NORTHERN ARIZONA UNIVERSITY

Department of Mechanical Engineering
Modular Sterile Cleanroom
Logan Bennett
Michelle Borzick
Gia Neve
Aaron Reynoza
ME486C Section 1 Spring 2024

Reflection

• Project Management - Successes:

Throughout the 1st semester, Dr. Becker Cleanroom team was successful in many ways with respect to the project management and team communication.

- Created a final design that is ready to be purchased and modified.
- Communicated information in a timely manner.
- Adapted to changes from the client without many complications.
- Projected cost analyses stayed within budget for the whole project.
- Completed all group assignments on time with high quality.

• Project Management - Room for Improvements:

While the group has been very successful with the Capstone Project, there are some areas that can be improved for the next semester:

- Completing presentations, the day before the deadline instead of hours before.
- Coordinating the availability of each teammate better.
- Practicing presentations more frequently.

• Project Management - Action Items:

- For the first issue, it can be solved by setting a date when all team members must have their assigned sections completed.
- The second issue can be improved by creating a calendar labeled with the groups availability which will help visualize the scheduling.
- For the last issue, it can be solved by setting a practice presentation date for the group to practice, which we did for the first presentation.

• Remaining Design Efforts:

- All design efforts have been completed.

Gantt Chart

Located below in **Figure 1** is the current Gantt chart for spring semester of 2024. The major work/millstones to be completed during the first hardware status update are as follows:

- Framing material, wall material, and connectors to be purchased by week 2 and delivered by week 4.
- Begin manufacturing frame holes week 4.
- Begin the building phase by week 4.
- Have FFU's ordered during building phase.
- Building instructions 50-75% complete.

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Dr. Becker Project

Logan Bennett, Michelle Borzick, Gia Neve, Aaron Reynoza

Project start: Fri, 1/19/2024

Display week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Project Management				
Update Fall Assignment	All	100%	1/17/24	1/19/24
Engineering Model Summary				
Top Level Design Summary		0%	1/19/24	1/26/24
Summary of Standards, Codes, Regulations		0%	1/19/24	1/26/24
Summary of Equations and Solutions		0%	1/19/24	1/26/24
Flow Charts/Diagrams		0%	1/19/24	1/26/24
Moving Forward		0%	1/19/24	1/26/24
Hardware Status Update 33%				
Order All Hardware	Gia	50%		2/5/24
Hole Manufacturing	Gia/Logan	0%		2/5/24
Hardware Status Update 67%				
Beams/Walls Assembled		0%		2/26/24
Draft of Poster				
Poster Draft		0%		3/25/24
Finalized Testing Plan				
Obtain Testing Equipment		0%		4/18/24
Finalized Testing Plan		0%		4/18/24
Hardware Status Update 100%				
Fans, Battery Assembled		0%		3/25/24
Schedule Certification	Michelle	0%		3/25/24
Final Poster and Powerpoint				
Final Poster		0%		4/8/24
Final Powerpoint		0%		4/8/24
Final CAD Package				
Complete CAD	Aaron	0%		4/8/24
Initial Testing Results				
Particle count, airflow testing complete	All	0%		4/8/24
Product Demo & Final Testing Results				
VR of Cleanroom	Gia	0%		4/15/24
Particle count, airflow testing complete		0%		4/15/24
Final Report				
Final Report		0%		4/17/24
Specification Sheet & Assembly Manual				
Specification Sheet & Assembly Manual	All	0%		4/23/24

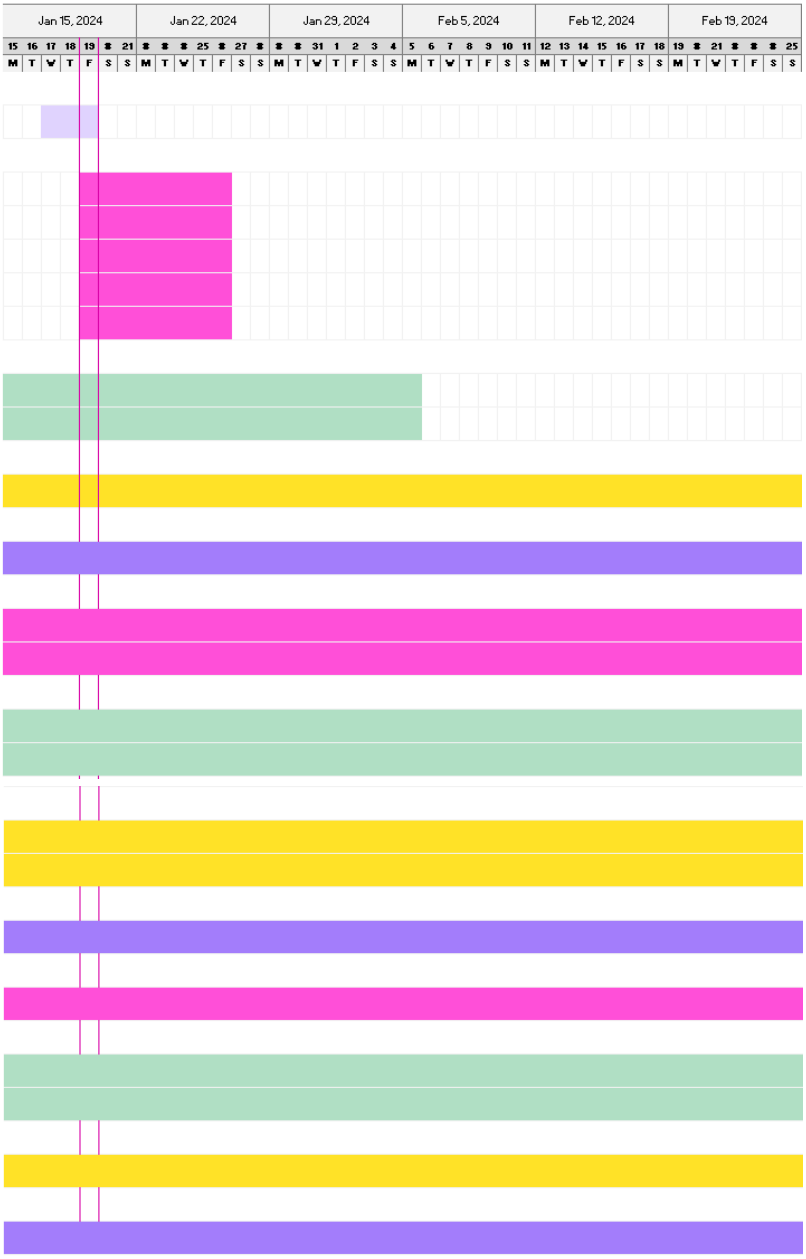

***Figure 1**: Spring 2024 Gantt Chart*

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Purchasing Plan

Regarding items already purchased, our team has only purchased material to build prototype 2. The items purchased can be seen below in **Table 1**.

Table 1: *Purchased BOM*

Purchasing BOM							
Part #	Part Name	Qty	Description	Image	Material	Vender	Cost ($)
13	Wood Beam	1	1.5" x 1.5" x 96"		Wood	Home Depot	$3.52
14	Duct Tape	1	1.88" x 55 yards		Polyethene, fabric, rubber-based adhesive	Home Depot	$8.97
15	Silicone Sealant	1	5.5 oz		Silicone	Home Depot	$7.98
16	Rubber Matting	1	8" x 18"		Rubber	Home Depot	$14.92
17	Removeable Caulk	1			Latex, silicone	Home Depot	$8.97
18	Sponge Stripping	1			Poly foam, adhesive	Home Depot	$5.93

Looking at the team's next steps for purchasing, **Table 2** illustrates items that plan to be purchased. The order of these items is as follows:

- Connectors for frames
- Ready tubes (Framing material)
- Polycarbonate sheets (Wall Material)
- FFUs

This list has been constructed based on fund availability. As of now, the team has 10K from the client, 1K from the class professor, and another 1K from the NAU Bioengineering Club. The team has access to the full fund amount as of end of week 1 spring semester.

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***Table 2**: Upcoming Purchases BOM*

Purchasing BOM													
Part #	Part Name	Qty	Description	Image	Material	Vender	Vender PO #	Lead Time	Part Status	Cost per Unit ($)	Unit Discount ($)	Estimated Tax/ Shipping	Cost ($)
1	Ready Tube	47	46"		Aluminum	80/20	9700	Unknown	Not purchased ye	$25.33	none		$1,190.51
2	Ready Tube	14	87"		Aluminum	80/20	9700	Unknown	Not purchased ye	$45.42	none		$635.88
3	Ready Tube	6	22.5"		Aluminum	80/20	9700	Unknown	Not purchased ye	$13.82	none		$82.92
4	Ready Tube	10	22"		Aluminum	80/20	9700	Unknown	Not purchased ye	$13.57	none	$563.73	$135.70
5	4-way Corner Connector	6	1.5" Connectors for frames		Nylon	Esto Connectors	545150	Unknown	Not purchased ye	$9.98	none	Unknown	$59.88
6	3-way Corner Connector	8	1.5" Connectors for frames		Nylon	Esto Connectors	533150	Unknown	Not purchased ye	$8.93	none	Unknown	$71.44
7	3-way Tee Connector	18	1.5" Connectors for frames		Nylon	Esto Connectors	532150	Unknown	Not purchased ye	$8.93	none	Unknown	$160.74
8	4-way Cross Connector	4	1.5" Connectors for frames		Nylon	Esto Connectors	544150	Unknown	Not purchased ye	$16.73	none	Unknown	$66.92
9	Straight Base Connector	20	1.5" Connectors for frames		Nylon	Esto Connectors	5323150	Unknown	Not purchased ye	$6.65	none	Unknown	$133.00
10	Clear Polycarbonate Sheet	31	1/16" X 48" X 96" Wall Matertial		Polycarbonate	Eplastics	PCCLR0.060AM48X96	Unknown	Not purchased ye	$60.27	none	$475.22	$1,868.37
11	Fan Filter Unit ; WhisperFlo	4	2'x4', HEPA, 120 V		Powder-Coated Stee	Terra Universal	6601-24-H	1-3 business days	Not purchased ye	$1,152.00	($115.00)		$4,148.00
12	Power Cord for Filter Unit	4	300V, 10A,MIN4 PL to 16AWG		Unknown	Terra Universal	6601-13	1-3 business days	Not purchased ye	$64.00	none	$956.37	$256.00
Total												$1,995.32	$8,809.36
Final Cost													

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Manufacturing Plan

At the end of Fall semester, the team had not manufactured nor outsourced any parts of the project. The current manufacturing plan starting spring semester is to drill holes into the Aluminum frame where the wall material will attach to the beams. This is to be completed by Logan Bennett and Gia Neve in the NAU machine shop. The expected lead time from start to finish is 1-2 weeks, depending on shop availability and the team's manufacturing skills. This information is detailed below in **Table 3**.

Table 3: *Manufacturing BOM*

Manufacturing BOM									
Part #	Part Name	Qty	Description	Image Location	Material	Manufacturer	Lead Time	Expected Finish	Manufacturing Location
1.1	46" Variant 1	1	Front: 1 hole at 23"	Appendix B.1	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
1.2	46" Variant 2	1	Top: 1 hole at 23", Front: 1 hole at 11", 34.75"	Appendix B.2	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
1.3	46" Variant 3	4	Top: 1 hole at 11.25", 35", Front: 1 hole at 2", 23", 44"	Appendix B.3	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
1.4	46" Variant 4	4	Top: 1 hole at 11", 34.75", Front: 1 hole at 2", 23", 44"	Appendix B.4	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
1.5	46" Variant 5	3	Top: 2 holes at 23"	Appendix B.5	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
2.2	87" Variant 2	8	Top: 2 holes at 2", 40.4", 78.8"	Appendix B.6	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
2.3	87" Variant 3	1	Top: 1 hole at 2", 40.4", 78.8", Front: 1 hole at 2.25", 40.65", 79.05"	Appendix B.7	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
2.4	87" Variant 4	3	Top: 1 hole at 2.25", 40.65", 79.05", Front: 1 hole at 1.85", 40.25", 78.65"	Appendix B.8	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
3.1	22.5" Variant 1	4	Front: 1 hole at 11.25"	Appendix B.9	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
3.2	22.5" Variant 2	22	Top: 2 holes at 11.25"	Appendix B.10	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
4.1	22" Variant 1	4	Bottom: 1 hole at 11"	Appendix B.11	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop
4.2	22" Variant 2	26	Top: 2 holes at 11"	Appendix B.12	Aluminum	Team	1-2 weeks	2/13/2024	NAU Machine Shop

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Appendix A: Final BOM

BOM														
Part #	Part Name	Qty	Description	Material	Purchased Vs Manufactured	Vender	Vender PO #	Manufacturer #	Lead Time	Part Status	Cost per Unit ($)	Unit Discount ($)	Tax/ Shipping	Cost ($)
1	Ready Tube	47	46"	Aluminum	Purchased	80/20	9700	N/A	Unknown	Not purchased yet	$25.33	none		$1,190.51
2	Ready Tube	14	87"	Aluminum	Purchased	80/20	9700	N/A	Unknown	Not purchased yet	$45.42	none		$635.88
3	Ready Tube	6	22.5"	Aluminum	Purchased	80/20	9700	N/A	Unknown	Not purchased yet	$13.82	none		$82.92
4	Ready Tube	10	22"	Aluminum	Purchased	80/20	9700	N/A	Unknown	Not purchased yet	$13.57	none	$563.73	$135.70
5	4-way Corner Connector	6	1.5" Connectors for frames	Nylon	Purchased	Esto Connectors	545150	N/A	Unknown	Not purchased yet	$9.98	none	Unknown	$59.88
6	3-way Corner Connector	8	1.5" Connectors for frames	Nylon	Purchased	Esto Connectors	533150	N/A	Unknown	Not purchased yet	$8.93	none	Unknown	$71.44
7	3-way Tee Connector	18	1.5" Connectors for frames	Nylon	Purchased	Esto Connectors	532150	N/A	Unknown	Not purchased yet	$8.93	none	Unknown	$160.74
8	4-way Cross Connector	4	1.5" Connectors for frames	Nylon	Purchased	Esto Connectors	544150	N/A	Unknown	Not purchased yet	$16.73	none	Unknown	$66.92
9	Straight Base Connector	20	1.5" Connectors for frames	Nylon	Purchased	Esto Connectors	5323150	N/A	Unknown	Not purchased yet	$6.65	none	Unknown	$133.00
10	Clear Polycarbonate Sheet	31	1/16" X 48" X 96" Wall Matertial	Polycarbonate	Purchased	Eplastics	PCCLR0.060AM48X96	N/A	Unknown	Not purchased yet	$60.27	none	$475.22	$1,868.37
11	Fan Filter Unit ; WhisperFlow	4	2'x4', HEPA, 120 V	Powder-Coated Steel	Purchased	Terra Universal	6601-24-H	N/A	1-3 business days	Not purchased yet	$1,152.00	($115.00)		$4,148.00
12	Power Cord for Filter Unit	4	300V, 10A,MIN4 PL to 16AWG	Unknown	Purchased	Terra Universal	6601-13	N/A	1-3 business days	Not purchased yet	$64.00	none	$956.37	$256.00
13	Manufacturing holes	200	Drilling holes into frame for wall material attachment. Will be completed by our team in the NAU machine shop		Manufactured				1-2 weeks	starting spring semester				$0.00
14	prototype 2	20	A Wooden cube comprised of 4 different gasketing materials purchased from home depot	duct tape, caulk, shelf liners, window sealer	Purchased	home depot			2 days	completed				$109.32
Total													$1,995.32	$8,918.68
Final Cost														$10,914.00

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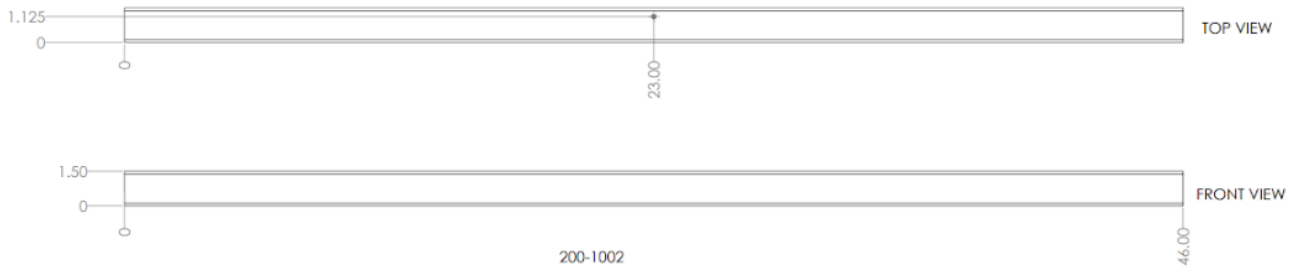
Appendix B: CAD of Beams

B.1



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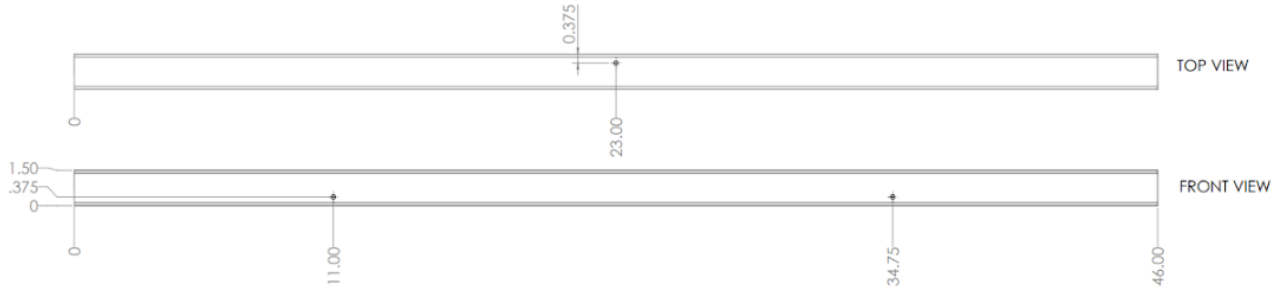

B.3

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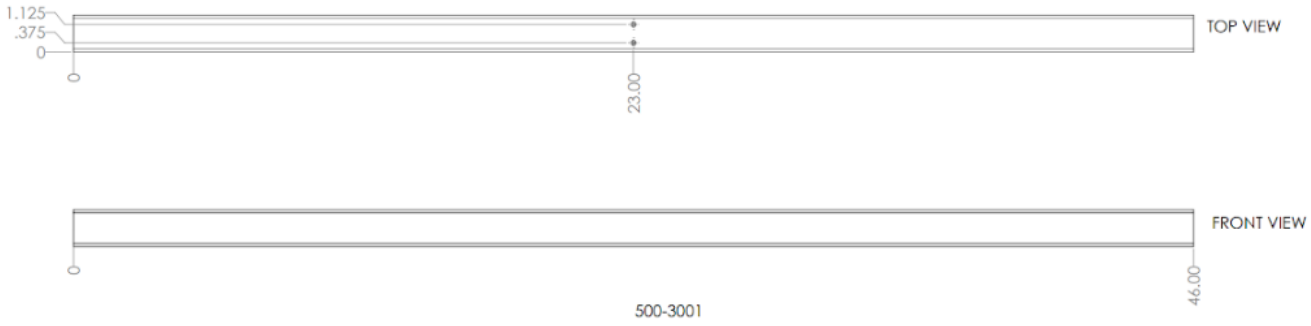
B.4

B.5



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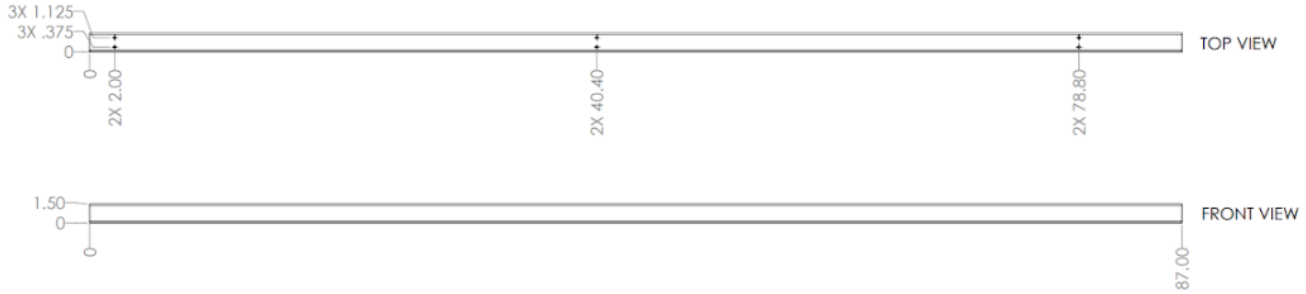
B.6



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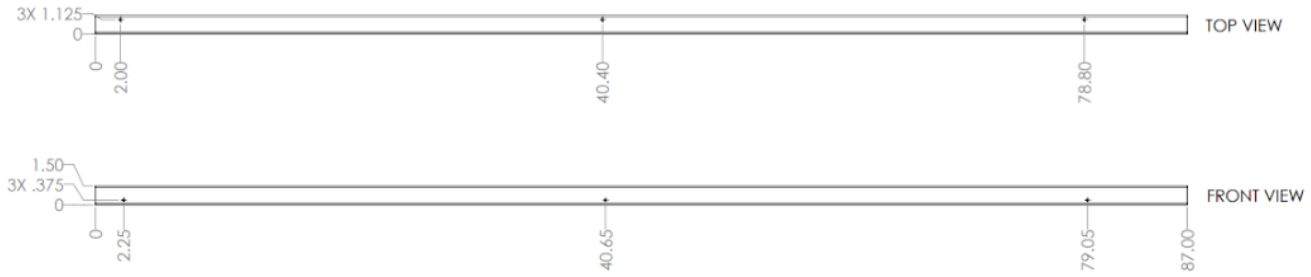
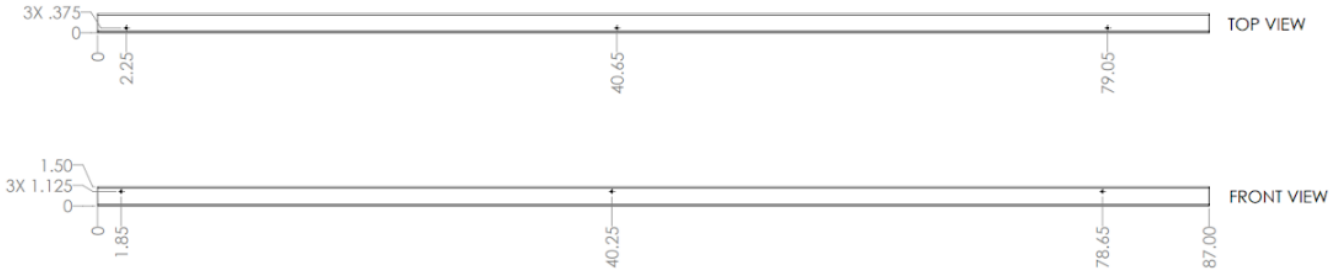
B.7



B.8



B.9

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B.10

B.11

B.12