GYRODOS ROBOTICS "SECTION X" Aptitude Test
FULL MARK: 40 (70) ~ 47 (82.25) MARKS (A + B1/2/3/4/5) 50 (87.5) MARKS (A + B6)
General Instructions :

1. This paper consists of **SEVEN** sections, Section A (Basic Robotics), Section B1 (Hardware - Mechanical Engineering), Section B2 (Hardware - Electrical Engineering) Section B3 (Software - Coding & Logic), Section B4 (Control - Usage of Robots), Section B5 (Presentation - Design Skills), and Section B6 (Advanced Integrated Tasks). Answer in the correct **GOOGLE FORM** provided for each section. Any answer on this Question Paper, the Useful Formulae List, or the Data File will **NOT** be marked.

2. Section A carries 15 marks, Section B1 carries 16 marks, Section B2 carries 16 marks, Section B3 carries 15 marks, Section B4 carries 13 marks, Section B5 carries 12 marks, and Section B6 carries 35 marks. Your score will be multiplied by a factor of **7/4** (1.75x) for fair comparison.

3. You should complete Section A, plus attempt either **TWO** of Section B1, B2, B3, B4 and B5 OR Section B6 alone. Your chosen elective will determine the departments you will be assigned to. More explained on Page 4.

4. Try your best to answer **all** the questions in your selected part of the Google Form. Creativity may bring extra marks.

5. The total time for this selection test is 90 minutes. It is advised that you should allocate your time according to the length and difficulty of each section.

6. Some or all tasks in your chosen section will require the use of the Data File. If you damage or deface the Data File, you may not be able to complete some tasks and we will not give you a new one.

7. If you are caught using any AI tools (e.g. ChatGPT, Claude, Gemini, o3, etc.), you **WILL** face mark deduction and/or disqualification for the test. Like seriously, we know whether an answer is AI or not and we **have ways to check**. It would also not be in your best interest to rely on AI to solve your engineering problems, since LLMs cannot solve everything and definitely not our special cases.

8. If any diagrams are unclear, please ask your nearest invigilator to show the relevant image.

P.S. Congrats for the courage to take Section X! You have a higher chance of getting into the MAIN TEAM compared to those who take the normal paper (**as your total mark is higher**). Go all out for this paper!!

LA SALLE COLLEGE ROBOTICS TEAM APTITUDE TEST - QUESTION PAPER FOR A, B1-5 and B6

SECTION A: BASIC ROBOTICS.
Instructions: This part MUST be answered no matter which elective paper you wish to take. Choose the best answer for each Multiple-Choice question.

Q1. A byte has 8 bits. How many bits are in 1 megabyte?
A. 8 B. 8000 C. 8192 D. 8000000

Q2. Which of the following is a valid value in a “Float” data type?
A. {4.2, 0.69, 6.7} B. 2147483647000 C. TRUE D. “6.02×10^23”

Q3. Which of the following can be used to directly measure distance to an object?
A. Gyroscope B. Ultrasonic sensor C. Colour sensor D. Piezometer

Q4. Which unit is used as a typical output of a wheel encoder?
A. m/s (meters per second) B. ° (Degrees)
C. N m (Newton metre) D. kJ (Kilojoule)

Q5. Which colour of electric wire is usually representing the Positive or Live wire?
A. Blue B. Green C. Red D. Black

Q6. In a circuit, the current only flows when…
A. The circuit is open B. The circuit is closed
C. The circuit is in parallel D. The power source is Direct Current (DC).

Q7. Which part of a robot gives Graphical information to the user?
A. Camera B. Microcontroller C. Relay D. Servo motor

Q8. In block coding, a “Repeat 10” function is an example of…
A. A loop B. A variable C. A sensor D. A condition

Q9. An “if-else” function makes a robot…
A. Do everything twice B. Choose between two actions based on a condition
C. Repeat the program indefinitely D. Stop the program

Q10. Which of the following pins CAN one apply an `analogWrite()` function to on an Arduino board?
A. AREF (Analog Reference) pin B. PWM (Pulse Width Modulation) pin
C. SCL (Serial Data Clock) pin D. TX0 (Transmit 0, Default UART) pin

Q11. Why should you use comments in code?
A. To tell the AI program what it is about B. To make the robot move faster
C. To reduce the program’s memory use D. To document what each function does

Q12. Why should we add a fuse to a circuit?
A. To increase its maximum rated voltage B. To reduce the current for the output device
C. To protect the circuit from overloading D. To make the power source waterproof

Q13. If a wheel is running anticlockwise but you need it to run clockwise, what is the best solution?
A. Invert the +5V and GND lines B. Invert the motor signal in the code
C. Install the motor in the opposite direction D. Use an idler gear to invert the motor’s output

Q14. Why should output devices (e.g. motors on a robot) NOT be wired in SERIES but in PARALLEL?
A. If a motor breaks down in a series network, everything will be unusable.
B. Motors wired in serial consume more electricity than motors wired in parallel.
C. It is harder to replace a motor wired in series than in parallel.
D. It is more expensive to find a power source for a circuit in series than in parallel.

Q15. Suggest why (a large amount of) AA batteries cannot be used to power a vehicle.
A. The final voltage will only be 1.5V
B. The AA batteries will run dry very soon.
C. The current will not be enough to start the car.
D. The AA batteries cannot be recharged at all.

- - - - - END OF SECTION A - - - - -
- - - - - PROCEED TO SECTION B - - - - -

SECTION B - ELECTIVE SKILLS

Section B consists of SIX sections, numbered B1 to B6.
The skills tested, difficulty estimated and suggested topics to familiarize yourself with are listed as follows, with different amounts of maximum marks for each skill.

B1 - 16 MARKS - ★★★★★☆ Hardware - Mechanical Engineering
Qualifies for **ME & 3D Design** departments with priority.
Topics: Material properties, Center of Gravity, Vectors, Buoyancy

B2 - 16 MARKS - ★★★★★☆ Hardware - Electrical Engineering
Qualifies for the **EE** department with priority.
Topics: Ohm's Law, Fuses, Kinematics, Efficiency

B3 - 15 MARKS - ★★★★☆☆ Software - Coding
Qualifies for the **Coding** department with priority.
Topics: Python, Debugging, Test Cases

B4 - 13 MARKS - ★★★☆☆☆ Control - Usage of Robots
Qualifies for the **Quality & Safety** Department with priority.
Topics: Sensor Properties, Input and Output Devices,

B5 - 12 MARKS - ★★☆☆☆☆ Presentation - Design Skills
Qualifies for the **Documentation** Department with priority.
Topics: SID Diagrams, Pitching Skills

B6 - 35 MARKS - ★★★★★★ Advanced Integrated Tasks
Qualifies for **ANY** department **(including Admin) with highest priority.**
Topics: Kinematics, Current, Material properties, Interface operation, Sensors, Troubleshooting

For Section B, you should choose to do ONE of the following:

1. Complete ANY TWO sections in B1 through B5.
(Note the maximum score will vary depending on which section you chose.)

2. Complete Section B6.
(This section is the most challenging, but yields the most marks possible.)

Please indicate on the Google Form your choice before proceeding. You may look at the questions before making your choice on which elective section to take.

GENERAL NOTE:

DO NOT write any unit for your calculations unless specifically asked to.
CORRECT your answer to 3 significant figures, unless specifically asked not to.

LA SALLE COLLEGE ROBOTICS TEAM APTITUDE TEST - QUESTION PAPER FOR A, B1-5 and B6

SECTION B1: HARDWARE - Mechanical Engineering (16M)

Q1 (3M, 1M@)
Basic material knowledge

(a) Compare the pros and cons of using carbon fibre tubes and CNC machined aluminium alloy (6061-T6) for the main body of the Gyrodos G2.2 ROV. Suggest ONE pro and con for each at least.
(b) Suggest a material and method for creating the coverings lids of the watertight compartment.
(c) Suggest a material for the claw and a possible safety concern to address.

Q2 (4M, 1M@)
Your Materials Engineer has compiled a table in the Data File of the properties of different materials that can be potentially used in the construction of Gyrodos Robotics' equipment. Find the best material for…
2i) [1M] Building the outer frame of Gyrodos G2.2, which will contact the ground directly and mount thrusters.
2ii) [1M] Building the robotic claw, which has to grab different objects to manipulate them. (NOT the arm)
2iii) [1M] Building the task objects, which are pre-built modules put in the water for the ROV to do tasks on.
2iv) [1M] Building the waterproof housing, which holds the voltage monitor and is a cylinder.

Q3 (9M, 5M + 4M)
Suppose the Gyrodos G2.0 has a circular ring shaped body. Four horizontal and two vertical thrusters at 500g each are used for horizontal movement, and two claws are needed. The watertight compartment is mounted in the center of the body. It is given that the radius of the body is 30cm. Let O be the centre of the ring body, and all items be considered as point masses.
Take forward(North, 0°) be positive on the Y-axis and right(East) be positive on the X-axis.

a) The four thrusters are mounted at 45°, 135°, 225° and 315°. The two claws are mounted at the front of the body, equidistant to the center and are mounted at 30° and 330° respectively. The claw on the right weighs 610g and the claw on the left weighs 432g. The ring body weighs 1000g and the control module weighs 800g. Assume the two vertical thrusters are mounted negligibly close to O along the X-axis.

ai) Calculate the c.g. relative to O.

aii) Suggest where and what weight of ballast should be added to the body. Answer in true bearing and take the forward direction as north. Remember that piece of ballast cannot be floating in the middle of nothing and must be attached to a solid part (i.e. somewhere on the ring)

b) Terence was in charge of Safety and has decided to add a total of 1000g of ballast to make the craft level. Now the craft is found to be too dense when submerged in water and lacks buoyancy. The two upward Thrusters provide 20N of thrust each.

bi) Find the average density of the craft, given that the volume of the craft with ballast is 3500cm^3.

bii) Hence, find the idle buoyant force in Newtons.

biii) Hence, find the minimum volume of foam of density 0.04g/cm^3 needed to be attached for the craft to not sink with zero thruster input.

End of Section B1

SECTION B2: HARDWARE - Electrical Engineering (16M)

Q1 - (4 Marks, 1M@)
Fundamental Electrical Calculations. Solve the questions below:

1a) Calculate the energy used if a motor runs at 12V and 5A for 30 minutes in watt-hours.
1b) There are two 20Ω resistors connected in parallel.
    1bi) Find the total resistance of the circuit.
    1bii) If a 12V power source is connected to the circuit, find the current.
1c) Two motors of 12A max loading are connected to a 12V power supply. Select the appropriate WAYTEK model.

Q2 - (4 Marks, 2M@)
In 2024, Gyrodos Robotics used ROVMaker “Sea Scooter” Thrusters. Gyrodos Robotics’ craft at that time, the **Gyrodos G2.0**, used six Sea Scooter thrusters at that time and ran them at **12V**. At maximum normal loading (when going full speed forward), four out of the six thrusters would fire at the same time. Each of the four thrusters were mounted at 45 degrees to the direction of movement (forwards).
> Assume Thrust (unit: kgf) scales with Power by **$T \propto P^{(2/3)}$**

2a) Calculate the percentage efficiency of the setup towards producing forward motion (Round to 3 s.f.).
2b) The Gyrodos G2.0 weighs 65N. Calculate the maximum forward acceleration of the ROV. (Round to 3s.f.)

Q3 - (8 Marks, 2M@)
Gyrodos G2.2 has 8 thrusters, and each thruster has 57.735% ($1/\sqrt{3}$) efficiency when the ROV is going in ANY direction. All thrusters are used in the positive direction when Gyrodos G2.2 is moving forwards. Gyrodos G2.2 weighs 108N, and runs the Sea Scooter thrusters at **12V**.

3a) According to the power chart, suggest the most appropriate Internal Value (IV) for the LUCARIO System such that Gyrodos G2.2 will have the closest acceleration to Gyrodos G2.0.
3b) Calculate the maximum vertical acceleration of Gyrodos G2.2.
3c) Calculate the Full Load Amps (FLA) of Gyrodos G2.2. (Ignore the loading of other devices).
3d) Terence was in charge of Safety in 2024 and used a 15A fuse for Gyrodos 2.0. He claims that the new system can still use the 15A fuse to meet the increased power demand. Is he correct? If not, which model of fuse should Terence be using? (Ignore the loading of other devices)

End of Section B2

SECTION B3: SOFTWARE - Coding & Logic (15M)
Please check the Data File for the code used in Section B3. Based on the code, answer the following questions. `Courier` font represents code.

MCQ (B3.1-B3.6, 6M@1): Choose the *best* answer.

B3.1 What is the purpose of the following lines 19-20?

```
19  for i in range(0,len(eq)):
20    symbList.append(eq[i])
```

A. To authorize whether the input is valid.
B. To add each character of the string input to a list.
C. To remove all items from a list.
D. To declare a variable storing the input.

B3.2 What is the objective of the function `renewCalc` (lines 65-70)?

A. To restart the calculation in case it runs into an error.
B. To continue onto the next operation in the same calculation.
C. To open a new line in the output.
D. To replace the calculated part by the output after operation.

B3.3 Which of the following is a valid input?

A. `2^2+3^(1+2(2))`
B. `2**2+3**(1+2*2)`
C. `2^2+3^[1+2*2]`
D. `2**2+3**[1+2(2)]`

B3.4 Which of the following is the output if the input is "`(-47+13(2*7-5)-6)^0.5`"?

A.
```
Answer: 8
```

B.
```
(-47+13(2*7-5)-6)^0.5
=8
Answer: 8
```

C.
```
(-47+13(2*7-5)-6)^0.5
=(-47+13*(14-5)-6)^0.5
=(-47+13*9-6)^0.5
=(-47+117-6)^0.5
=(70-6)^0.5
=64^0.5
=8
Answer: 8
```

D.
```
(-47+13(2*7-5)-6)^0.5
=(-47+13(14-5)-6)^0.5
=(-47+13(9)-6)^0.5
=(-47+117-6)^0.5
=(70-6)^0.5
=64^0.5
=8
Answer: 8
```

B3.5 This code has some limitations. Which of the following inputs does **NOT** give a correct output?

A. `-3^2`

B. `-3(2)`

C. `(-3)^2`

D. `-(2+1)^2`

B3.6 If the calculated result is larger than `9999999999999998`, the function `basicOptor` outputs the result is "`out of range`". What is the last line of the output if the input is "`2^100`"?

A. `Invalid input`

B. `Answer: out of range`

C. `out of range`

D. An error occurs.

LQ (B3.7-B3.9, 9M): Write your answers in complete sentences.

B3.7 Refer to the for-loop in lines 26-31.

```
26    for k in reversed(range(0, len(symbA))):
27      if "+" in optorData and symbA[k] == "-":
28        continue
29      if not symbA[k].isdigit() and symbA[k] != ".":
30        symbA = symbA[k + 1:]
31        break
```

Briefly explain the role of the `reversed` keyword in ensuring the code runs properly. (2M)

B3.8 Suggest a single-character addition to the string "`2+3`" as the input, which causes the last line of the output to be "`Invalid input`". State which error occurs and explain why. (3M)

B3.9 Determine whether the following statements are true or false. Explain your choice. (4M@2)

(a) Entering "`hello world`" as input outputs "`Invalid input`".

(b) The string in the variable `Calculation` does **NOT** change throughout the code.

End of Section B3

SECTION B4: CONTROL - Usage of Robots (13M)

Q1. (2 Marks)
Your robot has to inspect the network as shown in Image 1 of the Data File by using each black line **exactly ONCE**. Suggest the **shortest** additional distance by denoting the extra path (that is currently **NOT** marked by a black line) that the robot has to take to complete its task. Format should be in the [point]-[point] format (e.g. A-E)

Q2. (2 Marks, 0.5M@)
Your line-following robot has a Left and a Right colour sensor as shown in Image 2 of the Data File. The sensors return a value of 0 if it detects white colour, and a value of 1 if it detects black colour. Complete the following Truth table.

Left Sensor	Right Sensor	Left Motor	Right Motor
0	0	Backward	(2a)
0	1	(2b)	No Movement
1	0	(2c)	Forward
1	1	Forward	(2d)

Q3. (3 Marks, 1M@)
Gyrodos Robotics's inventory has multiple input devices:

Ultrasonic Sensor	Hall Sensor	Piezometer
Rotary Potentiometer	Infrared Sensor	Pressure Sensor
Gyroscope	GPS Detector	Temperature Sensor

3a) Which sensor would be the most reliable to measure water depth?
3b) Which sensors would fail to produce meaningful input underwater?
3c) Which brand should the ultrasonic sensor be from, if it is to be used to measure distance underwater?

Q4. (2 Marks, 1@)
The Gyrodos G2.2 ROV uses a PID controller to maintain its position against water currents.

4a) What does PID stand for?
4b) If a ROV consistently overshoots its target position and oscillates, which PID parameter should be reduced?

Q5. (4 Marks, 2M@)
Gyrodos Robotics' 2024 robot, the Gyrodos 2.0, is shown in Image 4 of the Data File. Comment on the waterproofing methods taken by the safety team.

5a) Smearing the end connectors and O-ring with Vaseline (an oily jelly)
5b) Filling the compartment housing (which has the electronics board) with water-absorbing cotton balls

End of Section B4

SECTION B5: PRESENTATION - Design Skills (12M)

The skills of presenting our product/robot and pitching ideas are essential. In order to be the best, we need not only a good machine but also fabulous descriptions.

Q1. (6M)
In the documentation, there is a part where a SID (System Interconnection Diagram) is required. Read the following description carefully:

An SID (System Integration Diagram) shows how the major subsystems and components of the Gyrodos G2.2 connect and communicate with each other. Start by identifying the three main sections: surface control, tether, and ROV. Within each section, create boxes for the major subsystems (like thrusters, sensors, power supply, communication modules). Then draw lines showing how power, and data/control signals flow between these components. Focus on the functional relationships rather than physical wiring details. We will explain how the Gyrodos G2.2 works below:

On the Gyrodos G2.2, there are three major parts, the shoreside control station, the tether, and the ROV. We use a 12V power supply on the shoreside, connected to the ROV through the tether. It should be noted that we need to use an appropriate fuse for protection. The LUCARIO interface is on a computer, and connected to a set of Joy-cons for ROV navigation. The computer then sends signals to an Arduino Mega board, which is connected to another Arduino Mega board on board of the craft. On the craft, we have 8 thrusters, running on 12V power. There is also an active gripper (claw), three servo motors for rotating the claw, a temperature sensor, a pressure sensor, and a gyroscope, which all runs on 5V power. For the camera system, the Gyrodos G2.2 has five cameras. One is located inside the housing and is a Power over Ethernet camera, transmitting to the computer's LUCARIO interface. The four others are mounted externally on the frame itself, and use RCA cables to transmit to a separate display which is battery powered.

It should be noted that connection lines should have arrowed heads indicating the direction of transfer, and different types of lines should have different colours. All components and indicators MUST be labelled. The correct Fuse Size should also be included (If you take section B2 and finished Q3d, write the value; otherwise, put down "x A" and we will not deduct any points). Additional components should be added appropriately to ensure electrical safety.

Please follow the description above and draw the correct SID in Google Drawings (or any other drawing software) and submit the .PNG file.

Q2. (6M)
Presentations are a required part in the MATE ROV competition. In order to give the judges a good image, some details must be excluded or omitted while excellency should be focused. Suppose you are now working on the presentation of the part where we share what lessons we learnt. The following are some events (fictional) that occurred during the process, and you should summarize, edit, and write a speech of no less than 200 words to give the best presentation. Please bear in mind that the overall message should be positive, somewhat upbeat, and give the team a good public image.

List of events/incidents: (Fictional)

- First year in the competition
- A late start in development, other teams months ahead of us.
- Advanced and detailed design featuring a more effective layout than our peers.
- Some teammates caught gaming while the rest are working.

- The breakdown of two thrusters because some EE engineers calculated the wrong required fuse level.
- Lack of a drafted diagram or CAD-based structural analysis.
- The innovation in the design of the hull received recognition from teachers.
- A lot of people didn't show up at meetings without filing an excuse.
- Teammates are eager to learn CAD design.
- Laser-cutted components shattered due to bad design. Unfit dimensions for thruster mounts.
- Unable to test since potential risk of leakage. But teammates are eager to set up a testing environment and be divers underwater.
- Failure to complete a working prototype before the deadline.
- Teammates are shy to communicate across departments as they weren't that acquainted. The weird usernames on the Discord server makes it even harder to identify people.
- Over-relying on the mentor's previous experience in MATE ROV.

Please write your speech. Be aware the public image of the team should remain good, and the message should be positive. Write no less than 200 words.

End of Section B5

Section B6: Advanced Integrated Skills
Note: In case you haven't read the instructions, you DO NOT need to complete anything from B1 to B5 if you take B6. However, you still need to complete Section **A**.

The situations presented in B6 are simulated data. It has been designed to emulate the real-life performance of the future Gyrodos G2.2, and discrepancies regarding the real-life performance of the ROV may occur.
Refer to the Data File and the described Situation, and answer the following questions.

YOU WILL GET A LOT OF QUESTIONS WRONG IF YOU DO NOT READ THE SITUATION CAREFULLY AND/OR NOT USE THE DATA FILE

Situation B6. (35 Marks)

You are in charge of the Gyrodos G2.2 in an underwater robotics competition. Refer to the physical hand-out Data File and Useful Formulae List for all relevant information.
CORRECT ANSWERS TO 3 S.F. UNLESS OTHERWISE ASKED, ELSE GOOGLE FORMS MARK WRONG

B6-1 (15M)
In the planning phase, you and your committee are in charge of designing a more efficient ROV than last year's entries.

1a) **[11M]** Your rival, Team Overdefined, splits their thrusters into two sets: Four horizontal thrusters mounted at 30 degrees to the forward direction (thus achieving 86.6% efficiency per thruster), and four more thrusters mounted vertically (to provide up/down movement).
One of your engineers proposes a new layout (Fig. 2). All eight thrusters are mounted at the corners, and each one has 1/√3 of its regular efficiency when moving in ANY of the six directions (up/down/front/back/left/right).
> Assume Thrust (unit: kgf) scales with Power by **T∝P^(2/3)**
> Ignore water resistance for 1ai to 1aiii.

1ai) [2M] If Team Overdefined and Gyrodos Robotics use the same thrusters **at 12V** and operate them at the same power, calculate the percent that Gyrodos Robotics' layout is more efficient than Team Overdefined's.
1aii) [2M] Gyrodos Robotics' Gyrodos G2.2 weighs 108N. Find the theoretical maximum acceleration.
1aiii) [2M] Find the theoretical maximum acceleration if False Swipe Mode is on, which limits the thrusters to an Internal Value (IV) of ±128.
1aiv) [2M] The drag coefficient of G2.2 is 1.2, and it has 0.2m^2 of surface area. Find the maximum vertical ascending speed of Gyrodos G2.2 in cm per minute, if we assume that Gyrodos G2.2 is **Neutrally Buoyant.**
1av) [3M] Terence was in charge of Safety in 2024 and used a 15A fuse for Gyrodos 2.0. He claims that the new system can still use the 15A fuse to meet the increased power demand. Is he correct? If not, which model of fuse should Terence be using? (Ignore the loading of other devices onboard.)

1b) **[4M]** Your Materials Engineer has compiled a table of the properties of different materials that can be potentially used in the construction of Gyrodos Robotics' equipment. Find the best material for…
1bi) [1M] Building the outer frame of Gyrodos G2.2, which will contact the ground directly and mount thrusters.
1bii) [1M] Building the robotic claw, which has to grab different objects to manipulate them. (NOT the arm)
1biii) [1M] Building the task objects, which are pre-built modules put in the water for the ROV to do tasks on.
1biv) [1M] Building the waterproof housing, which holds the voltage monitor and is a cylinder.

B6-2 (20M)
At 10:31:15, your teammates put the Gyrodos G2.2 into the water and your mission starts. At 10:31:35 (0 minutes, 20 seconds) into the run, you notice something has gone wrong with the Gyrodos. Refer to the screenshots of the “LUCARIO” Interface, the Data File and answer the following questions.

2a) [**3M**] The Gyrodos G2.2’s claw uses a master-slave setting with a Master Hand on the dockside control panel. You move the claw in the water by moving the 1:1 claw onshore, and it will immediately follow. However, there has been a “Servo Overload Error” on the dashboard.

2ai) [1M] Find the potentiometer(s) with an error; and
2aii) [2M, 1M@] Outline the steps to resolve the issue by typing in the correct command sequence, separating the commands with commas. Type “N/A” (without the quotation marks) if there is no command needed.

2b) [**7M**] The Gyrodos G2.2 model is equipped with an array of sensors.

2bi) [2M] Which measurement sensor on the dashboard MUST be faulty? Correct that measurement sensor’s reading by typing in the correct value at 10:31:35 (correct to 3 s.f.) **WITH UNIT.**
2bii) [4M, 1M@] Match the BEST information source with the four kinematics measurements (Speed, Vertical Speed, Depth, Displacement)
2biii) [1M] Hence, suggest which measurement is the most inaccurate.

2c) [**10M**] Gyrodos G2.2 is having some thruster issues too. With regard to the motor chart, key component positions, and the guide to using the onboard artificial horizon, answer the following questions. Currently, you have set the command to `/FWRD [200]`.

2ci) [1M] Describe the current pitching and rolling direction of Gyrodos G2.2.
2cii) [1M] Which thruster MUST have broken down?
2ciii) [2M] You have managed to bring Gyrodos G2.2 to level orientation. Outline the steps to make it be able to go straight forward, starting by shutting down the faulty thruster, separating the commands with commas. Type “N/A” (without the quotation marks) if there is no command needed.
2civ) [4M, 1M@] Terence, who is in charge of Safety, has decided to shut down Thrusters 5,6,7 and 8. With reference to the structure of Gyrodos G2.2, decide whether or not these motions are still possible.

- 2civ-1) Moving backwards
- 2civ-2) Directly rising upwards
- 2civ-3) Moving sideways
- 2civ-4) Rotating sideways in place

2cv) [2M] Find the **MINIMUM** number of thrusters that need to be turned on in order to make Gyrodos G2.2 move forwards. Hence, suggest a possible set of the thrusters. Answer with the thruster numbers, separated by commas (e.g. 5,2,1,8)

End of Section B6

End of Paper