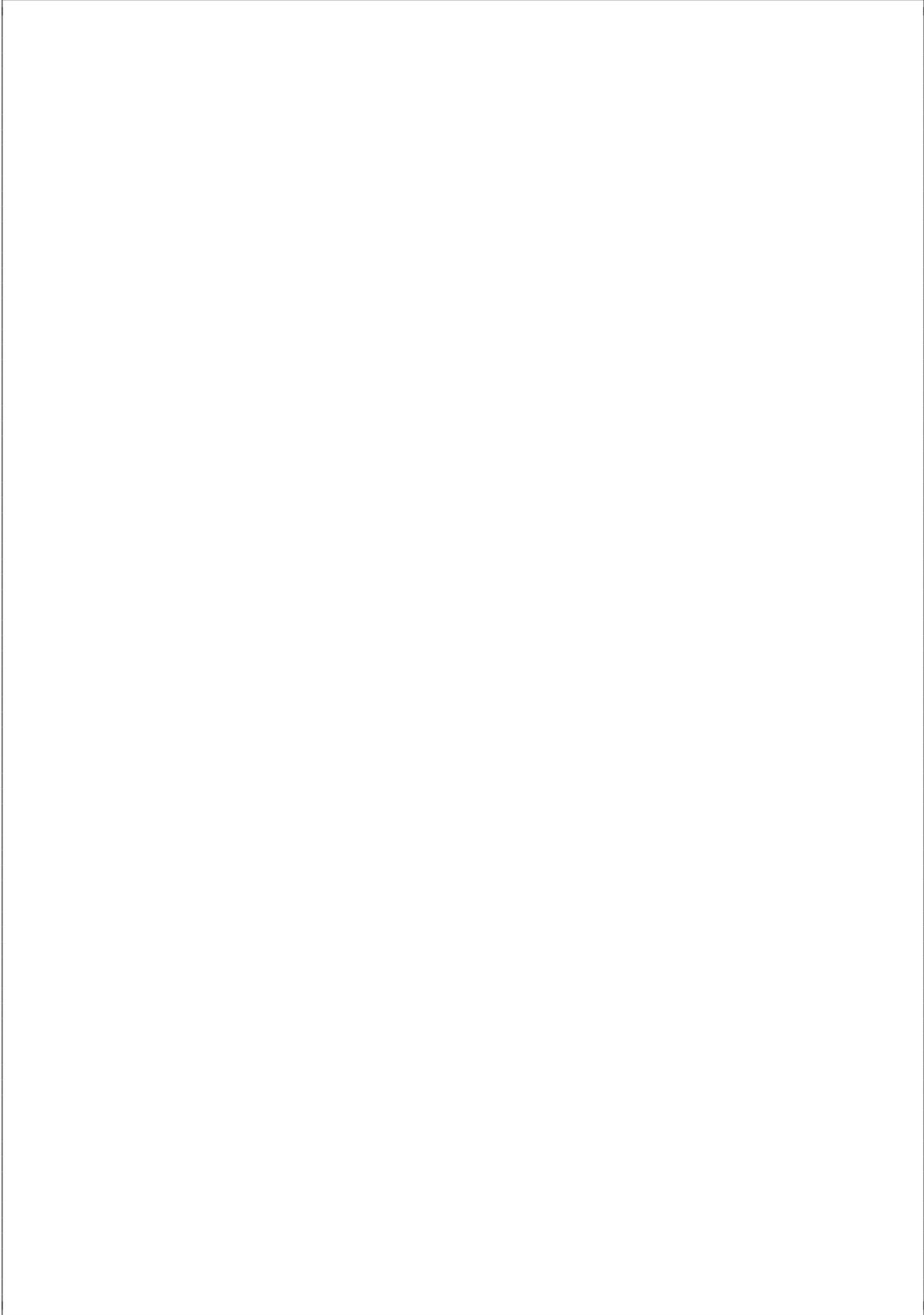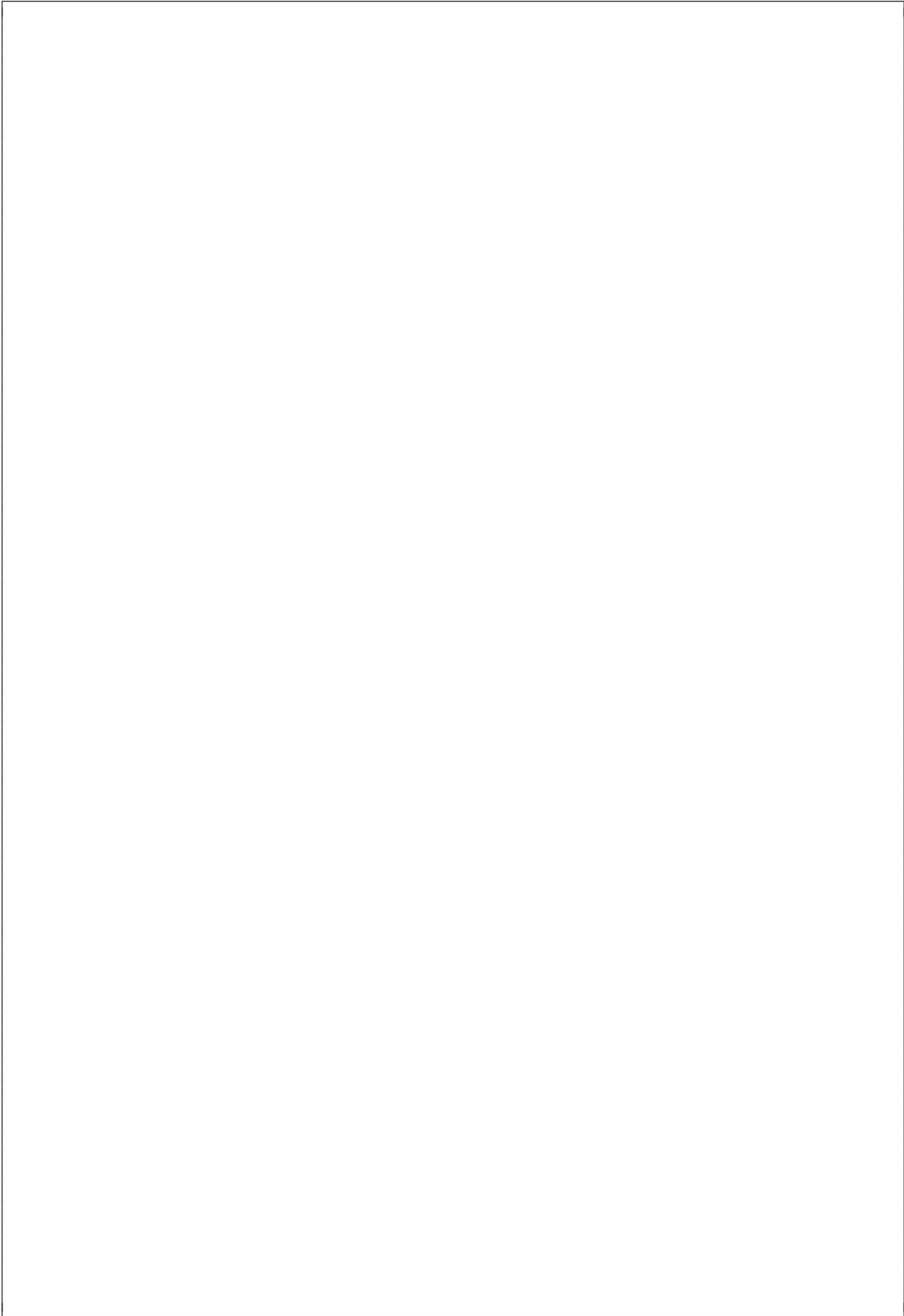
Lesson 3.2

Draw a valid polyhedron that has a genus of 2 (you can also describe it if your drawing is not clear). Also, list the following: (1) number of vertices; (2) number of edges; (3) number of surfaces; (4) number of shells;
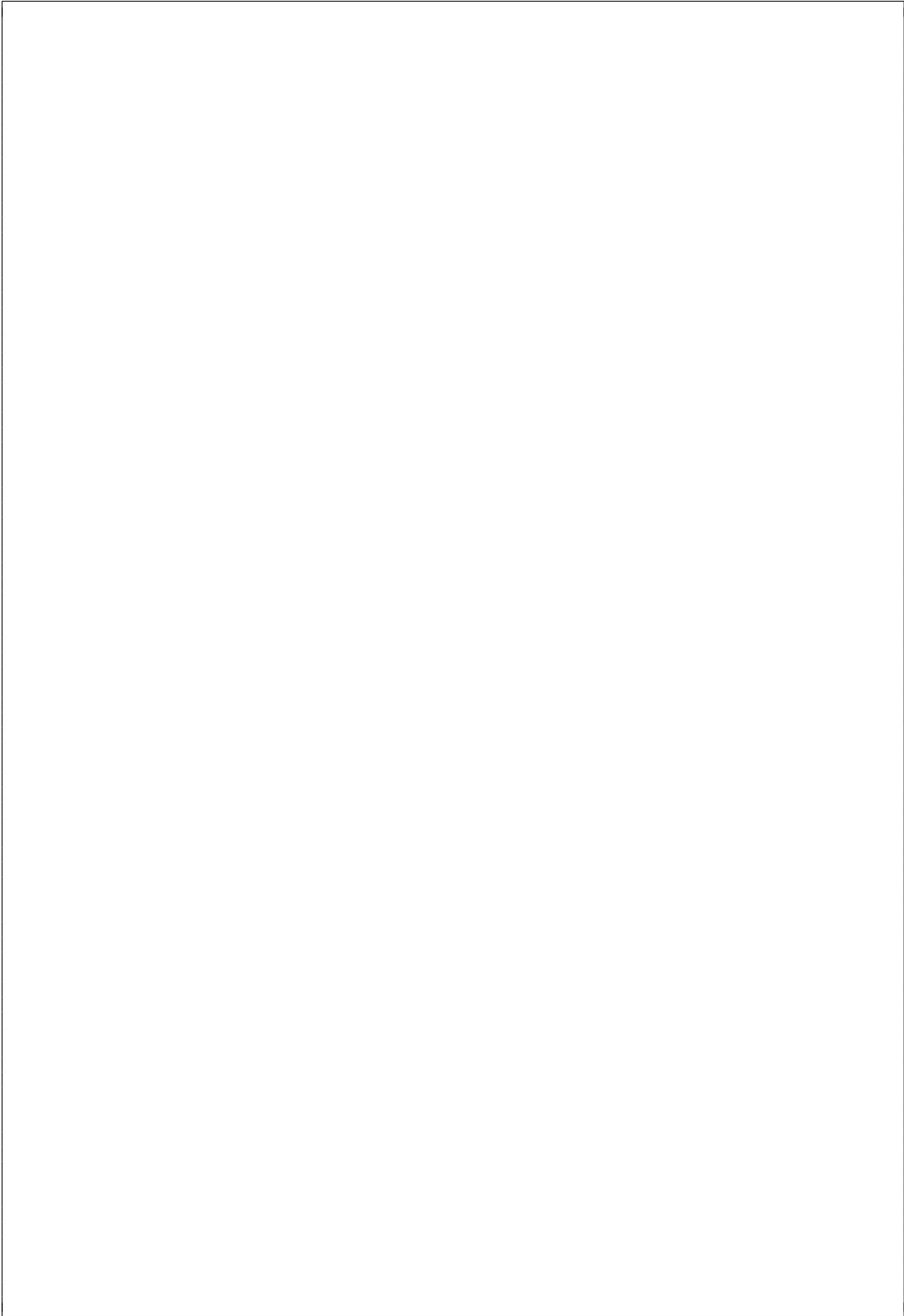
Lesson 4.1

3D city models should ideally be *spatio-semantically coherent*. Describe briefly what this concretely means, and give an example where it is useful in practice.
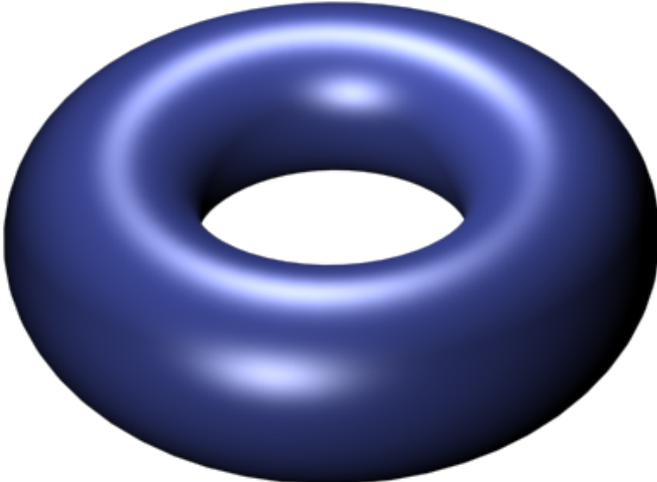
Lesson 4.2

Given a quadratic Bézier curve with point coordinates $(0, 0)$, $(1, 0)$, $(1, 1)$, what coordinates do we obtain when we evaluate it at $t = 0.5$? (½ point) Explain your reasoning (½ point).
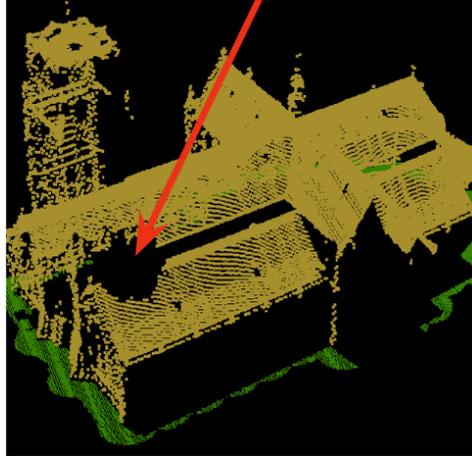
Lesson 5.1
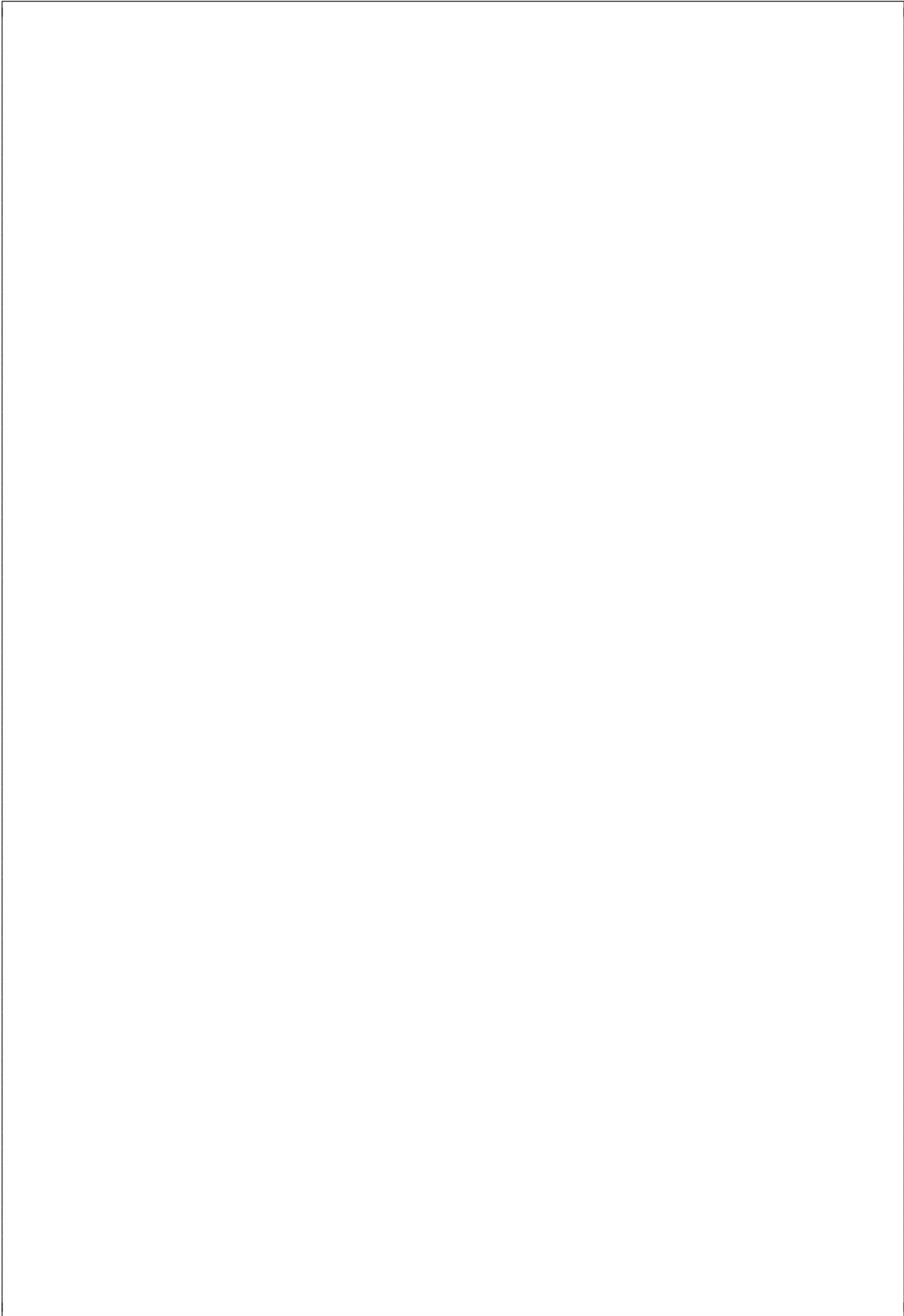Describe and illustrate the MAT of a torus as depicted below.

Lesson 5.2

Consider the 3DBAG model shown below next to its input point cloud. It has an artefact due an occlusion effect in the point cloud. Explain two ways to fix this problem (½ point each).

Lesson 6.1

Explain in your own words the CSG operations needed to create a cube from a set of half-spaces. You may use a drawing if it helps.

Lesson 6.2

Describe the geometry that is being represented in this IFC snippet. Provide as much information as you can obtain from it.

```
#237=IFCEXTRUDEDAREASOLID(#236,#234,#230,6000.);
#238=IFCDIRECTION((1.,0.,0.));
#239=IFCDIRECTION((-1.,0.,1.));
#240=IFCCARTESIANPOINT((-2500.,0.,3000.));
#241=IFCAXIS2PLACEMENT3D(#240,#239,#238);
#242=IFCPLANE(#241);
#243=IFCHALFSPACESOLID(#242,.F.);
#244=IFCBOOLEANCLIPPINGRESULT(.DIFFERENCE.,#237,#243);
```

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