American Regions Math League
Power Contest

Dear Coach:

Welcome to **Round 1** of the **2020–2021 ARML Power Contest**. The topic for this contest is "fractional progrmming", which you'll have to read about to see what's going on. Basically, multiplication by selected fractions can be used to create amazingly complex "programs" capable of computing practically anything. A few parts of this problem are amenable to brute force computation, while other parts need more delicate logic or the assembly of several earlier pieces. Thus, smaller or less experienced teams will be able to accomplish many of the parts while the larger and more experienced teams will still be challenged by some of the more complex pieces.

If the regular ARML competition takes place in June, we will be awarding plaques to the top teams. If the pandemic is still restricting our activities, we will try to send out awards by mail instead. But we know that the students are in it for the fun and challenge of solving interesting problems, so let's get to it!

This page should be the first in a seven-page document consisting of the items below:

1. This letter.
2. (3 pages) Rules and Directions page.
3. Grading sheet.
4. Answer sheet.
5. Comment sheet.

The contest itself is in a separate file on the contest website. All materials are available online for download from your team's page at the ARML website. Go to `www.arml.com`, click on the Power Contest link, then the Team Login link and log in to access all materials.

Things are obviously going to run a little differently this year, so please make sure to read through the Rules and Directions. There are options for how students will work together and for how the final submission will be sent in for grading. Ideally, the contest should be administered between Saturday, October 24 and Sunday, November 8 (inclusive), but dates will be flexible.

The solutions to Round 1 will be posted to the team home pages at the conclusion of the contest window. Physical papers sent to me for grading will be returned via regular mail when grading is complete. Papers submitted online will be able to be viewed as soon as they are graded in late November.

Warmest Regards,
Micah Fogel

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2020–2021 ARML Power Contest
Round 1
Rules and Directions

Due to the global pandemic, some teams may be working in-person while others will be working together online. In order to keep things as fair as possible, the restriction on using electronic devices (such as calculators) is lifted for this year. The fall contest has been written so that calculators should not be all that useful, anyway. All teams and students are on the honor system to not use online assistance or to attempt to look up answers or other information.

There are also two options for submitting team responses: mail and electronic. Instructions for both are below.

Teams working in-person

For teams where students are all in the same place, the contest will be in its familiar format. Please make enough copies of the answer sheet (included in this packet) and contest questions to ensure a good supply for all participants. Once the students are assembled and you are ready to begin the contest, read the student instructions below and begin the contest. Students will have 45 minutes to work, and may use calculators and other electronic devices, including computers running computer algebra systems. At the end of 45 minutes, collect the student work and choose one of the submission options detailed below.

Hybrid teams, where some of the team is working together in-person and others are working remotely via computer should be considered to be online teams and follow the instructions in the next section.

Teams working online

This includes hybrid teams, and means any team where not all team members are in the same location and must communicate electronically. Students may use any means to communicate with each other. For example, they may call each other on phones, communicate via an online meeting platform such as Zoom or WebMeet, Google Hangouts, Discord servers, or whatever channel(s) that they feel will provide adequate communication abilities.

To administer the contest, the students will ideally be able to employ the regular answer sheets, which will be provided as a separate PDF. If this is not feasible, students may write their answers and solutions on any clean, blank, white paper. It may be lined or graph paper, but colored papers will make grading difficult or impossible in some cases. Prior to starting the contest, distribute to each student a copy of the contest questions, as well as copies of the answer sheet and the comment sheet. Once you have verified that all students have the material, they may have 45 minutes to work on the questions. At the end of that time, have them send all work to you in whatever formats are convenient. You will need to assemble the student work into one complete submission. Here are some suggestions for making this as convenient as possible:

- Each student sends his or her work in a pre-arranged format, and you use a program such as Adobe Acrobat to assemble all the files into one submission.

- Employ Microsoft OneNote, allowing students to create pages for their work.
- Google Jam Boards can be employed to allow students to upload work to different pages and then all the material is in one place already.
- Open a session for your students in an online whiteboard system such as Limnu or Awwapp; students can draw or write directly on the whiteboard, or upload pictures of their work, and the whole can be downloaded as a single file.

As you are collecting the work from the students, they should not be taking extra time to solve the problems; their scans and uploads should reach you in a reasonably short amount of time.

Submission by mail

Once you have collected your students' work, there are two options for submitting it for grading. The first is the traditional mail-in response. Assemble your students' work (or print the file that you have assembled from their online work), sign and attach the scoresheet, and mail your submission by November 15 to:

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1500 Sullivan Road
Aurora, IL 60506
USA

If you must mail after this date, contact me for a different mailing address, as it will be unlikely that your paper will reach me in time for the main grading session if you use the address above.

Electronic submission

The preferred way to submit papers this year is electronically. Please follow these steps:

1. Collect your students' work into a submission file. You have either already created this file if your students are working online, or you can scan your students' work if you have it all on paper. An automatic document feeding scanner is ideal, but if you must take pictures of student work with a smartphone then that is what you must do. *The final submission must be a single document in Portable Document Format (PDF).* Be warned that some scanners have a very difficult time reading pencil-on-paper, as graphite pencil marks are somewhat reflective. You may have to play around with the scan settings to achieve a readable result.
2. Create a student account on `www.gradescope.com`. Go to the website, click the "Sign up" button and create a student account. You may use a student account you already have on the system; if you only have an instructor account you will need to create a new student account (probably using a different e-mail address).
3. Log into your GradeScope student account and join the ARML Power Contest class by using the join code **BPEWVX**.
4. You will now be able to submit your students' work by uploading the PDF of their responses.
5. You will then have to tell GradeScope where in the PDF the students have solved each problem. The GradeScope software guides you through this process, and allows you to adjust your PDF (e.g. re-order or rotate pages) if necessary.

6. Click "Submit" and wait for GradeScope to e-mail you that the paper has been graded.

The GradeScope website hosts a number of short videos outlining how to work with their software, as well as advice on getting good scans or pictures of your students' work.

Instructions for students

To be read to the students prior to the start of the contest:

This is the first round of the 2020–2021 ARML Power Contest and should take place between Saturday, October 24 and Sunday, November 8.

You will have 45 minutes to complete this set of problems. During this time you are encouraged to work together, communicating and sharing ideas. It is important that everyone understands the problem before splitting up into smaller groups.

The topic of the first contest this year is fractional programming. It is possible to write computer programs by stringing together fractions in the right way. Though not particularly convenient, it is immensely powerful!

Please pay careful attention to the directions in each contest question, as that may save you quite a bit of writing! Remember that this is a contest of mathematical writing, and many problems require mathematical justification or proof. Be clear and concise. Some of the problems rely on each other, though most can be solved independently, assuming the result of an earlier problem. You may refer to an earlier problem in your work—even if you didn't solve that problem—but you may *not* refer to a later problem.

If you are working together in person, please write on only one side of each answer sheet. You may submit multiple problems on a single page, but be sure to submit only one solution for each problem. If you are working together online, your coach will have specific directions about how you will submit your work.

At the conclusion of the contest, submit your solutions *in order* to your coach. Problems that are out of order (except when multiple solutions are written on the same page) have sometimes been overlooked by graders, and there is unfortunately no way to give credit retroactively if this happens.

The contest has a total of 40 points possible. You will be given a copy of the scoring sheet; the point value of each problem is also listed in the left margin on the contest sheets.

You are encouraged to include any comments or concerns about the problem on the comment sheet.

Contests will be mailed in or submitted electronically, and scores will be posted online as soon as possible. The solutions will also be posted for coaches to download.

Good luck, and enjoy!

(Proctors: please distribute the contest materials and begin the 45-minute contest period.)

2029–2021 ARML Power Contest
Round 1
Grading Sheet

Team Name: _____

1a. ____ [2]
1b. ____ [2]
2. ____ [2]
3. ____ [2]
4. ____ [2]
5. ____ [2]
6. ____ [2]
7. ____ [2]
8. ____ [2]
9. ____ [2]
11a. ____ [2]
11b. ____ [2]
11c. ____ [1]
11d. ____ [3]
12. ____ [8]

Total score: _____

We have complied with the rules of this contest. _____
(Coach's signature)

_____
(Date)

2020–2021 ARML Power Contest
Round 1
Answer Sheet

Page ____ of ____. Problem(s) _____.

2020–2021 ARML Power Contest
Round 1
Comment Sheet