A Centre of Excellence & Innovation in Science & Mathematics

2022

PrintACar

Challenge

PrintACar

Contents

Overview

The PrintACar challenge is a statewide event that engages teams of 2-4 primary and secondary students in the design and racing of 3D printed cars. The objective of the challenge is to provide an authentic application of the design process and engage students in the processes of 3D Printing technologies. A school may enter a maximum of 2 teams into the competition from primary year levels (3-6) and 2 teams from secondary year levels (7 – 12), with the possibility of an additional team upon written request.

Qualifying Day/s

Qualifying trials will take place at Quantum Victoria.

For 2022 the qualifying days will be held virtually and will be live streamed to the competing schools.

Each team must send 1 car, but may send up to 2 different cars to race on the day (we highly recommend sending two different car designs so that they can both be tested on the track).

Each school must send their cars to Quantum Victoria by the set dates at their expense so they are received by the dates outlined on page 15. The School must provide a copy of the courier tracking number to Quantum Victoria within one business day of dispatching the car package.

Teams must produce a portfolio that provides information on the team and its members, the design and the printing process of their car and the relevant physics associated with the design. (Please refer to portfolio specifications, see page 6).

An electronic copy of the portfolio must be submitted prior to the qualifying day. (See page 15 for dates) For each team who enters the competition, a unique link to a google drive folder will be provided for submission of the portfolio.

Feedback on how a team performed will be provided following completion of the Qualifying Days.

In order to qualify for the Finals Day, **original car designs need to be used** during the Qualifying Day (i.e. **not the same design used in previous years** if a team has competed before).

Students are **encouraged to submit a 1 minute introduction video for their team**. This should include their team name, group members, why they decided to enter and something interesting that they learnt during the process. This will be included in the live stream event during Qualifying Day. 'Recording - Authorisation and Privacy Consent Forms' will need to be competed and submitted one week prior to the first Qualifying Day (see page 15). Student and adult forms can be found here and here, respectively.

Racing (50% of total Qualifying marks)

Each car will be marked by Quantum Victoria staff with reference to the rules in this field guide (see page 9). **Cars that do not meet the specifications in each rule will either be allocated a time penalty or may be disqualified from racing.**

Each car will race 3 times and will receive a final time based on their fastest race time and any time penalties that may have been incurred for breaching car rules.

The fastest final time will receive full racing marks, with each team racing after that point, receiving less marks. Any team that races but does not complete a race, will still receive marks, however, it will be 1 mark less than the slowest race time. Any car that does not race will not receive any marks.

Portfolio (50% of total Qualifying marks)

Teams will be awarded marks for their portfolio based on the inclusion of **all the required information**, the **level of detail of the information** and the **presentation of the information**. Teams are encouraged to invest in presenting a portfolio that addresses **all three areas.**

There will be marks awarded for **Flair and Effort** demonstrated in the Portfolio and Car Design.

Winners

The team with the **fastest car** (including penalties) and the team with the **best portfolio** from each Qualifying day will automatically proceed to the finals. Each team will be marked out of 40. For the remaining teams, the teams with the highest overall scores across all Qualifying days will receive entry into the finals.

Finals Day

Finals day will be onsite at Quantum Victoria. Each qualifying team is expected to be on site for the Finals Day.

Each qualifying team must bring **1 car, a portfolio AND a poster to be eligible** to compete on **Finals Day**.

Teams will receive marks for their **race times**, **their portfolio, their poster**, and the **originality** and **creativity of** their entry.

Racing (15 Marks)

Cars will compete in time trials to determine which cars progress to the semi-finals and then to the final. Each car will receive a mark based on their position in the time trials and finals (this is determined by the fastest race time adjusted to include penalties due to nonconformance with this field guide), with the winning car receiving full race marks.

Portfolio (15 Marks)

Teams will be awarded marks for their portfolio based on the **inclusion of all the required information**, **the level of detail of the information**, and the **presentation of that information**.

Poster (5 Marks)

Teams will be awarded marks for their poster based on the **inclusion of the required information**, the **level of detail,** and the **visual presentation of the display**.

Originality / Creativity (5 Marks)

Teams will be awarded marks based on the originality / creativity of their car design, their portfolio, and their poster. We encourage teams to submit unique car designs, in particular, those teams that are competing for a second time. This criterion will be judged both on the **appearance of the car**, and through the **process of how the final design was reached**, **as described in the portfolio and poster**.

Winners

There will be an **overall Primary** and an **overall Secondary** winner. The team with the **highest combined scores for each category**, will be the **PrintACar Champions**. The **Primary and Secondary overall winning teams** will receive a **3D printer and trophy** for their school.

In addition, to the overall prizes, awards will be given to the finalists in the following categories:

- Fastest penalty adjusted race time for the day (Combined Primary and Secondary)
- Fastest Reaction time for the day (Combined Primary and Secondary)
- Best Portfolio (individual Primary and Secondary Awards)
- Best Poster (individual Primary and Secondary Awards)
- Most Original Car Design (Combined Primary and Secondary)
- Quantum Victoria Director's award (Combined Primary and Secondary)

Each team is only eligible to receive one award from the above list of additional awards. The next eligible team will be allocated the award if the higher placed team has already received an award.

Please note: As a condition of entry into the PrintACar competition, any prizes/awards will only be awarded to schools not individual students. Quantum Victoria reserves the right to reclaim the prize should any requirement be compromised. Quantum Victoria's decision is final, and no correspondence will be entered into.

Qualifying Portfolio Specifications

Portfolio Requirements

Qualifying Day

Teams are required to produce a **digital portfolio** that is **4-8 pages long and formatted for A3 size** with the following information:

- **Team Profile** (1 to 2 pages)
  - Name of School
  - Name of team
  - Team Logo
  - Name of team members
  - Roles of team members
  - Individual Photos of each team member or a group photo of the team
- **The Design Process and Physics** (including aerodynamics) (2 to 4 pages)
  - State the 3D modelling software used and why it was used.
  - What was the inspiration for final design? Explain this through the features of your design.
  - Discuss design features of your car that you feel will make it faster.
  - Discuss the relevant Physics which support the design features noted in the previous dot point.
  - Discuss your wheel design and how this will make your car faster.
  - Detail the steps involved to get to your final design.
  - What modifications were made as you progressed and why were they made?
  - Include a **minimum of 3 images** of your car design throughout the 3D modelling process. These images must illustrate (as a minimum) **the beginning, middle and the end of the process**. These should include hand drawn sketches and/or images from design/printing software.
  - Additional Images of the car from **at least 3 angles** showing:
    - Exact measurements of the car. Measurements must be in **millimeters**.
    - Different feature measurements of at **least 3 different features**.
    - Features that have changed (these should explicitly be pointed out on the image).
- **The Printing Process** (1 to 2 pages)
  - What model printer did you use?
  - What type of material did you use? What properties of this material made it the best choice for your model?
  - What printing/slicing (not 3D Modelling) software did you use?
  - What challenges did you encounter when you printed the car(s)?
    For example:

        - Print quality challenges.
        - Software challenges.
        - Team dynamics.
    - Pictures of any printed prototype cars.
    - Pictures of final car(s) **straight from the printer AND before any finishing**.
- Pages in excess of the page limits for each of the above sections **WILL NOT** be marked.
- Portfolios will be marked for the **inclusion of all the required elements, the level of detail in responses and the visual presentation of the portfolio**.

Finals Portfolio / Poster Requirements

Finals Day

Teams are required to produce a **Physical Portfolio** that is **6-12 pages long, in A3 size AND** a **Poster of A2 size**.

Portfolio Requirements

The **Portfolio** may include additional information to the Qualifying Day Portfolio and **must** include **all the information required on the Qualifying Day (see page 4) as well as following information:**

- Changes from Qualifying Day (2 to 4 pages)
    - Did you change your car design from Qualifying Day?
        - If so, why did you change it and what changes were made?
        - If not, why didn't you change your car design?
        - What new challenges did you encounter when you made the changes?
    - Discuss any finishing to your car and why you think this may make your car faster.
    - Were you able to improve your print quality since Qualifying Day? If so, how?
    - Pictures of any printed prototype cars and the final car straight from the printer (before any finishing).
- As before, **pages exceeding the page limits for each section (including the Changes from Qualifying Day) WILL NOT be marked.**
- **Portfolios** will be marked for **the inclusion of all the required elements, the level of detail in responses and the visual presentation of the Portfolio.**

Poster Requirements

The **purpose** of your **Poster** is to promote your team and your car.

The A2 poster **must include** the following information:

- School name
- Year Level(s) of team members
- Name of team
- Team Logo
- Name of team members
- Roles of team members
- Pictures of team members
- Pictures of your car
- Brief summary of unique / important features of your car
- Inclusion of all the required elements, level of detail in responses and creative flair in the presentation

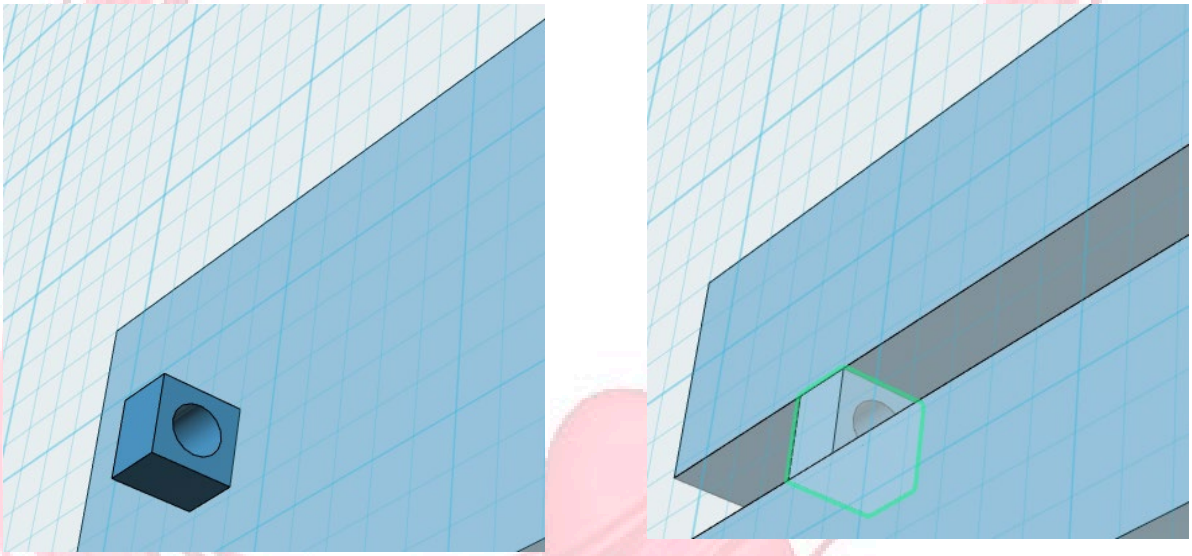
Car Rules and Regulations

Note: penalties that may result in your car <u>being disqualified</u> are shown in red, all other time penalties are shown in blue.

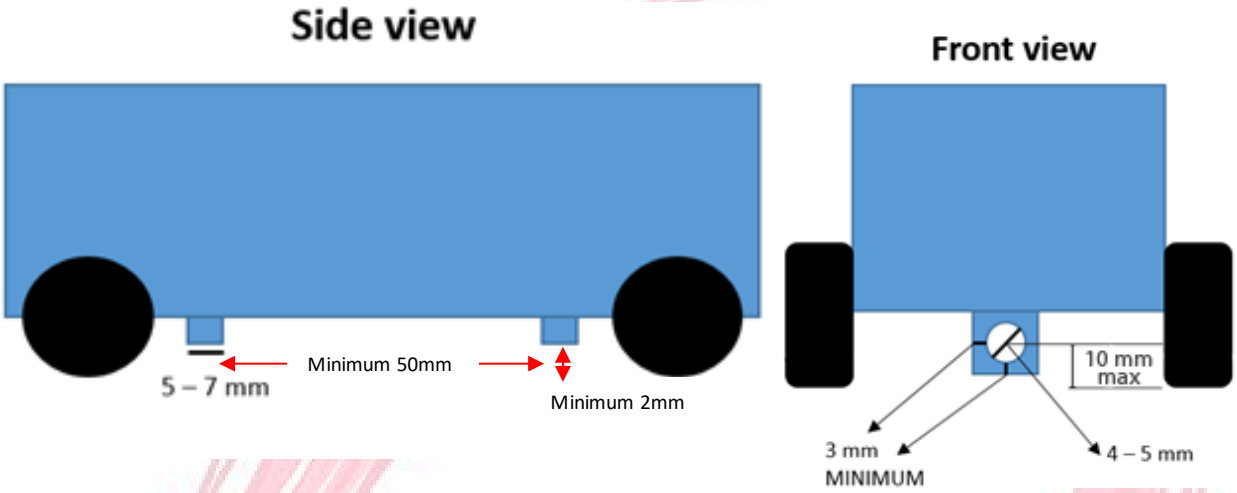
1. All components of the car **<u>must be manufactured using 3D Fused Deposition Modeling (FDM) printing technology with ABS or PLA filaments</u>**. **0.2s time penalty**
   EXCEPTIONS
   a. Axels (We recommend the use of brass rod).
   b. Adhesives (Used to stick wheels to axels or parts of the car together).
   c. Paints, Sealants and Stickers **(FINALS DAY ONLY)** (You may finish your car with paint or sealant for finals ONLY and these **<u>must be dry).</u>**
2. The car must have axles that rotate freely with the wheel fixed to the axle **1.0s time penalty**
3. Assembly and finishing of the car must be done **<u>before</u>** race day. This includes gluing pieces of the car together, attaching of wheels or painting (paint must be dry by race day). **0.5s time penalty**
4. The **completed car must have a mass of 50g or greater (fully assembled, without the CO_2 canister).** **0.3s time penalty**
5. Length of car **MUST** be between 100 mm – 150 mm. **0.1s time penalty**
6. Height of car **MUST** be between 45 mm – 75 mm. **0.1s time penalty**
7. The widest part of the car **MUST** be between 40 mm – 75 mm. **0.1s time penalty**
8. Cars **MUST** have a cylindrical hole/opening for the CO_2 canister to be inserted in.
   a. The hole **MUST** run parallel to the ground (once the wheels are attached) and in-line with the center of the car. **0.1 s time penalty**
   b. The hole **MUST** have:
      i. A diameter between 19 and 20 mm. **0.1 s time penalty**
      ii. A depth between 50 – 52 mm. **0.1 s time penalty**
      iii. A minimum wall thickness of 3 mm around the entire cylinder (no holes/openings except in the rear). **0.1 s time penalty**
      iv. The cylinder hole/opening needs to be circular (and not oval). **0.1 s time penalty**
      v. The inner end of the cylinder must be flat (not curved) **0.1 s time penalty**
   c. To facilitate launching, the entrance to the CO_2 canister hole/opening **MUST**:
      i. Be the most rear point of the car (no part of the car including wheels should stick out behind the canister entrance point). **0.1 s time penalty**
      ii. Have its centre between 25mm and 50mm from the ground (fully assembled). **0.05 s time penalty**
9. The car will race along a guide wire; therefore, eyelets **MUST** be included in your print so that your car can be threaded onto the wire.
   a. Your car **MUST** have <u>exactly two distinct eyelets</u>. **0.1 s time penalty**
   b. The eyelets **MUST**:
      i. Be at least 50 mm distance between the rear most point of the front eyelet and the forward most point of the back eyelet. **0.1 s time penalty**

ii. Be in-line with the center of the car. **0.05 s time penalty**
iii. Have a hole/opening between 4 - 5 mm in diameter. **0.05 s time penalty**
iv. Have the center of the hole **no more** than 10mm off the surface of the track when fully assembled (including wheels). **0.05 s time penalty**
v. Have the bottom of the eyelet a minimum of 2mm from the surface of the track **0.1 s time penalty**
vi. Have the depth of the hole/opening (along the direction of the hole) between 5 - 7 mm. **0.05 s time penalty**
vii. Have a minimum wall thickness around the hole/opening of 3 mm. **0.05 s time penalty**
viii. Have a clear path between the eyelet holes and the front and back of the car. **Note: axles must not impede the path of the guide string. 0.3s time penalty**
ix. Must not cause or potentially cause damage or breakage of the guide wire (as judged by Quantum Victoria staff) **Disqualification**

10. Car Finishing
    a. **Qualifying day** - The quality of the 3D printing must be visible so that feedback can be given. As a result, you should not sand, paint or apply stickers or decals to your cars.
    b. **Finals day** - Your car may be sanded, and may then also be finished with paint, stickers, and decals in line with rule 1c above.



The diagram above illustrates eyelets protruding from the bottom of the car (left) and embedded into the car (right) with a trench to clearly distinguish that there are two present.



The diagram above shows the dimension ranges for the eyelets as stated in rule 9.

Note: Quantum Victoria at any time has the right to refuse the racing of any car deemed to be unsafe to race or cause damage to the track. This includes the situation where a car becomes unsafe during racing.

Other Information

Frequently Asked Questions

Q. What glue can I use to assemble my car?

A. You should research the best glue to use for the material you have chosen (this might be a good thing to add to your portfolio). You must NOT use hot melt glue to attach eyelets to your car or wheels to the axles.

Q. Are we allowed to use a lubricant on the axles?

A. No.

Q. If my car breaks during racing can I fix it?

A. This will depend on how much the car breaking affects its safety. We will allow you (or a Quantum Victoria staff member) to repair your car if it is safe to do so. However, if the car breaks in the same way again, it will not be allowed to race further on that day.

Q. How much teacher input is allowed, if any?

A. We want teachers to act as a guide to their teams. Teachers can discuss and clarify the requirements as listed in '***The Field Guide***' and also teach skills needed to complete the tasks required for the students to compete, **HOWEVER**, students **MUST** **design** and **create** their cars, **Portfolio** and **Poste**r themselves. Teachers can provide access to the use of the 3D printer, but the students **MUST** print their designs themselves. You need to show evidence of this in your portfolio.

Q. Do we have to use our school printer to print our car?

A. The **Quantum Victoria PrintACar Challenge** has been designed to engage students in **authentic experiential learning** through the disciplines of **Science, Technology, Engineering and Mathematics (STEM)** and for schools to use their printers with their students to help spark ideas for future projects. If you **DO NOT** have access to a printer at your school or your printer is **unable** to print anything of reasonable quality, you **MUST** notify us before proceeding.

Q. Does it have to be printed with a specific type of 3D printer? If so, what type?

A. Students can use any 3D printer that uses filament. Note that only one of **ABS** or **PLA filament** can be used.

Q. Do the wheels need to be printed?

A. **YES,** all parts of the car **MUST** be **manufactured with a 3D printer** **except for the exceptions listed in rule 1** of the **Car Rules and Regulations** (see page 9).

Q. What are the tolerances for printed shapes?
A. Tolerances will vary depending on your printer and materials used. Some trial and error might be needed. You can initially allow for up to 1mm variance in your printed objects. However, judging **WILL NOT** take tolerances into account.

Q. How does the car launch?
A. A CO_2 canister is inserted into the cavity at the back of the car. A launch pod is placed at the back of the car, the CO_2 canister is placed inside the launch pod and then a firing pin is triggered to puncture the CO_2 canister.

Q. Does the Portfolio / Poster need to be printed or can it be hand written for the Finals?
A. Portfolios need to be **digital for the Qualifying day** and need to be uploaded to the Google Drive Folder provided by the due date as identified in key Dates and Submissions Check List page 15.
Finals Day Portfolios and posters can be either printed or handwritten, however the design, neatness, appearance and the information included in both, will be taken into consideration when marked.

Q. Do I need to remove any 3D printed support material?
A. Yes, you need to remove all support material (including in the eyelet holes and the canister hole).

Q. My school is in Melbourne close to Quantum Victoria. Do I have to send my car(s) by courier or can I hand deliver it?
A. You can hand deliver your car as long as it is delivered and handed in to Quantum Victoria by the date mentioned in key dates page 15.

Q. How can we learn more about how to use 3D Design and Printing?
A. Teachers can book their classes into one of our 3D Modelling and Printing programs to upskill their students (subject to availability). Visit https://www.quantumvictoria.vic.edu.au for more information on the Primary and Secondary onsite 3D Printing programs.

Register

Teams must register by Friday 27th of May. A waiting list will be created if the competition numbers reach capacity. **Places are limited and we encourage you to register your teams as soon as they have been created.**

Please complete the online form via the below link to register your interest

Registration Form

Once registration is confirmed the following information will be required:

- School name
- Team name
- Team members
- Year level of each student
- Supervising Teacher(s) names
- Supervising Teacher(s) contact details (email and mobile number)
- School contact telephone number and email address

2022 Qualifying Days will be held virtually on **Thursday 18th** and **Friday the 19th of August 2022** during National Science Week and competing teams will be allocated a day upon confirmation.
The **PrintACar Final** will be held **25th November 2022**, with the venue to be confirmed.

Quantum Victoria reserves the right to amend these rules at any time should circumstances warrant this. Dates may also vary beyond the control of Quantum Victoria. Competing teams will be informed if this occurs.

Contact Details

If you have any further questions or queries, please contact us at: admin@quantumvictoria.vic.edu.au

Key Dates and Submission Checklist

Google Drive will be use to upload all the relevant designs and documentation. A link will be sent to each competing team with a folder where the documents/designs are to be uploaded.

A photography/video permission form will be sent out to schools, as the event is live streamed. Student and adult forms can also be found here and here, respectively. Those students who don't have permission will not have their introductory video shown.

- ☐ Registrations open on **Monday 14th February 2022**
- ☐ Registrations close **Friday May 27th 2022**
- ☐ Qualifying Day cars to be sent by the competing school to Quantum Victoria by **Thursday August 4th 2022**
- ☐ Notification of courier tracking details for Qualifying Day cars to be received by Quantum Victoria within 1 business day after sending car(s)
- ☐ 3D Design of car/s submitted by **Thursday 11th August 2022** via Google Drive
- ☐ Qualifying Day Portfolio to be submitted by **Thursday 11th August 2022** via Google Drive
- ☐ Submission of student 'Recording - Authorisation and Privacy Consent Form' for use in live streaming submitted by **Thursday 11th August 2022** via Google Drive
- ☐ Introduction video (if included) submitted by **Thursday 11th August** 2022 via Google Drive
- ☐ Qualifying Day 1 is **Thursday 18th August 2022 (schools will be allotted a day)**
- ☐ Qualifying Day 2 is **Friday 19th August 2022 (schools will be allotted a day)**
- ☐ Finals Day is **Friday 25th November 2022**