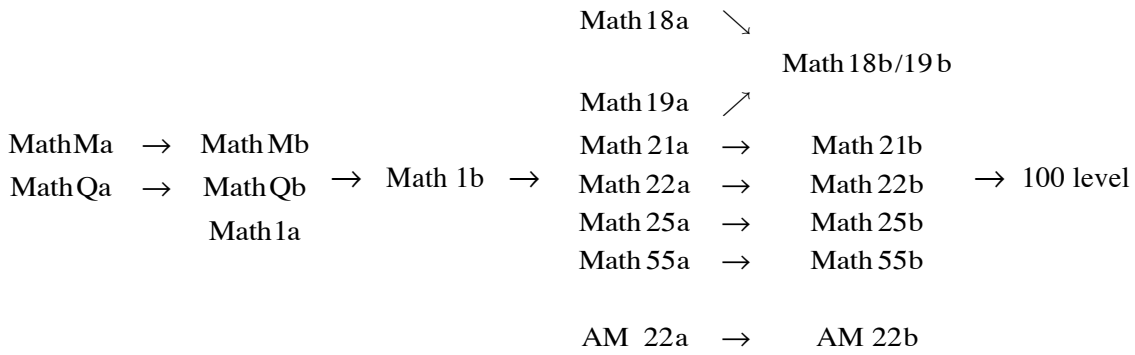
## MATH FOR FIRST YEAR STUDENTS

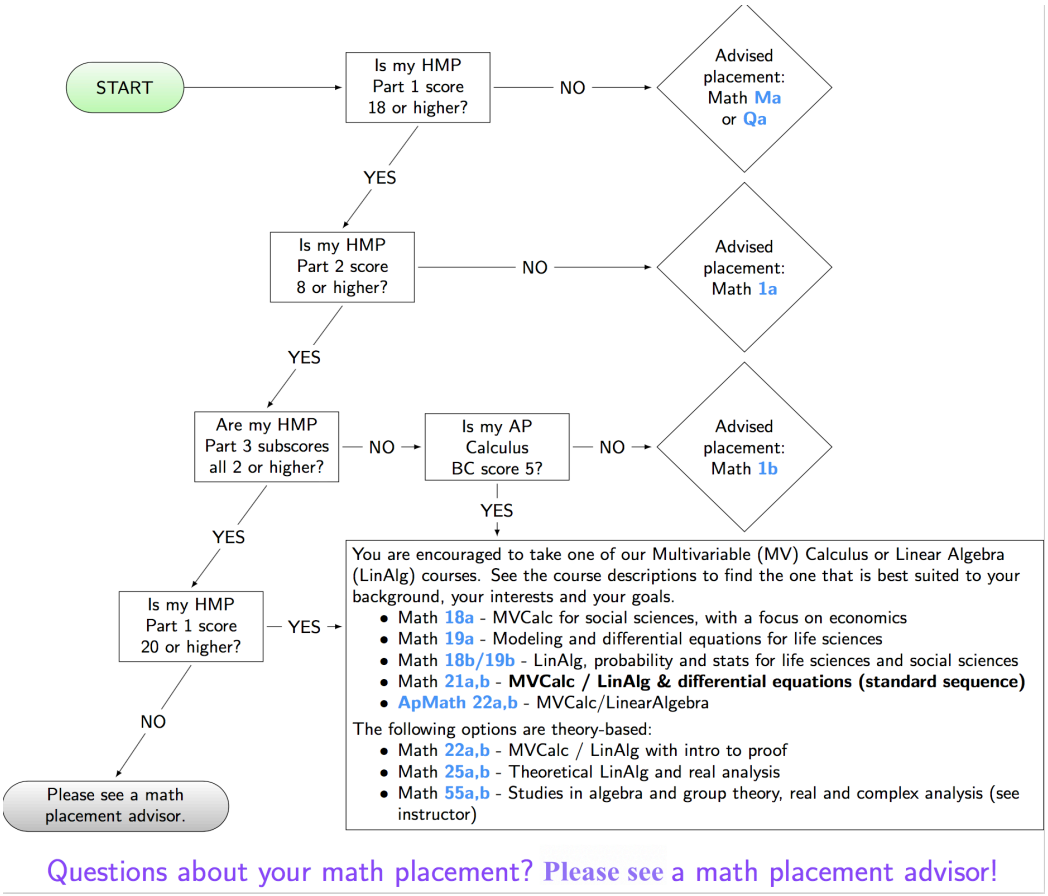
The following chart lists the introductory mathematics courses.




Each student receives a math placement recommendation that indicates either the right most column of Math Ma and Qa; or Math 1a; or Math 1b; or the column with Math 18-55 and AM22a. More is said about all of the courses in the diagram and the math placement recommendation in what follows. Given the starting course, the arrows indicate the most likely next course (or suite of possible courses). Except for Math 21a and Math 21b, the column with Math 18a at the top indicates courses taught only in the fall semester and the next column to the right (with Math 18b/19b at the top) indicates courses taught only in the spring semester. Math 21a,b are taught in the fall and again in the spring.

### 1. The crucial information

- Placement: The placement recommendation must be taken very seriously. A student who questions the placement recommendation should talk to one of the **math placement advisors**. Dedicated Math advisors can help students make an informed choice of first course; see the website https://www.math.harvard.edu/undergraduate/placement-advising/ (please wait until August 17). Do not take placement advice from other students or alumni or non-math advisors because the risk of error is too large. There is also a special video *Making sense of your placement scores* by the Math Department placement advisors to tell students about the meaning of their placement scores. A link to the video is at the following url *https://www.math.harvard.edu/undergraduate/first-year/*. The chart on the next page explains the logic behind the math placement recommendations.




- The placement test does not distinguish between the courses in the Math 18, 19, 21, 22, 25, 55 and AM 22 column. What a student placed in that column takes depends partly on the student's interests and partly on how much time the student wishes to spend on mathematics this year. Any and all questions about which course to take in this column will be answered at a special Zoom meeting in early/mid August titled *Shall I take Math 18, 19, 21, 22, 55 or AM22?* The website https://www.math.harvard.edu/undergraduate/first-year/ will have the time and date posted before hand. Please don't miss this meeting if your placement recommendation is in the Math 18-55, AM 22 column (this is a unique opportunity to get info to help you choose.)
- Sectioning: Math Ma, Math 1a, Math 1b, Math 21a, and Math 21b are all taught in small sections. In addition to registering for the course on my.harvard.edu, you need to fill out a form (the link to the form will be on the course website) listing your time preferences for your math section.
- The other courses on the list are not taught in sections.

**Placement recommendation questions:** Math advisors will be ready to answer questions about Harvard Math Placement recommendations and to help each student choose the correct starting math classes. The math placement advising schedule and contact information can be found

online at https://www.math.harvard.edu/undergraduate/placement-advising/. (Placement advising won't be available before this coming August 17. Please have patience till then.)

**Questions about higher level math courses:** Questions about math courses numbered above 55 can be addressed to Prof. Cliff Taubes (chtaubes@math.harvard.edu). Questions can also be addressed to Wes Cain (jcain2@math.harvard.edu).

**2. Brief course descriptions**

The following briefly describes the courses for first year students.

- Math Ma,b: This is a two semester course which combines pre-calculus with one variable calculus including the basics of integration and differentiation. A student who completes this sequence enters directly to Math 1b. This course satisfies the QRD requirement.

  * ESPa,b: This is an academic enrichment program for people at the Math Ma,b level interested in fields of science, technology, engineering or medicine. See https://emergingscholars.math.harvard.edu/ for more information and for how to apply (or contact the Harvard Math Department). A Zoom meeting for students about the ESP program will be held in mid August titled the *The Emerging Scholar Program information session*. See https://emergingscholars.math.harvard.edu/ for more info about this meeting
- Math Qa,b: This is a two semester, applied alternative for Math Ma/Math Mb or Math 1a for students interested in Economics and the Social Sciences. Students completing Math Qa and Math Qb will satisfy the Math 1a requirement for the Economics Concentration. This course also satisfies the QRD requirement.
- Math 1a: This is a standard first semester one variable calculus course that covers differentiation and the basics of integration. This course satisfies the QRD requirement.
- Math 1b is the second semester of a basic introduction to calculus sequence. Math 1b has a tripartite curriculum: It teaches integration of densities over surfaces and volumes, it discusses sequences and series, and it gives an introduction to ordinary differential equations up to second order equations with constant coefficients. All three parts of the curriculum are important for natural and social science concentrations. This course satisfies the QRD requirement.
- Math 18a: This course is taught in the fall only. Math 18a covers the concepts and techniques of multivariable calculus most useful to those studying the social sciences, particularly economics. Math 18a should not be taken in addition to Math 21a, but the courses Math 18b/19b (or Math 21b) can be taken before or after Math 18a. This course satisfies the QRD requirement.
- Math 19a: Math 19a is given in just the fall; it teaches multivariable calculus and differential equations for applications to the life sciences. It is recommended by those taking the Life Science 1a,b courses and by the life science concentrations (this means Biological

Anthropology, Chemical and Physical Biology, Human Evolutionary Biology, Molecular and Cellular Biology, Neurobiology, Organismic and Evolutionary Biology, and Social and Cognitive Neuroscience.) In any event, it is usually preferable to Math 21a for those majoring in a life science except for students who plan to take Physics 15/16. This course satisfies the QRD requirement.

- Math 18b/19b: This one course is given only in the spring semester. Math 18b/19b is a follow-on course for both Math 18a and Math 19a. It is for people interested in life sciences or social sciences or economics. The course teaches linear algebra with enough probability and statistics to forgo the beginning statistics courses such as Stat 100, 102, 104. Some programming will also be taught. Most of the linear algebra in Math 21b is taught; The differential equations in Math 21b is traded for probability and statistics. This course satisfies the QRD requirement.
- Math 21a: This course covers the basics of multivariable calculus in 2 and 3 dimensions: Curves, surfaces, functions, their derivatives, calculus of variations, multi-variable integration, integration on curves and surfaces, multivariable generalizations of the fundamental theorem of calculus. This course satisfies the QRD requirement.
- Math 21b: This course is on basic linear algebra in dimensions 2, 3 and higher. A good part of the course uses linear algebra to study ordinary and partial differential equations. This course satisfies the QRD requirement.
- Math 22a,b: This course covers multivariable calculus and linear algebra for students interested in theoretical sciences. It covers the same topics as Math 21a,b but with more rigor. Students are taught techniques of proof and mathematical reasoning. The workload and content is comparable with the 21 sequence. But unlike in the latter, the linear algebra and calculus is more interlinked.
- Math 25 and 55: These are theory courses that should be elected only by those students who have a particular interest in and enjoyment of abstract mathematics, as well as a solid understanding of one-variable calculus. These courses assume a willingness to think rigorously and abstractly about mathematics, and to work hard. Both courses study multivariable calculus and linear algebra plus many very deep related topics. These courses come with an iron clad guarantee that you will be challenged by the mathematics.

* **CHOOSING BETWEEN MATH 22, 25 OR 55**: Math 25 differs from Math 22 by virtue of the work load in Mathematics 25 being significantly more than in Math 22; but then Mathematics 25 covers more material than Math 22. Note however that any course that asks for Math 25 as a prerequisite accepts Math 22 as well. Mathematics 55 differs from Mathematics 25 in that the former assumes a very strong proof oriented mathematics background. Mathematics 55 requires the consent of the instructor.

- Applied Math 22: The Applied Math 22a,b sequence (*Solving and optimizing* and then *Integrating and approximating*) covers most of the same material as Math 21a,b but the order of presentation is different with linear algebra appearing in AM 22a and much of

multivariable calulus in AM 22b. It is also taught from a somewhat more applied point of view and with less on differential equations. AM 22a,b are taught in large lecture format.

NOTE: Math 18a or 19a and Math 18b/19b can be taken in either order; Math 21a,b can also be taken in either order. Math 21a can be taken with Math 18b/19b and Math 19a can be taken with Math 21b. Math 22b can be taken after Math 21b and Math 21a after Math 22a.

OTHER COURSES:

- Math 101: Math 101 (fall and spring semesters) is designed to give people with a Math 1b level background and with interest in mathematics a taste of what modern mathematics is all about. This course can be taken concurrently with Math 21a or 21b. It is not to be taken with Math 25 or 55 (without special permission). It can be taken with Math 22 (concurrently or after). Math 101 also gives a good background for writing and following mathematical proofs. This skill will be needed in any event for most higher level math courses. This skill is also taught in Math 22 and Math 25, and in a few other 100 level courses.
- Freshman taking other 100 level courses: This is OK in principle (but concurrent registration in Math 25 or 55 is recommended). In any event, any freshman that is considering this has to talk first with the Mathematics DUS, Professor Cliff Taubes (chtaubes@math.harvard.edu).
- Courses at MIT: Any freshman considering a mathematics course at MIT must talk first with Professor Taubes.
- Freshman Seminars: Most freshman seminars by Mathematics Department faculty members can be used as one of the 8 required Mathematics courses for a concentration in Mathematics. To do this, a student must petition to Professor Taubes after taking the course. Freshman seminars are to be recommended. There is one this fall taught by Professor Robin Gottlieb.

**3. Calculus section information**

After an early morning introductory meeting on Wednesday, August 31 (see below), the courses **Math Ma, 1a, 1b, 21a** and **21b** are taught entirely in small sections. To enroll in these courses, you must first register for the course on my.harvard.edu as you would for any other course. After doing that, you must specify a time slot preferences for your math section by filling out a form that is linked to on the course website. These forms will become active on August 17; the form should then be filled out by the end of registration period, August 26. You can re-section as often as you like during this time and the previous entry will be erased. (Information about how to enroll and choose a section after these dates will also be available on the course websites.) Section assignments and meeting room information will be emailed to students before the first section meeting.

The courses Math 18a, 19a, Math 22a, 25a, 55a and Applied Math 22a are not taught in sections.

**4. Course meeting times**

The sectioned courses Math Ma, Math 1a, Math1b, Math 21a and Math 21b will have an early morning meeting of all enrolled students on Wednesday, August 31. See the course website for the room number and time of this meeting. The actual sections in Math Ma, Math 1a, Math1b, Math 21a and Math 21b begin in person on Friday, September 2. Non-sectioned courses 18a, 19a, 22a, 25a, 55a and AM 22a begin on the first day of classes (Wednesday, August 31). Math course numbered 101 and above start on either Wednesday, August 31 or Thursday, September 1; the day/time is noted in the Course Catalogue.