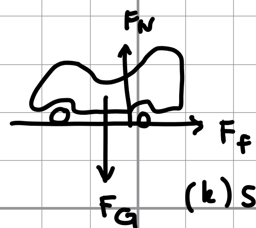
Mophom 1800W Electric DC Brushless motor, 48 V — DC. Brushless.

power: 1800 W → total 4000 W
Speed: 4500 rpm (max 5600)
current: 33 A
weight: 9.26 lb | 4.2 kg ; 6.7 x 4.2 x 4.3"
torque: 4 N·m → total 16 N·m b/c directly proportional

wheel radius: 5 in = 0.127 m
High Torque = High acceleration = Low maximum speed



* neglecting air resistance

(k) static friction of hard rubber on dry concrete = 0.6

assuming the weight of the kart is 150 kg (330 lbs),

Force required to move kart = m·g·k = 150 × 9.81 × 0.6
= 882.9 N

each wheel: 220.73 N

220.73 × 0.127 = 28.03 N·m Torque needed to mo kart from rest.

to reach 28 N·m, we need a gear ratio of 7:1 to move the kart initially.

\# of teeth on motor: 11 → # of teeth wheel gear: **78**

circumference of the wheel: 2 × 0.127 × π = 0.80 m/rev.
motor: 3500 rpm → w/ gear ratio: 4500/7 = 642.9 rev/min.

$$0.80\ \frac{m}{rev} \times 642.9\ \frac{rev}{min} \times \frac{1\ mi}{1609\ m} \times \frac{60\ min}{1\ hr} = 19.18\ mi/hr$$

on avg. on flat surface

maximum speed:

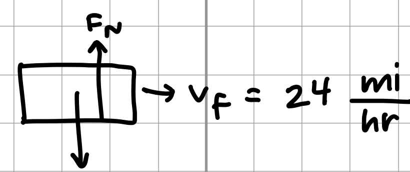
$$0.80 \frac{m}{rev} \times 800 \frac{rev}{min} \times \frac{1 \, mi}{1609 \, m} \times \frac{60 \, min}{1 \, hr} = 23.87 \;\; mi/hr$$

maximum 24 mi/hr $= V_0$ $\qquad V_f = 0$ mi/hr

$$24 \, \frac{mi}{hr} = \frac{38624.3 \;\; m}{3600 \;\; s} = 10.73 \;\; m/s$$

estimating 300 kg for kart & humans

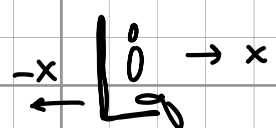
$$a = \frac{V_f - V_0}{t} = g \text{ force}$$



if it takes 1 second to brake,

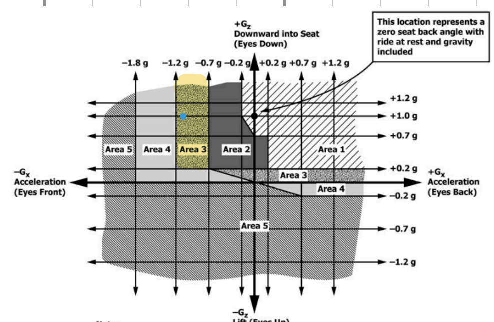
$$a = \frac{10.73 \;\; m/s}{9.81 \;\; m/s} = 1.09 \, g$$

$$F_g = 300 \times 9.81$$
$$= 2943 \text{ N}$$



∴ If the seat is at a 0° angle with respect to the surface, the maximum G force the guest will experience is 1.09 g in the $-G_x$ direction.

Since the seat is tilted backwards 5°, the guest will experience less g than 1.09 g, making the restraint within Area 3.



Notes
1) For cases on a boundary, the lower category may be chosen.
2) Accelerations are limited to the sustained values in section 7.
3) This diagram is intended for use with restraint systems where the patron begins the ride in the sitting or standing position (that is, spine nearly aligned with gravity).

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FIG. 2 Restraint Determination Diagram—Accelerations in Design Stage

Tesla Batteries: panasonic 2170 cell (21 mm × 70 mm)
3.7 Volts, 21.8 Wh (0.83 in × 2.76 in)

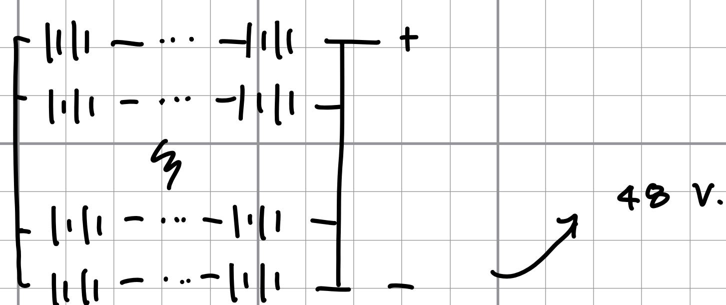
current chosen motor: 48 V

$\frac{48}{3.7}$ = 12.97 ⇝ ~13 cells needed in series to match 48 V

current chosen motor: 1800 W × 4 = 7200 W total
33 A × 4 = 132 A total

cells × WattHours = AmpHours × Volts
13 × 21.8 Wh = x Ah × 48 V
5.9 AmpHours

$\frac{5.9 \text{ AmpHours}}{33 \text{ Amps}}$ = 0.12 Hours ≈ 7.2 min.
If only 13 batteries.

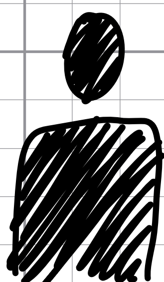


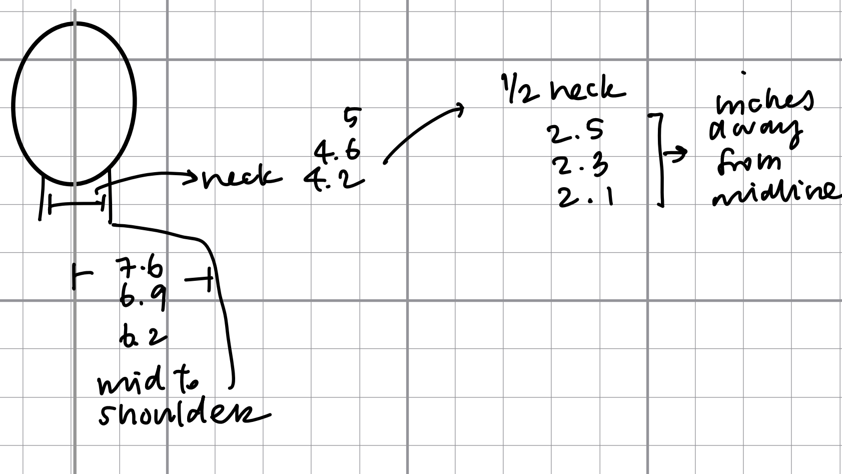
If the kart should run for 30 min, there should be 5 bricks, with 13 cells / brick, of a total of 65 cells.

ASTM Standards, Designation F2007-18

Standard Practice for Design, Manufacture, and Operation of Concession Go-Kart and Facilities

5.10.1 Restraint systems based on anthropomorphic data such as Dreyfuss Human Scales 4/5/6, 7/8/9, or CDC Growth charts.

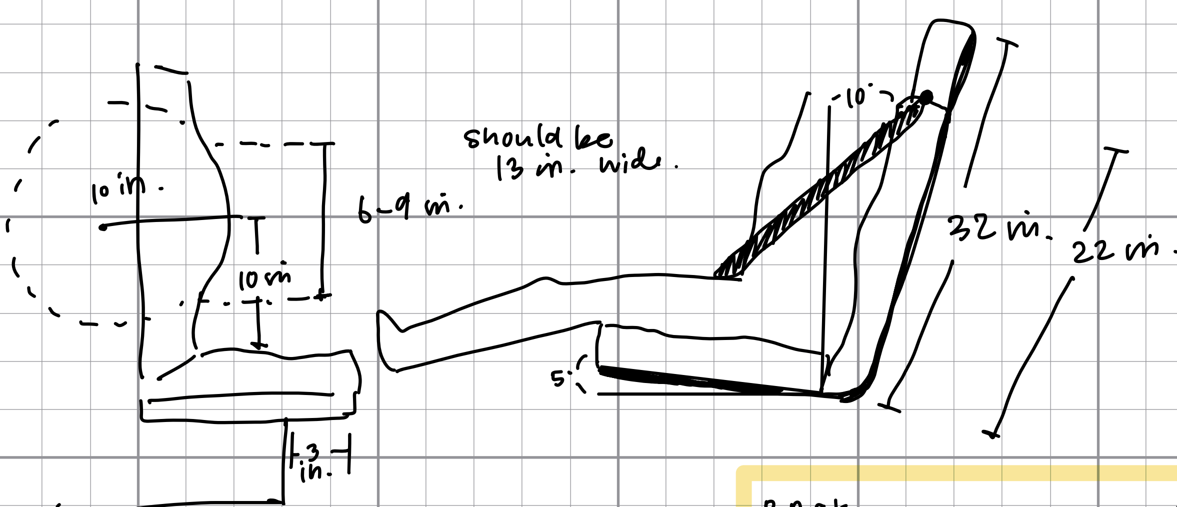


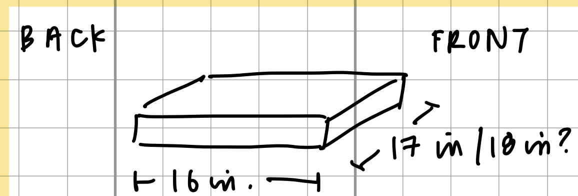


seat belt must be 2.5 to 6.2 inches away from the midline (3.7 inches range, mean 4.35 inches)

Seat belt height 22 inches from seat to go over shoulder of 97.5 percentile man

31.2 inches minimum for head support





5.10.2 If restraints are by seat belts, they are designed using F2291, subsection 6.2.1 : securely fixed to the ride structure

FIG 2. Restraint Determination Diagram

outlines what type of restraint is needed depending on the seat inclination and experienced G-forces.

- I am predicting that this attraction will be within Area 3.

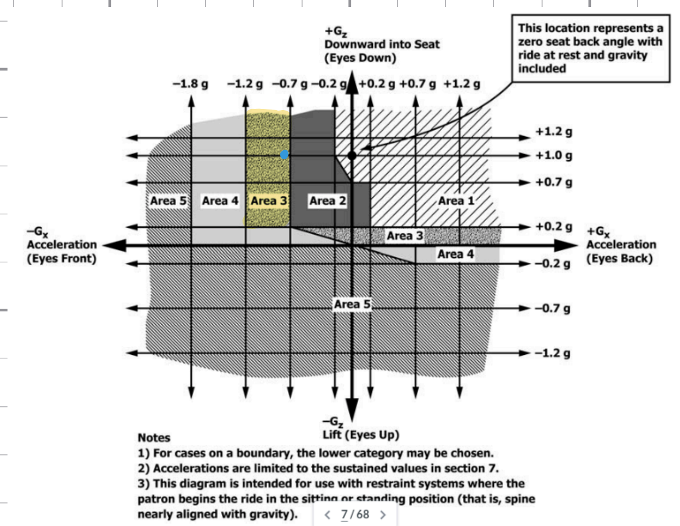
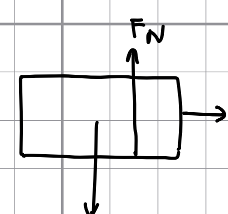


FIG. 2 Restraint Determination Diagram—Accelerations in Design Stage

Maximum 16 mi/hr = V_0 $\quad V_f = 0$ mi/hr

$16 \frac{mi}{Hr} = \frac{25749.5 \text{ m}}{3600 \text{ s}} = 7$ m/s

825 lb = 374.21 kg



$a = \frac{V_f - V_0}{t} = g$ force

if it takes 1 second to brake,

$a = \frac{-7 \text{ m/s}}{9.81 \text{ m/s}} = -0.71 g$

$F_g = 374.21 \times 9.81 = 3671$ N

∴ If the seat is at a 0° angle with respect to the surface, the maximum G force the guest will experience is 0.71 g in the $-G_x$ direction.

∴ The restraint must follow Area 3 guidelines

ASTM 6.4.3.6: Area 3 Guidelines

class 3 Restraint Required

- final latching: must be variable in relation to patron, multiple latching positions
- type of latching / unlatching: either manual or automatic
- redundancy not required
- design allows operator to visually or manually check latch

conclusion: a 4-point or 5-point restraint is not necessary. Having a seat-belt style restraint will suffice (lap and shoulder).

5.10.3 Lap belts installed to engage guest at 40-70° angle.
Preferred: 60° + with respect to the horizontal plane

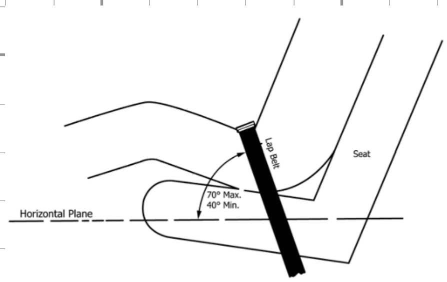
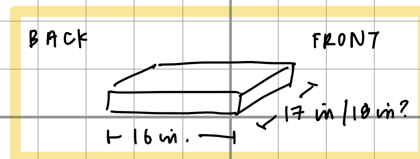
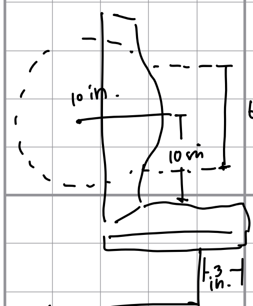


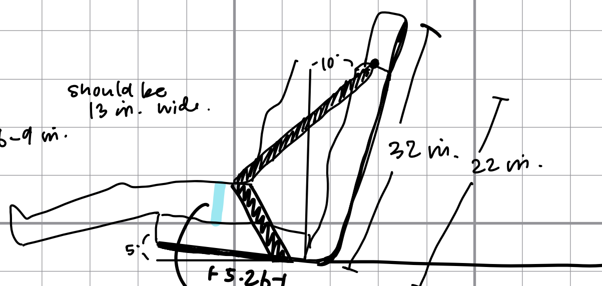
FIG. 1 Proper Lap Belt Mounting Angle

5.10.4.1 belt should not slide off shoulder or engage the neck

5.10.5 Belts a minimum of 1.75 in. in width



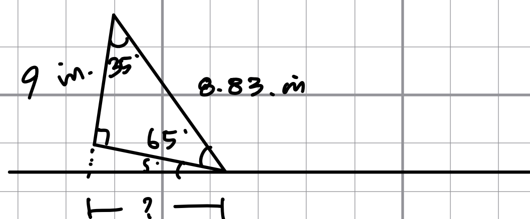




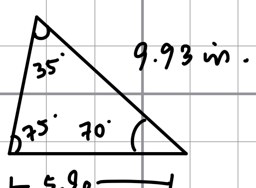
6.5 in. between front edge & knee (wheel clearance)

about 7 in. + 2 in. seat = 9 in from top of thigh to horizontal plane.

[avg. thigh (male) 7.1, 6.7, 5.7]

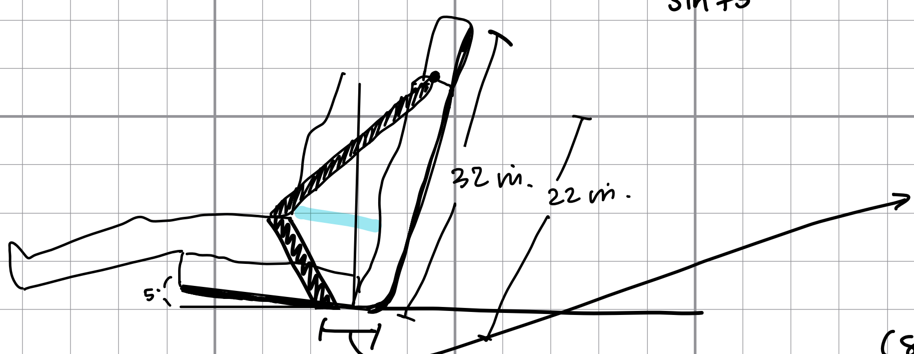


$H = \frac{9}{\sin 65} = 9.93$



$\frac{\sin 75}{9.93} = \frac{\sin 35}{x}$

$x = \frac{9.93 \cdot \sin 35}{\sin 75} = 5.90$



5.10 in

(seat)

chest avg. male [9.9, 7.9, 6.5]

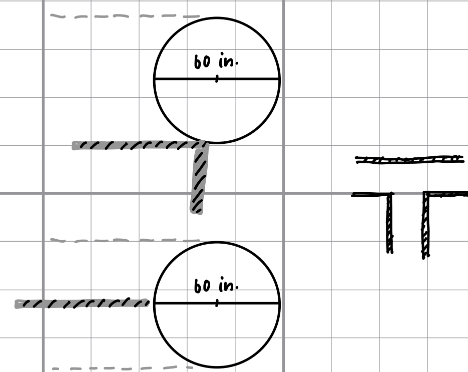
using 9 inches: 9 in + 2 in = 11 in.

11 - 5.90 = 5.10 in from seat back (anchor)

5.13 Braking system have sufficient braking capacity to override the power of the engine while at a standstill.

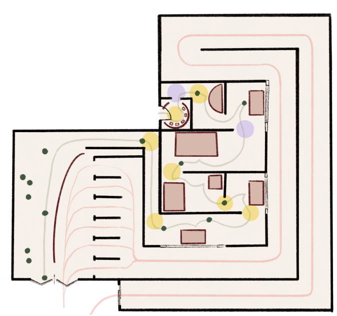
ADA Guidelines: Chapter 10. Amusement Rides

* Note: Go-Karts are an exception due to the rider-operated nature of the ride. However, an accessible route to the ride and turning space is necessary.



Accessible Routes

- 60 in. diameter or T-shaped space
    - For this attraction, both route solutions will be used. (see below)



Floor plan

Key
- 60 in. diameter
- T-shaped space

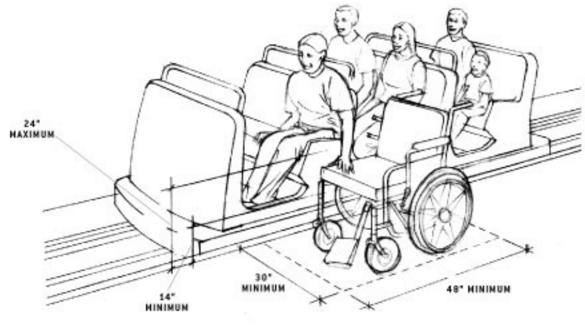
- 80 in. minimum vertical clearance

Amusement Ride Seats Designed For Transfer

* Note: although these guidelines do not apply to go-karts, keeping these restrictions in mind will make the attraction more accessible and better guide the design process.

- Clear Floor Space: 30 in. by 48 in. minimum
    - Because the loading area of the go-karts is outside, each experience is individualized to each guest, and each kart will be assisted by a trained employee, the clear floor space guideline is met.

- Transfer Height:
  between 14 & 24 inches above the unload/load surface.



RIDE SEAT DESIGNED FOR TRANSFER

Guidelines Diagram

- The chosen go-kart tire wheels are 10 in. in diameter.
- The predicted height of seating is also around 10 inches. The actual height will be calculated in the future.
- Because most of the go-kart has a low center of gravity to maximize the aerodynamics, the kart will likely have a seat of less than the guideline for other amusement rides.
- To accomodate for this difference, guests can be offered a cushion or seat that may also be used for other purposes/safety (eg. individuals/childen under a specific height).