



## Mathematics/Science

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### Aligned to the Research: Science and Mathematics Graduation Requirements

By Kyle Zinth and Jennifer Dounay

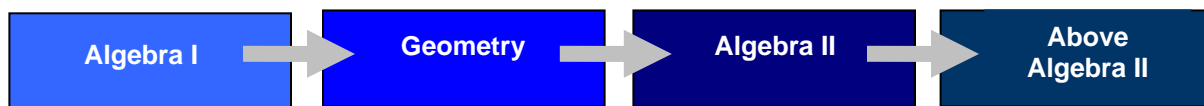
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#### What Are the Optimum Requirements?

Recent years have seen much attention on mathematics and science education, and one of the most visible actions many states have taken is raising high school graduation requirements for the two subjects. The goal of increasing graduation requirements in [mathematics](#) and [science](#) is typically to increase the likelihood of student success after high school, whether in the workforce or while enrolled at a postsecondary institution. Influential recent reports from Cliff Adelman and ACT have found if increased success after high school is in fact the goal of increasing graduation requirements, it is most effective to require *specific courses*, rather than simply requiring more mathematics and science courses.<sup>1</sup> Additionally, the American Diploma Project (ADP) has identified a similar course sequence.

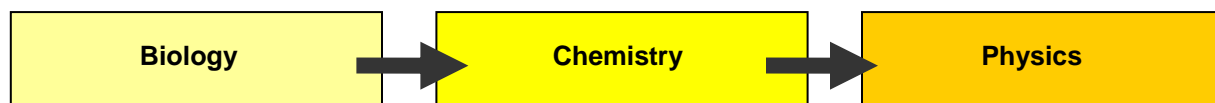
#### Mathematics

Adelman suggests 3.75 Carnegie units in high school math, with calculus, pre-calculus or trigonometry being the highest level of high school math completed. ACT's "gold standard" in mathematics is completion of Algebra I, Geometry, Algebra II, trigonometry and calculus; while ADP's benchmarks reflect content typically taught in Algebra I, Algebra II and Geometry, as well as data analysis and statistics. A reconciliation of these recommendations is below.



#### Science

Adelman suggests at least 2.5 Carnegie units of science *or* more than 2.0 Carnegie units of core laboratory science, namely biology, chemistry and physics. ACT's recommended course sequence includes biology, chemistry and physics. A reconciliation of the two recommendations is below.



# State Graduation Requirements

## Highlights

- Three states will require all students to complete the biology, chemistry and physics sequence: **Oklahoma** (class of 2010), **South Dakota** (2010) and **Texas** (2016).
  - Nine states will require all students to complete the Algebra I, II, geometry sequence: **Texas** (class of 2008); **Arkansas, Oklahoma and South Dakota** (2010); **Delaware, Indiana and Michigan** (2011); and **Idaho and Kentucky** (2012).
  - Michigan** (class of 2011) and **Kentucky** (2012) will require all students to take mathematics in their senior year. (**Indiana** strongly encourages this.)
  - Seventeen** states currently require or plan to require at least two lab sciences.\*
  - Thirty five** states require three or more units of science, or are in the process of phasing in such requirements.
  - All sciences are explicitly lab-based in **Georgia, Indiana and West Virginia**. All science classes in **Tennessee** must "include laboratory experiences."
- \*This report examines state statutes and regulations, for that reason readers are urged to use caution when interpreting this information, as more than one state defines all sciences as lab sciences in their science standards.*

## 50-State Summary

Shaded cells in the table correspond to subjects as indicated in the key below. **Each shaded cell corresponds to one required Carnegie unit.** When applicable, phased-in requirements appear below current requirements. Cells indicated as "other" includes those states that provide a list of classes a student may choose from that include at least one course option that does not appear in the key. For mathematics, "Algebra +" indicates when a state requires a student to complete a course above Algebra without indicating a specific course. "Lab Science" indicates when requirements call for a lab science, but do not specify beyond that. LEA = Local Education Agency. Corrections to listed polices are welcome.

### Mathematics Courses

	Alg. I	Alg. II	Geo.	Alg. +	Other	Non-specified	Key
Alabama							
Alaska							
Arizona							
Arkansas							
Class of 2009							
Class of 2010							
California							
Colorado	LEA Determination						
Connecticut							
Delaware							
Class of 2011							

### Science Courses

	Bio.	Chem.	Physics	Physical Science	Lab Science	Other	Non-specified
Alabama							
Alaska							
Arizona							
Arkansas							
Class of 2009							
Class of 2010 <sup>2</sup>							
California <sup>3</sup>							
Colorado	LEA Determination						
Connecticut							
Delaware							
Class of 2011							

**Mathematics Courses**

**Science Courses**

Alg. I	Alg. II	Geo.	Alg. +	Other	Non-specified	Key	Bio.	Chem.	Physics	Physical Science	Lab Science	Other	Non-specified
<b>District of Columbia</b>							<b>District of Columbia</b>						
Class of 2008							Class of 2008						
Class of 2011							Class of 2011						
<b>Florida</b>							<b>Florida</b>						
Class of 2011 <sup>4</sup>							Class of 2011						
<b>Georgia</b>							<b>Georgia</b> <sup>5</sup>						
<b>Hawaii</b>							<b>Hawaii</b>						
<b>Idaho</b> <sup>6</sup>							<b>Idaho</b>						
Class of 2012							Class of 2012						
Class of 2013							Class of 2013						
<b>Illinois</b>							<b>Illinois</b>						
Class of 2009							Class of 2009						
Class of 2010							Class of 2011						
<b>Indiana</b>							<b>Indiana</b> <sup>9</sup>						
Class of 2008							Class of 2008						
Class of 2011 <sup>11</sup>							Class of 2011 <sup>12</sup>						
<b>Iowa</b>							<b>Iowa</b>						
Class of 2011							Class of 2011						
<b>Kansas</b>							<b>Kansas</b>						
Class of 2009 <sup>13</sup>							Class of 2009						
<b>Kentucky</b>							<b>Kentucky</b>						
Class of 2012 <sup>15</sup>							Class of 2012 <sup>16</sup>						
<b>Louisiana</b>							<b>Louisiana</b>						
Class of 2009							Class of 2009						
<b>Maine</b>							<b>Maine</b>						
<b>Maryland</b>							<b>Maryland</b> <sup>17</sup>						
<b>Massachusetts</b>							<b>Massachusetts</b>						
Class of 2011							Class of 2011 <sup>19</sup>						
<b>Michigan</b>							<b>Michigan</b>						
Class of 2011							Class of 2011						
<b>Minnesota</b>							<b>Minnesota</b>						
Class of 2008							Class of 2008						
Class of 2011 <sup>21</sup>							Class of 2011						
Class of 2015							Class of 2015						

**Mathematics Courses**

**Science Courses**

Alg. I	Alg. II	Geo.	Alg. +	Other	Non-specified	Key	Bio.	Chem.	Physics	Physical Science	Lab Science	Other	Non-specified
<b>Mississippi</b>							<b>Mississippi</b>						
Class of 2009							Class of 2009						
Class of 2012							Class of 2012						
<b>Missouri</b>							<b>Missouri</b>						
Class of 2010							Class of 2010						
<b>Montana</b>							<b>Montana</b>						
<b>Nebraska</b>						LEA Determination	<b>Nebraska</b>						LEA Determination
<b>Nevada</b>							<b>Nevada</b>						
<b>New Hampshire</b>							<b>New Hampshire</b>						
<b>New Jersey</b>							<b>New Jersey</b>						
<b>New Mexico</b>							<b>New Mexico</b>						
Class of 2009							Class of 2009						
Class of 2013							Class of 2013						
<b>New York</b>							<b>New York</b> <sup>24</sup>						
<b>North Carolina</b>							<b>North Carolina</b> <sup>25</sup>						
<b>North Dakota</b>						LEA Determination	<b>North Dakota</b>						LEA Determination
<b>Ohio</b>							<b>Ohio</b>						
Class of 2014							Class of 2014						<sup>26</sup>
<b>Oklahoma</b>							<b>Oklahoma</b>						
Class of 2010 <sup>27</sup>							Class of 2010 <sup>28</sup>						
<b>Oregon</b>							<b>Oregon</b>						
Class of 2010							Class of 2010						
Class of 2012							Class of 2012						
Class of 2014							Class of 2014						
<b>Pennsylvania</b>						LEA Determination	<b>Pennsylvania</b>						LEA Determination
<b>Rhode Island</b>							<b>Rhode Island</b>						
Class of 2008							Class of 2008						
<b>South Carolina</b>							<b>South Carolina</b>						
<b>South Dakota</b> <sup>29</sup>							<b>South Dakota</b>						
Class of 2008							Class of 2008						
Class of 2010							Class of 2010 <sup>30</sup>						
<b>Tennessee</b> <sup>31</sup>							<b>Tennessee</b> <sup>32</sup>						
Class of 2009 <sup>33</sup>							Class of 2009						

## Mathematics Courses

## Science Courses

Alg. I	Alg. II	Geo.	Alg. +	Other	Non-specified	Key	Bio.	Chem.	Physics	Physical Science	Lab Science	Other	Non-specified	
<b>Texas</b>							<b>Texas</b>							
Class of 2008														
Class of 2011														
Class of 2016														
<b>Utah</b> <sup>37</sup>							<b>Utah</b> <sup>38</sup>							
Class of 2011														
<b>Vermont</b>							<b>Vermont</b>							
<b>Virginia</b> <sup>40</sup>							<b>Virginia</b> <sup>41</sup>							
<b>Washington</b>							<b>Washington</b>							
<b>West Virginia</b>							<b>West Virginia</b> <sup>42</sup>							
Class of 2008														
Class of 2009														
Class of 2010														
Class of 2012														
<b>Wisconsin</b> <sup>46</sup>							<b>Wisconsin</b>							
<b>Wyoming</b>							<b>Wyoming</b>							

### Source:

Jennifer Dounay, [Standard Graduation Requirements](#), Education Commission of the States: <http://mb2.ecs.org/reports/Report.aspx?id=735>.

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## Helping State Leaders Shape Education Policy

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- <sup>1</sup> Cliff Adelman, *The Toolbox Revisited: Paths to Degree Completion from High School Through College*, U.S. Department of Education, February 2006, [Crisis at the Core](#), ACT, Inc., 2004, *Courses Count: Preparing Students for Postsecondary Success*, ACT, Inc., 2005
- <sup>2</sup> Three units of lab sciences, chosen from physical science, biology or applied biology/chemistry, chemistry, or physics or Principles of Technology I and II or PIC Physics.
- <sup>3</sup> Must include "biological and physical sciences."
- <sup>4</sup> Districts "are encouraged to set specific goals to increase enrollments in, and successful completion of, geometry and Algebra II."
- <sup>5</sup> Students must meet the requirements for the College Preparatory (CP) or College Preparatory with Distinction (CP+) seal, or pass any three units of science including one physical science, one life science or two units of applied biology/chemistry. All must be lab-based.
- <sup>6</sup> May be fulfilled by "Applied Mathematics, Business Mathematics, Algebra, Geometry, Trigonometry, Fundamentals of Calculus, Probability and Statistics, Discrete Mathematics, and courses in mathematical problem solving and reasoning."
- <sup>7</sup> Algebra II or advanced mathematics beyond geometry.
- <sup>8</sup> Ibid.
- <sup>9</sup> "All approved high school science courses are laboratory courses and must be taught as laboratory courses."
- <sup>10</sup> Must include Algebra I or Integrated Mathematics I.
- <sup>11</sup> Students must complete one of two course sequences: (1) Algebra I, geometry and Algebra II or (2) Integrated Mathematics I, II, III.
- <sup>12</sup> Students required to complete one unit biology, one unit chemistry, physics or integrated chemistry-physics and one unit additional credit in Core 40 science courses.
- <sup>13</sup> Courses must include "algebraic and geometric concepts."
- <sup>14</sup> Third unit must be a math elective from the program of studies in 704 KY. ADMIN REGS. 3:303.
- <sup>15</sup> Students must be engaged in math every year of high school. Pre-algebra may not be counted as one of three math credits but may be counted as an elective.
- <sup>16</sup> Must include: biological science, physical science, earth and space science and unifying concepts.
- <sup>17</sup> Two lab units must be chosen from earth, life and/or physical science.
- <sup>18</sup> Fourth unit must be chosen from trigonometry, statistics, pre-calculus, calculus, applied math, accounting, business math or retake of Algebra II. All students must take one math course during senior year of high school.
- <sup>19</sup> All three units must be lab science, and include biology and chemistry or physics. Fourth unit science strongly encouraged.
- <sup>20</sup> Three units must include algebra, geometry, statistics and probability.
- <sup>21</sup> All students required to complete Algebra I by the end of 8th grade.
- <sup>22</sup> Three units must include algebra, geometry, statistics and probability.
- <sup>23</sup> Must also include one unit chemistry or physics.
- <sup>24</sup> Three units of "commencement level science," including one unit life sciences, one unit physical sciences and one unit either life sciences or physical sciences. Must include one lab unit.
- <sup>25</sup> All diploma options must include biology, a physical science, and earth/environmental science.
- <sup>26</sup> One unit advanced science chosen from: (1) chemistry, physics or other physical science; (2) advanced biology or other life science; (3) astronomy, physical geology, or other earth or space science.
- <sup>27</sup> Three units of mathematics, limited to Algebra I, Algebra II, Geometry, Trigonometry, Math Analysis, Calculus, Advanced Placement Statistics, or any mathematics course with content and/or rigor above Algebra I and approved for college admission requirements.
- <sup>28</sup> Three units of laboratory science, limited to Biology, Chemistry, Physics, or any laboratory science course with content and/or rigor equal to or above Biology and approved for college admission requirements.
- <sup>29</sup> Five units math and laboratory science, of which at least two units must be math.

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- <sup>30</sup> Students required to complete two units of lab science.
- <sup>31</sup> Must include one unit Algebra 1, Math for Technology II or Integrated Mathematics I.
- <sup>32</sup> Must include one unit Biology I, Biology for Technology or the equivalent in an integrated curriculum. All sciences courses must "include laboratory experiences."
- <sup>33</sup> Students must also complete one of the following: Algebra II, Geometry, Integrated Math II, or Technical Geometry.
- <sup>34</sup> Students must complete Integrated Physics and Chemistry.
- <sup>35</sup> Two additional credits must be chosen from: (1) integrated physics and chemistry; (2) chemistry; and (3) physics or Principles of Technology I.
- <sup>36</sup> Ibid.
- <sup>37</sup> Students must complete elementary Algebra or Applied Mathematics I and Geometry or Applied Mathematics II. High school math credit may not be earned in courses below Elementary Algebra and Applied Mathematics I.
- <sup>38</sup> Two units must be chosen from the four science areas: earth systems science, biological science, chemistry and physics. Up to one unit may be earned in any of the four disciplines.
- <sup>39</sup> Students required to complete three units, to include Elementary Algebra or Applied Mathematics I and Geometry or Applied Mathematics II.
- <sup>40</sup> Courses completed to satisfy this requirement must be at or above the level of algebra and include at least two units from among: Algebra I, Geometry, Algebra II or other mathematics courses above the level of algebra and geometry.
- <sup>41</sup> Courses completed to satisfy this requirement must include course selections from at least two different science disciplines: earth sciences, biology, chemistry or physics.
- <sup>42</sup> Coordinated and Thematic Science (CATS) 9, CATS 10, and one course above CATS 10.
- <sup>43</sup> Ibid.
- <sup>44</sup> Four units, CATS 9 and three courses above CATS 9.
- <sup>45</sup> All students must take physical science, biology and chemistry in consecutive order.
- <sup>46</sup> Must include "instruction in the properties, processes, and symbols of arithmetic and elements of algebra, geometry, and statistics."
- <sup>47</sup> Must include "instruction in the biological sciences and physical sciences."