9 BRAKES and AXLES

1. At least two wheels must have brakes.

2. Brakes must be fitted to two wheels of the same axle. Either both front wheels or both rear wheels depending on vehicle construction.

3. The two brakes must have separate actuation cables. If both brakes are to be actuated by a single hand or foot lever then both cables should be attached to the lever.

4. Regenerative braking is permitted in addition to conventional brakes.

5. The vehicle must not roll if pushed while brakes are applied. The vehicle must also be able to demonstrate a straight stop from a speed of 25 MPH in less than 40 feet.

6. Axles supported at both ends must have a diameter of at least 3/8"(10mm).

7. Axles supported only on one end must have a diameter at least ½"(12mm)

8. Safety wire or cotter pins must be used to secure cantilevered wheel axle nuts. Nylon lock nuts and double nuts alone are not acceptable.

10 WHEELS and TIRES

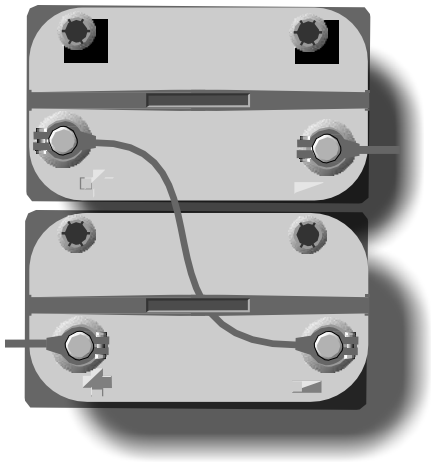
1. Tires must be a pneumatic (inflatable) type.

2. Wheels and tires of any diameter or width may be used.

3. The minimum ground clearance is to be judged by the cars ability to roll over a 2x2 that is milled to be 1½" x 1½". This is to prevent the vehicle from sliding on the ground in the event of failure of any or all of the tires.

4. While in driving position the driver's body must not be able to come in contact with tires, wheels or spokes.

11 BATTERIES



1. Batteries must be lead acid only. Only batteries that will not leak if punctured, such as gel cell or AGM (Absorptive Glass Mat) will be allowed to participate at events in practice or in competition.

2. Battery number and voltage is not limited, but must meet specified weight limits, or must be the accepted battery types listed.

3. Batteries must display all original manufacturer's labels.

4. Batteries must be commercially retailed and available to any competitor. Custom built or specialized batteries are not allowed.

5. Batteries must be stock and unmodified in any way, and meet all conditions of the manufacturer's written warranty.

6. Total battery weight can not exceed 73 pounds. Total battery weight includes any batteries used for controls actuation, or functioning of the vehicle. Computers, radios or similar equipment are not included.

7. Batteries cannot be exchanged or recharged from an outside source during a competition. Batteries may be recharged by regenerative braking, or, in the Solar Class, through use of solar panels.

8. Batteries must be securely attached to the vehicle in such a manner to withstand an impact or roll-over.

The following list of batteries are accepted as standard, meaning two of the following batteries will be allowed regardless of actual weight:

- Optima Yellow Top **D35, D75/25**
- Optima Red Top **SC25A, SC35A, SC75/35**
- Odyssey Genesis **G42 (VP, VPX, EP, EPX)**
- MK **40**
- Exide Orbital Model **75/35**
- Champion Vortex **75/35**

25 COMPETITOR MEMBERSHIP CARD

1. To compete in a sanctioned event, all vehicles must be accompanied by an Electrathon America Competitor Membership Card. This card will be made available by Electrathon America and can be presented as proof of current year paid membership. The Event Organizer may request a computer roster of current competitor members to verify memberships.

26 BALLAST

1. Drivers must weigh a minimum of 180 pounds. This includes race clothing and helmet. Drivers under this weight limit must provide non-liquid ballast to increase their weight to the legal limit.

2. Ballast cannot be performance related items such as communication equipment or computers. However, non-performance items such as cameras or music systems may be permitted as ballast provided they do not present a safety risk to the driver or other competitors.

3. Ballast must be removable for weigh in. Ballast must be securely attached to the vehicle in such a manner to withstand an impact or roll-over. If a vehicle loses its ballast during competition, it will be black flagged and disqualified.

4. Each driver is responsible for providing the correct amount of ballast.

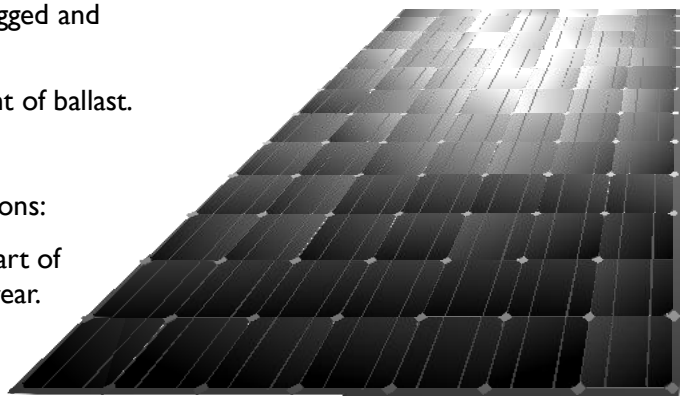
27 SOLAR CLASS

All other Standard Class rules apply with the following additions:

1. Solar panels are permitted provided they are an integral part of the vehicle body and do not protrude to the front, sides or rear.

2. Wings or trailers are not permitted.

The Solar Class allows the use photovoltaic cells to provide additional power during a race. In most cases that additional power will be more than offset by the increased weight and aero drag of the cells, and while the cost of PV cells is usually prohibitively expensive, they are often donated to schools. It was also felt that solar power offers a sustainable alternative to conventional enrgy sources, and fit the general objectives of Electrathon.



28 ADVANCED BATTERY CLASS

The Advanced Battery Class is intended to foster experimentation on with newer battery technologies that offer higher energy density than the more traditional lead-acid, and reflect the rapidly expanding availability and usage in the transportation industry. The weight limits are meant to keep the available power under ***one kw/hr****, or about the same as the current Standard Class. This list will be reviewed and updated periodically.*

All other Standard Class rules apply with the following exceptions:

1. Any type of the following sealed production batteries may be used as long as their weight does not exceed:

- Nickel-Metal-Hydride **41 lb.**
- Silver-Zinc **23 lb.**
- Nickle-Zinc **44 lb.**
- Nickel-Iron **58 lb.**
- Lithium-Ion **15 lb.**
- Lithium-Iron-Phosphate **29lb.**

2 . Maximum output of any battery combination used may not exceed a one-hour rating of one kilowatt/hour according to the manufacturer's data.

29 COMPLIANCE

1. All vehicles must meet all Vehicle Design Rules to drive at any Electrathon America sanctioned event. This is true for competition, practice or testing and includes driver's clothing, safety equipment, batteries, battery securing systems, seat belts, etc.

BATTERIES

Electrathon allows only non-leaking lead-acid batteries, with no more than 73 lbs. total weight. Batteries generally offer higher performance when they are warmer, so if you are racing on a cold day, it might make sense to heat them, at least to a level they were designed for, say a hot day in Arizona. Remember, batteries heat naturally when they are being charged or discharged, so keeping them in an insulated box retains more of their energy. Heating can be done with warming blankets, hair dryers, or immersion heaters. Hot tap water is often enough, as there may be diminishing return and permanent damage after 120 degrees (oven thermometers are a handy tool).

Batteries may be labeled as starter or deep cycle, although the distinction has become blurred in recent years and the cost is about the same. Generally, starter batteries have more and thinner plates inside, so they will charge or discharge more quickly, but their useful life is shorter. The heating and deep discharging of racing is hard on any battery, but if you are kind to them (don't go below 21 volts and don't leave them drained for more than a day or two, even starter batteries should last a couple racing seasons.

Most lead acid batteries are 12 volt, and most Electrathon vehicles use two of them in series for 24 volts. It's the common compromise. Motors run more efficiently at higher voltages, but fewer batteries usually means more of the battery weight is "capacity holding material", not plastic cases and terminals. But Electrathon is all about creativity and experimentation, so anything is worth a try. Besides...technology evolves. While the basic idea hasn't changed much in a hundred years, manufacturers are trying harder than ever to improve them.

TESTING

The most important thing to know about your batteries is how much power they have. There is no way to know how fast you can go in an hour until you know how much power you have available. This is the Art (or Science) of Electrathon. To make an intelligent guess you need to draw them down over the course of an hour at a rate you think you can sustain. You can, of course, do that in the car on a track. Since this is not always convenient, or even possible, you can recreate those conditions in the shop. The simplest and most accurate method is to connect a test load directly to your car (and its meter). You will need something that uses power: 12 volt light bulbs (25 or 50 watt) work great, but you should wire them in pairs and test pairs of batteries together if you have a 24 volt system. Screw or unscrew bulbs until you draw the amperage you want. 36 amps is a good number. More than that and you've got a sure winner! To be more precise, you can keep screwing and unscrewing bulbs to maintain a constant draw (or just figure an average draw). Notice that the amps will drop as the voltage drops. This process also gives you a chance to plot the voltage curve. Record the voltage at even increments, say every 10 minutes. Having this data in the car can help you keep track of how much power you are using. A good set of fully charged batteries will show over 26 volts with no load. Under load that will drop to about 24 volts, and continue a slow drop to 21volts. At that point they will drop rapidly, and continuing to drain them will cause lasting damage. While it shows admirable determination to keep a car going at walking speed, it can be expensive if it ruins the batteries.

Electrathon America has tested these batteries to establish a reference point. Your actual results may vary

Optima SC25A AGM (**SC35A** are the same with "reversed posts")
41.8 Amp/hours, 480 Watt/hours

Optima 75/35 AGM (Double Post)
38.9 Amp/hours, 447 Watt/hours

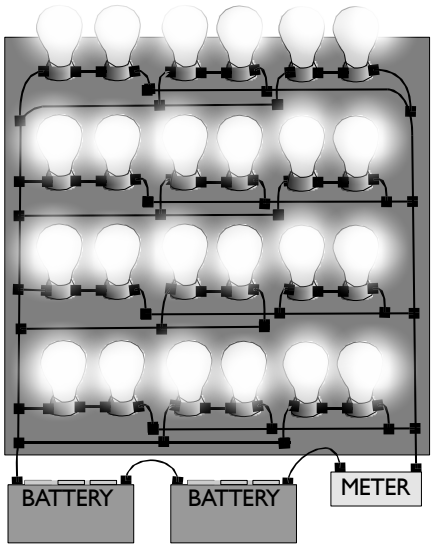
Exide Orbital 75/35 AGM
(Double Posts & built in Handles)
37.4 Amp/hours, 445 Watt/hours

Champion Vortex 75/35 AGM
(Double Posts & built in Handles)
35.8 Amp/hours, 415 Watt/hours

MK 40 amp/hr Gel Cell
21.5 Amp/hours, 233 Watt/hours

CHARGING

Battery chargers come in many sizes over a broad price range. 10 amp chargers are fine, they just take 6-8 hours to charge, where a 50amp charger can do it in 2-3 hours.
20 amps is a good compromise, and if it has a 24volt option, you can charge pairs together. Its better to charge them individually, though, as a weaker one will get weaker as you cycle them, and a strong one will get stronger.



Typical 24V system test board