AZEOTROPY 2019

ChemRover Problem Statement

Deadline for abstract submission – 11:59 pm, 28th January, 2019

INTRODUCTION

We all are aware of the fact that the demand for energy has increased manifold over the years, which has increased the burden on the conventional sources of energy. These conventional sources are present in limited amounts in nature. It is therefore of utmost importance that we start looking for sustainable sources of energy, which would be capable of fulfilling our present needs and would also cater to the future requirements.

PROBLEM STATEMENT

The objective of the competition is to design a chemically powered car which is capable of travelling along a well defined path in a specified amount of time. The design should consist of three mechanisms, namely the **Start, Propagation** and **Stopping Mechanisms.**

Each of the three mechanisms should be powered using only non conventional sources, which might consist of chemical, physical and thermodynamic changes, but **no manufactured electrical sources.** There are two available tracks – **A straight track and a curved track**. You have to choose one of the two tracks and design your model accordingly.

MODEL SPECIFICATIONS

1. **Dimensions of the model** – The model should comfortably fit into a box of dimensions **40cm*30cm*30cm**.
2. **Cost Limitations** – The expenditure on the design **should not exceed INR 6,000**.
3. **Payload** – The model is expected to carry a payload of **100ml water**. The model should have the provision of accommodating the payload.

TRACK STRUCTURE

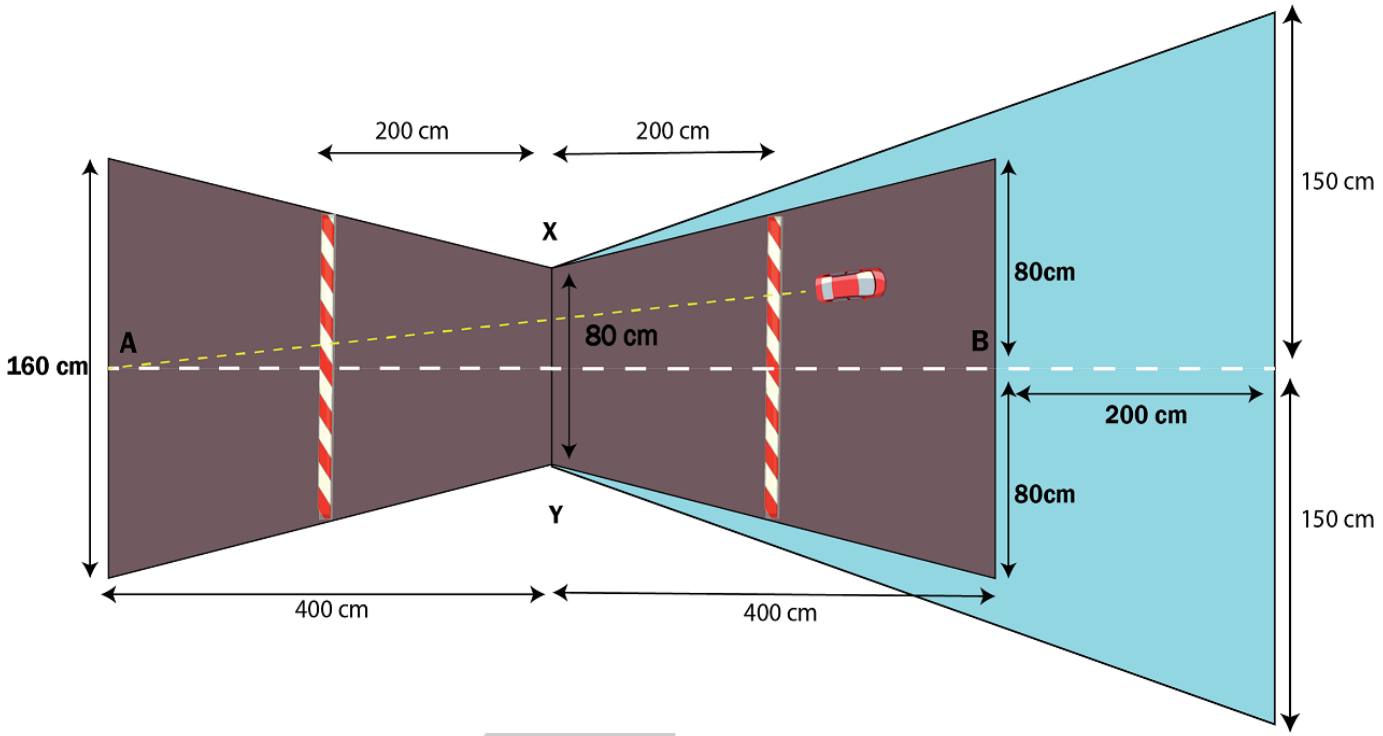


FIGURE 1

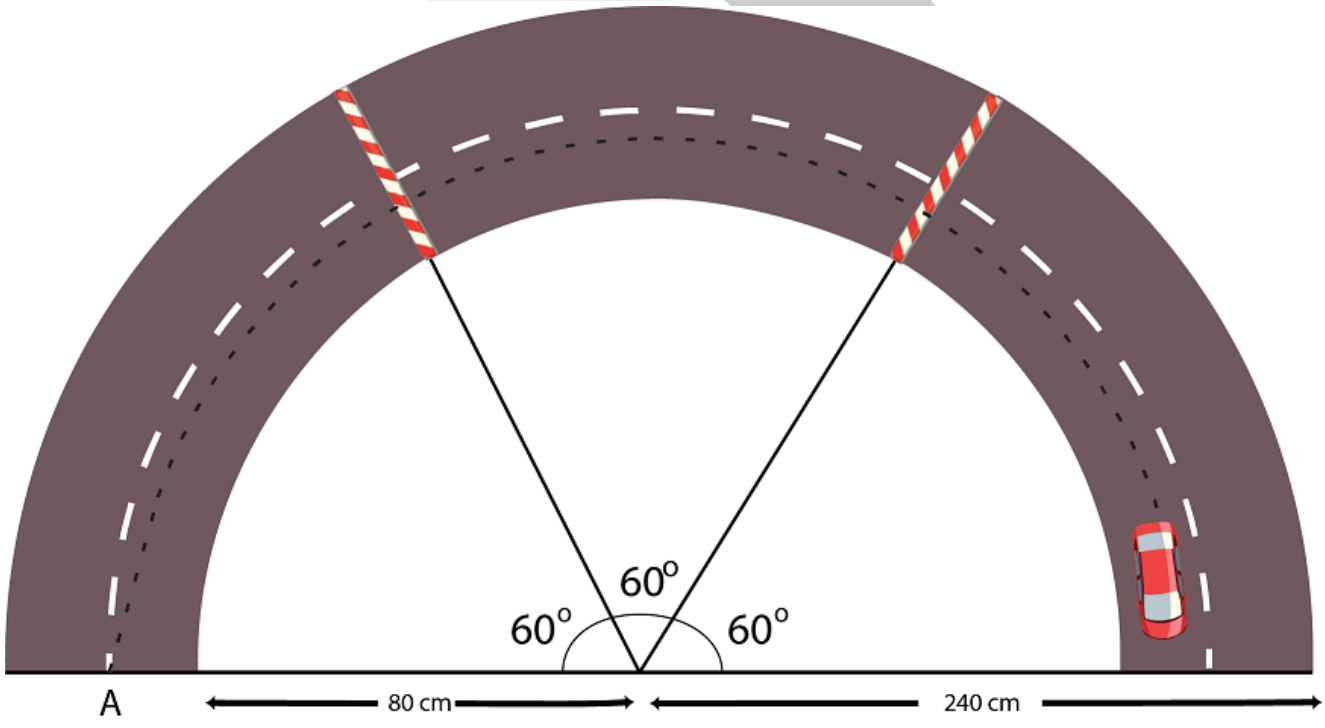


FIGURE 2

SOME INFORMATION ABOUT THE TRACK STRUCTURE

The central line is defined as the **middle line** in the figures that divides the track into two equal parts. It is labelled as a **dotted white line** in the figures.

1) The straight track will be **800 cm** in length, marked in **grey**. As can be seen from Figure 1, the track would be tapered with two trapezoidal tracks combining at the shorter parallel edge to form a single track. The track is divided into 3 regions**,** and there is also an **Extra Region** marked in **blue**, the significance of which will be explained later. The outer width of the track is 160 cm, while the inner width at the intersection is 80 cm. The cars will start from point A on the central line and will try to complete the track. There will be **two obstacles** in the form of small cylindrical speed breakers (of approximate height 1-2cm), both at distances of 200 cm from the middle intersection line XY of the track. For better understanding of the track structure, refer to the figure **Figure 1.**

2) The curved track will be in the form of a semicircle of internal radius 80 cm and external radius 240 cm, with a **mean radius of 160 cm**, thus making the mean track length to be approximately **500 cm**. The cars will start from point A and will try to complete the track of width 160 cm. There will be **two obstacles** in the track in the form of small speed breakers (of approximate height 1-2cm). One obstacle will be at an angle of **60^{o}** and the other at an angle of **120^{o}**. For better understanding of the track, refer to the figure **Figure 2.**

JUDGING CRITERIA

1) Abstract submission (Weightage-**15%**)
2) Innovativeness of the model (Weightage-**10%**)

   Innovativeness includes using techniques **other than** the following conventional methods:
   - Aluminium Air Reaction, Thermoelectric Generator (TEG) and Zinc Air Battery for the starting mechanism.
   - Iodine Clock Reaction for stopping mechanism.
   - Use of Microprocessors like Arduino, R-Pi, etc.

   Shortlisted models should use techniques different from the ones mentioned above (and must not violate rules and regulations), so as to get a good score for innovativeness.
3) Performance of the model on the event day (Weightage-**60%**)
4) Viva taken by the judges on the basis of the model on event day (Weightage-**15%**)

PERFORMANCE OF THE MODEL (OUT OF 60 POINTS)

Let **L** denote the **Central length** which is the distance travelled by the car along the central line, that is, the component of the length traversed along the central line.

Let **y** denote the **Deflection of the car** from the central line, in either direction **perpendicular** to the central line.

Let the **Effective length** be defined as the difference between the Central Length and the Deflection of the car. Mathematically,

$$\text{Effective Length} = \text{Central length} - \text{Deflection of the Car}$$

$$\text{Effective Length} = L - y$$

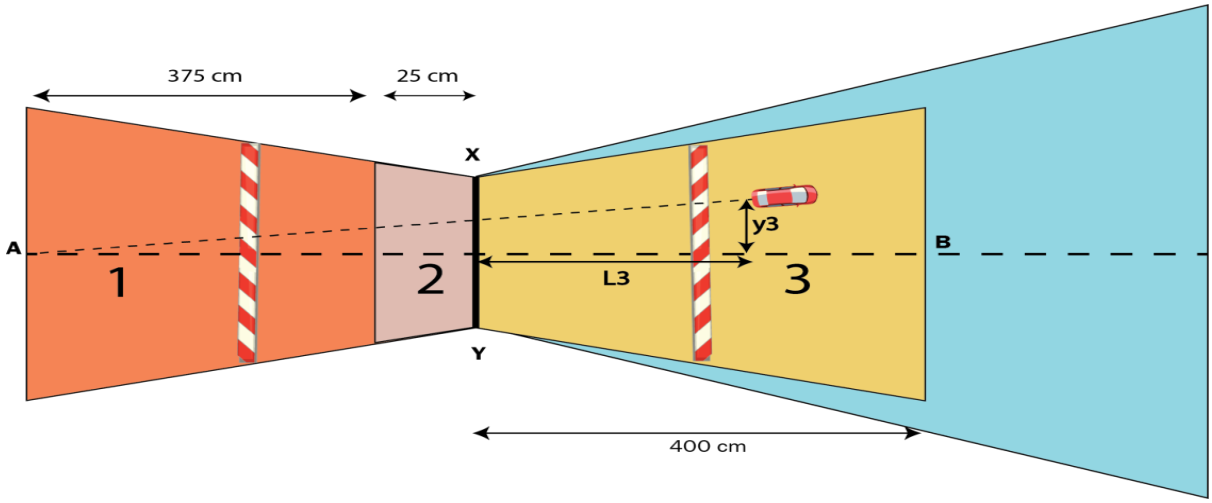
And let the **Ideal Length for a region** be defined as the length of the central line in that region. For example, if for a **particular region** within the track, the length of the central line is L' cm, the Ideal Length is defined mathematically as –

$$\text{Ideal Length} = L'$$

- The teams designing their cars for the **curved track** will be given **10 points** in advance for attempting to build the car. That is, the judging on the event day will be done out of **50 points** for these teams.

FOR THE STRAIGHT TRACK –

The track consists of three regions, **Region 1**, **Region 2** and **Region 3**, as marked in the figure below.



As can be seen from the above figure, Region 1 is 375cm long, marked in **orange**. Region 2 is 25cm long, marked in **pink** and Region 3 is 400cm, marked in **yellow**. Thus the total length of the track is 800cm. The Extra region marked in blue is a buffer region for cars that might cross Region 3. Points would be deducted for entering the Extra Region, as it is not a part of the track. **Note that if your car crosses the extra region, your team will not be awarded any points for Region 3 + Extra Region.**

The judging for the three regions is as follows –

For Region 1 (Weightage 25 points)

If the central length covered by the car in this region is L1 cm and the deflection is y1 cm, then the effective length travelled by the car is

$$\text{Effective Length} = L1 - y1$$

Now, the Ideal Length (L') for Region 1 is 375 cm, as can be seen from the figure. Therefore, the **Normalised Score (N1)** for Region 1 out of 25 is calculated as-

$$N1 = \frac{\text{Effective Length}}{375} * 25$$

For Region 2 (Weightage 10 points)

For Region 2, let the central length be L2 cm. Let y2 cm be the deflection of the car in this region. The effective length for this region will be calculated as follows.

$$\text{Effective Length} = L2 - \frac{y2}{4}$$

Note the factor of $\frac{1}{4}$ in the formula

The ideal length for this region is 25cm. Therefore the **Normalised Score (N2)** for this region is given mathematically by –

$$N2 = \frac{\text{Effective Length}}{25} * 10$$

For Region 3 + Extra Region (Weightage 25 points)

Let the Central Length of the car in Region 3 be L3 cm**.**

Let the Central Length of the car in the Extra Region be L4 cm**.**

Let the Overall Deflection of the car (for Region 3 + Extra Region combined) measured perpendicular to the central line be y3 cm**.** The above figure shows how L3 and y3 will be measured if the car stops in Region 3.

If the car moves on to the Extra Region, then points would be deducted for crossing the boundary of the track. Please note again that if your car crosses the Extra Region, then your team will not be awarded any points for Region 3 + Extra Region.

The effective length for this region will be calculated as follows.

$$\text{Effective Length} = L3 - \frac{y3}{3} - \frac{L4}{4}$$

Now, the Ideal Length for Region 3 is 400 cm from the figure. Therefore, **Normalised Score (N3)** for this region out of 25 is calculated as-

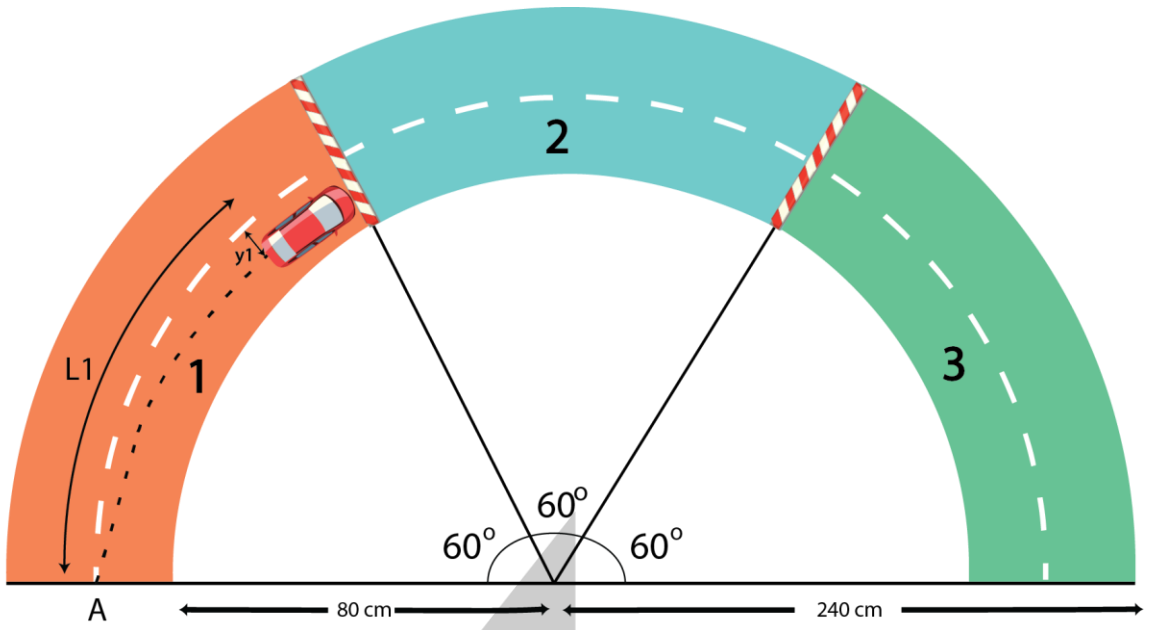
$$N3 = \frac{\text{Effective Length}}{400} * 25$$

The combined Nominal Score (N) out of a total of 60 is given by –

$$N = N1 + N2 + N3$$

FOR THE CURVED TRACK **-**

The Curved track also consists of three regions**,** Region 1, Region 2 and Region 3. They divide the track into three equal parts, as shown in the figure below. Here, the central line is the white dotted line as shown in the figure. The three regions are identical with the circumference of each region approximately 166cm. There will be two obstacles, one at 60^o and one at 120^o, as can be seen from the figure below. **Also please note again that 10 points will be awarded to the teams designing their models for the curved track. And their evaluation on the event day will be done out of 50 points.**



The judging for the three regions is as follows -

For Region 1 (Weightage 15 points)

For Region 1, if the length covered by the car along the central line is L1 cm, and the deflection perpendicular to the central line is y1 cm, then the effective length covered by the car in Region 1 is given by –

$$\text{Effective Length} = L1 - y1$$

The Ideal Length for region 1 is 166 cm, as can be seen from the figure. Therefore, the **Normalised score (N1)** for Region 1 out of 15 will be given by –

$$N1 = \frac{\text{Effective Length}}{166} * 15$$

The above figure shows how L1 and y1 will be measured for the car in Region 1.

For Region 2 (Weightage 15 points)

For Region 2, if the length covered by the car along the central line is L2 cm, and the deflection perpendicular to the central line is y2 cm, then the effective length of the car in Region 2 is given by -

$$\text{Effective Length} = L2 - y2$$

The Ideal Length for region 2 is 166 cm. Therefore, the **Normalised score (N2)** for Region 2 out of 15 will be given by –

$$N2 = \frac{\text{Effective Length}}{166} * 15$$

For Region 3 (Weightage 20 points)

For Region 3, if the length covered by the car along the central line is L3 cm, and the deflection perpendicular to the central line is y3 cm, then the effective length of the car in Region 3 is given by –

$$\text{Effective Length} = L3 - y3$$

The Ideal Length for region 3 is 166 cm. Therefore, the **Normalised score (N3)** for Region 3 out of 20 will be given by –

$$N3 = \frac{\text{Effective Length}}{166} * 20$$

A few turning methods

- The two rear wheels of the car can be rotated with different angular velocities, by supplying different voltages to the motors.
- Attaching propulsive equipment which is capable of ejecting effluents perpendicular to the motion of the car can also act as a rotating mechanism.
- Make sure that the effluent is not harmful and is in accordance with Rules and Regulations and Precautions and Safety measures.
- Make sure that the method used for turning is adjustable for different radii of curvatures. **Using wheels of different diameters and permanently curved axles will not be allowed**.

PERFORMANCE OF THE MODEL

The performance time for the run on the straight track will be **6 minutes**, while it will be **5 minutes** for the curved track. This means that the participants will be given a 6 minute time slot on the straight track and a 5 minute slot on the curved track to perform. The participants can use the time given to perform twice if they wish to, but this is the only time slot they will get. If the car is still in motion at the end of the performance time of the run, then its position at that instant will be considered as the final position and the performance parameters will be calculated with that position.

STRUCTURE OF THE COMPETITION

Participation Procedure

- Participants will firstly have to get their **unique AZeo Ids** by filling the form on the link - http://azeotropy.org/2019/azeoid/.
- Register for the ChemRover competition by filling the form on the link http://azeotropy.org/2019/competitions/rover.

Stage 1- Abstract Submission (Mandatory for further selection)

- Each team is required to upload an abstract of their model (word limit 1000 words, with maximum 5 pages and a file size of less than 1.5 MB). Your abstracts must include the following -
    - Team ID, name of the team members and the **AZeo IDs**.
    - All the chemicals used and their individual and total costs.
    - **Specification of the track for which you have designed your model (Curved track or Straight track).**
    - A well labelled diagram of the model, along with its dimensions.
    - A Descriptive Procedure of the setup of your model.
    - Working procedure of the model, and the mechanisms used for each step (The Starting, Propagating and Stopping mechanisms).

- Your model can also include the following –
- Unique features, innovative ideas and designs used in your model.
- Your views on why your model is environment friendly and the safety measures you have undertaken to ensure safe working of the model.

Upload your abstracts with the file name as ' ChemRover_<team ID>.pdf' on the website by 11:59 pm, 28th January, 2019.

Stage 2- Performing Round (On the day of the event)

- On the event day, each team will be given a **Trial Run** on a side track to test their model. In this test run, the model will be tested for any harmful chemical gases which might get released (poisonous gases, concentrated acids, etc). Your model would be declared unsafe if the chemicals used are hazardous and are harmful to the surroundings. You will be disqualified from the competition if the judges declare your model unsafe. You'll be given only one opportunity to test your model.

- Since the judging is separate for separate regions of the track, the teams will be required to provide a provision for a **white board marker** attached to the car, to help trace the path of the car and ease the calculation of the judging parameters**. Note that only a white board marker is to be used and not a permanent marker**.
- Each team will be given at maximum **two runs** on the main track and only the last run would be considered for evaluation. All of this would have to be performed in the given time slot. No extra time would be given for finishing the runs.
- After performing the run on the main track, there will be a viva conducted by the judges, related to your model and the track you chose, which would eventually add to your final evaluation. **Please bring a few copies of your abstracts on the event day**.

INSTRUCTIONS

1) Each team should consist of **maximum four members**, with **at least two** members majoring in Chemical Engineering. Multiple teams from a college will be allowed to participate, given that their abstracts and models are different.
2) One team is allowed to present only one model.
3) Teams must strictly adhere to the given deadlines. Failing to do so will lead to disqualification or heavy penalisation.
4) The final date for abstract submission is **28th January, 2019**. Modified abstracts can be submitted, but the final abstract submitted before **28th January, 2019** will be considered for the competition. Your ChemRover model should be built based on the final abstract submitted.
5) The decision of the judge or the event managers will be considered to be final and no further arguments will be entertained.
6) The participants are expected to arrange and take care of their chemicals on their own. Team AZeotropy holds no responsibility to provide chemicals for participants.
7) Any changes in the problem statement and updates regarding the competition will be conveyed to the participants through emails.
8) Participants are expected to arrive 15 minutes before their time slot.
9) Each container should be clearly labelled with the name of the chemical and the concentration.

RULES AND REGULATIONS

1) Use of chemicals **beyond 1- MSDS rating** is **not** allowed.

   This includes i) **inflammable chemicals** like dynamite, fireworks, mercuric chloride, white phosphorous and nitro-glycerine, etc. ii) **strong concentrated acids** like concentrated Sulphuric Acid, Nitric Acid, Hydrofluoric acid, etc. iii) **Poisonous gases** like hydrogen cyanide, fluorine and chlorine, etc.

2) Chemical reactions that can be safely conducted indoors should be used.

3) The model should not employ any battery or pre-manufactured source of energy.

4) The automated mechanism (that is the trigger) can involve chemical or mechanical processes but **should not involve any electronic/electric components**.

5) Make sure that the chemicals used do not spill on the track.

PRECAUTIONS AND SAFETY MEASURES

Each team is required to incorporate appropriate safety measures and equipments in the chemical preparation and ensure that there are no spills, exposures or hazards. Each team is expected to follow the following rules –

1) All containers containing chemicals, like beakers, syringes, and bags must be properly labelled. This includes all the containers holding reactants, intermediates and products. The labels must properly specify the chemical contained and must also have the **ChemRover Team ID** specified. It is the responsibility of the team to carry extra labels if necessary.

2) All teams must possess the required personal protective equipment depending on the possible hazards that could be encountered. Equipment may include lab coats, safety glasses, gloves, face shields, and hearing protection.

3) If the judge deems the car as **unsafe**, the team will be disqualified. Hence, every team should try to follow the given characteristics:

   - **Secure attachments**: Chemicals must be securely attached to the car to prevent the container from tipping over during the competition.

   - **Pressure related restriction:** Pressurized vessels and car components represent a significant explosion hazard due to the substantial energy contained in it. Student teams must demonstrate through appropriate pressure measurements that the pressures during normal operations do not

exceed equipment specifications. The following restrictions apply to cars operating under pressure:

1. **Maximum operating pressure** - This is the highest pressure within the vessel during normal operation. For initial design purposes, the maximum operating pressure can be estimated from the stoichiometry — but the actual pressure must still be measured once the car is operational.

2. **Pressure requirement** - If the pressure of your car is greater than 1 psig, then your car should have the following: pressure gauge, emergency relief device (must be in the proper location), pressure certification, proper management system to prevent overcharging.

4) **Chemical containment hazard:** This applies to any solvent, diluents, reactants, intermediate species or product that is present on your car during operation. Suitable measures must be taken while handling chemicals in the car preparation area to prevent human exposure.

5) **Electrical hazard:** Wiring and exposed electrical components must be electrically insulated or covered to prevent the possibility of electrical shock or ignition of any component of a car.

GENERAL RULES

1) All abstracts must be original. Plagiarism in any form (including and not limited to -
A) Replication of old abstracts and models
B) Submission of similar abstracts by teams from the same institution) or falsifying information in the abstracts will lead to immediate disqualification.

2) The decision regarding final selection of the teams rests with team AZeotropy 2019.

3) The judging criteria and specifications may be subject to changes until the event day. Team AZeotropy holds the right to do the same.

4) Final decision making authority lies with Team AZeotropy, IIT-Bombay.

CERTIFICATE POLICY

1) **Top 3** teams will be awarded **Certificates** and **Cash Prizes**.

2) Certificates and Cash prizes will also be awarded to the team with "**Best Innovative Model**" (apart from the top 3 teams)

3) **Certificate of Participation** will be given to all the teams performing on the event day.

CONTACT-

For any queries related to the Problem Statement or Registration, participants can contact:

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