

Kentucky Summative Assessments



Grade 11 Science Released Items 2026



In 2014, a portion of the floor of the National Corvette Museum in Bowling Green, KY, collapsed. The collapse was the result of a sinkhole beneath the museum floor that gave way. The sinkhole turned out to be 60 feet in diameter and 40 feet deep. Because sinkholes are common in Kentucky, it was important to determine the reason for the collapse. Joseph, a student at a local high school, read about the sinkhole collapse. He decided to research sinkholes to see what was currently being done to protect buildings from sinkholes.

Joseph learned that even ordinary rainwater is somewhat acidic because carbon dioxide, which is itself acidic, dissolves in rain as it falls. The following table provides information on the rock types and compositions of the most common underlying rock in four states.

State	Common Rock Type of Underlying Formations	Chemical Composition	Effects of Rainwater on Various Types of Rocks
KY	Limestone Sedimentary	Calcium carbonate CaCO_3	
PA	Granite Igneous	Quartz and feldspar silica Silicon dioxide SiO_2	
FL	Coquina Sedimentary	Calcium carbonate CaCO_3	
AR	Basalt Metamorphic	Aluminum Silicate Al_2SiO_5	



SCHS1606_00a

Joseph found in his research that much of the rock underlying Kentucky is limestone. He decided to do an experiment. In his experiment, he put acidic water on samples from the underlying rock found in each state. He found that only rocks from Kentucky and Florida bubbled and changed.

1

SCHS1606_02_4

Which one of the following explanations is **most likely** consistent with Joseph's experiment?

- A** Sinkholes are caused by natural chemical processes that occur with silicon compounds.
- B** Slightly acidic rainwater chemically reacts with the limestone, causing the acid to give off carbon dioxide gas.
- C** Rock in states with underlying limestone will have sinkholes as long as acid rain falls, due to carbon dioxide gas.
- D** Slightly acidic rainwater causes chemical reactions with calcium carbonate, causing rock to give off a gas and dissolve.



Released Item Performance

Kentucky Summative Assessments

Spring 2026

Grade 11

Science

Item: SCHS1606_02

Book Question Number: 1

Standard: HS-ESS2-5

Item Type: MC

Key: D

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,825	44%	0.44	7%	23%	26%	44%
Gender							
Female	22,539	45%	0.45	7%	23%	26%	45%
Male	23,285	43%	0.43	8%	23%	26%	43%
Ethnicity							
African American	5,046	33%	0.33	10%	28%	29%	33%
American Indian or Alaska Native	67	51%	0.51	9%	19%	21%	51%
Asian	945	55%	0.55	4%	21%	20%	55%
Hispanic or Latino	4,615	37%	0.37	9%	26%	28%	37%
Native Hawaiian or Pacific Islander	72	44%	0.44	7%	25%	24%	44%
White (non-Hispanic)	32,859	46%	0.46	7%	22%	25%	46%
Two or more races	2,219	42%	0.42	9%	22%	27%	42%
Migrant							
Migrant	182	24%	0.24	12%	30%	34%	24%
English Learner							
English Learner	2,403	26%	0.26	11%	29%	33%	26%
Economically Disadvantaged							
Economically Disadvantaged	24,596	39%	0.39	9%	25%	28%	39%
Students with Disabilities							
Students with Disabilities	4,517	31%	0.31	13%	27%	30%	31%



2

SCHS1606_03_3

In order for Joseph to have reliable data, which one of the following variables is **most** important to control?

- A** The type of rock he is using for all of the tests.
- B** The temperature in the room for each of the tests.
- C** The concentration and amount of water applied to each rock.
- D** The way he measures the number of gas bubbles being given off from the reactions with the rocks.



Released Item Performance

Kentucky Summative Assessments

Spring 2026

Grade 11

Science

Item: SCHS1606_03

Book Question Number: 2

Standard: HS-ESS2-5

Item Type: MC

Key: C

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,818	51%	0.51	24%	7%	51%	19%
Gender							
Female	22,535	53%	0.53	23%	6%	53%	18%
Male	23,282	49%	0.49	24%	7%	49%	20%
Ethnicity							
African American	5,044	38%	0.38	25%	11%	38%	26%
American Indian or Alaska Native	67	48%	0.48	30%	7%	48%	15%
Asian	945	57%	0.57	22%	5%	57%	15%
Hispanic or Latino	4,615	41%	0.41	26%	8%	41%	25%
Native Hawaiian or Pacific Islander	72	51%	0.51	24%	6%	51%	19%
White (non-Hispanic)	32,854	54%	0.54	23%	6%	54%	17%
Two or more races	2,219	50%	0.50	24%	8%	50%	19%
Migrant							
Migrant	182	27%	0.27	26%	12%	27%	36%
English Learner							
English Learner	2,401	27%	0.27	24%	13%	27%	36%
Economically Disadvantaged							
Economically Disadvantaged	24,588	45%	0.45	25%	8%	45%	22%
Students with Disabilities							
Students with Disabilities	4,521	33%	0.33	22%	11%	33%	33%



3

SCHS1606_04_3

Based on Joseph's experiment, which one answer **best** shows the results he would record in the last column "Effects of Rainwater on Various Types of Rocks" in the table? Results are indicated as:

RS = "Rocks Were Stable"
OR
RC = "Rocks Were Changed"

State	Common Rock Type of Underlying Formations	Chemical Composition	Effects of Rainwater on Various Types of Rocks
KY	Limestone Sedimentary	Calcium carbonate CaCO_3	
PA	Granite Igneous	Quartz and feldspar silica Silicon dioxide SiO_2	
FL	Coquina Sedimentary	Calcium carbonate CaCO_3	
AR	Basalt Metamorphic	Aluminum Silicate Al_2SiO_5	

A

KY	RS
PA	RS
FL	RS
AR	RS

B

KY	RS
PA	RC
FL	RS
AR	RC

C

KY	RC
PA	RS
FL	RC
AR	RS

D

KY	RC
PA	RC
FL	RC
AR	RC



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Grade 11

Science

Item: SCHS1606_04

Book Question Number: 3

Standard: HS-ESS2-5

Item Type: MC

Key: C

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,743	72%	0.72	7%	18%	72%	3%
Gender							
Female	22,501	75%	0.75	5%	17%	75%	3%
Male	23,241	69%	0.69	8%	19%	69%	3%
Ethnicity							
African American	5,020	60%	0.60	10%	26%	60%	4%
American Indian or Alaska Native	67	81%	0.81	4%	13%	81%	1%
Asian	945	81%	0.81	4%	13%	81%	1%
Hispanic or Latino	4,602	65%	0.65	8%	24%	65%	4%
Native Hawaiian or Pacific Islander	72	61%	0.61	7%	31%	61%	1%
White (non-Hispanic)	32,822	75%	0.75	6%	16%	75%	3%
Two or more races	2,213	70%	0.70	7%	20%	70%	3%
Migrant							
Migrant	182	55%	0.55	12%	28%	55%	5%
English Learner							
English Learner	2,385	47%	0.47	12%	35%	47%	6%
Economically Disadvantaged							
Economically Disadvantaged	24,541	67%	0.67	8%	22%	67%	3%
Students with Disabilities							
Students with Disabilities	4,507	52%	0.52	13%	30%	52%	5%



4

SCHS1606_05_1

After Joseph analyzed his data, he determined that Florida and Kentucky are the two states of the four that are most likely to have sinkholes. Which one of the following is the **best** evidence to support this finding?

- A** The two sedimentary rocks, coquina and limestone, have the same chemical structure (calcium carbonate) and dissolve in acidic water.
- B** The rocks in two of the states are made from granite, feldspar, and quartz, all of which are made of minerals, and minerals are harder than rocks.
- C** The states all have bedrock supporting the land and the bedrock is similar; however, rocks in Kentucky and Florida are closer to the surface and react with rainwater.
- D** The way the two sedimentary rocks in his experiment reacted to acid is the same way the rocks in Kentucky and Florida were formed hundreds of millions of years ago.



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Science

Item: SCHS1606_05

Book Question Number: 4

Standard: HS-ESS2-5

Item Type: MC

Key: A

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,821	61%	0.61	61%	11%	18%	11%
Gender							
Female	22,539	63%	0.63	63%	9%	17%	10%
Male	23,281	58%	0.58	58%	12%	18%	11%
Ethnicity							
African American	5,043	46%	0.46	46%	15%	25%	14%
American Indian or Alaska Native	67	64%	0.64	64%	10%	13%	12%
Asian	945	72%	0.72	72%	7%	13%	8%
Hispanic or Latino	4,615	52%	0.52	52%	14%	21%	13%
Native Hawaiian or Pacific Islander	72	51%	0.51	51%	15%	18%	15%
White (non-Hispanic)	32,856	64%	0.64	64%	10%	16%	10%
Two or more races	2,221	61%	0.61	61%	10%	18%	11%
Migrant							
Migrant	182	35%	0.35	35%	16%	30%	19%
English Learner							
English Learner	2,401	31%	0.31	31%	21%	31%	17%
Economically Disadvantaged							
Economically Disadvantaged	24,591	54%	0.54	54%	13%	21%	13%
Students with Disabilities							
Students with Disabilities	4,517	37%	0.37	37%	19%	28%	16%



SCHS1606_00b

Kentucky has a large number of underground caves.

5

SCHS1606_06_4

Which one is the **best** explanation of how the causes of the sinkhole under the National Corvette Museum and the causes of the caves in Kentucky are related?

- A** Sinkholes in southern states are the result of caves that have always been in these states. Sand from the surface is washed into the caves, which results in a sinkhole.
- B** Sinkholes in Kentucky are caused by the movement of the Earth due to seismic activity. The caves are also formed by seismic activity that occurred millions of years ago and continues today.
- C** Kentucky's caves formed when limestone layers formed. These caves are usually filled with water; however, during droughts the water drains out and the surface collapses.
- D** Caves form when water running through the underlying rock reacts with limestone, causing large openings in the rock. Sinkholes occur when the top layers of rock collapse into the openings.



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Science

Item: SCHS1606_06

Book Question Number: 5

Standard: HS-ESS2-5

Item Type: MC

Key: D

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,812	55%	0.55	10%	15%	19%	55%
Gender							
Female	22,536	58%	0.58	8%	15%	19%	58%
Male	23,275	53%	0.53	11%	16%	20%	53%
Ethnicity							
African American	5,041	39%	0.39	14%	22%	25%	39%
American Indian or Alaska Native	67	61%	0.61	4%	13%	21%	61%
Asian	945	65%	0.65	6%	12%	17%	65%
Hispanic or Latino	4,613	45%	0.45	13%	19%	23%	45%
Native Hawaiian or Pacific Islander	72	56%	0.56	11%	11%	22%	56%
White (non-Hispanic)	32,851	59%	0.59	9%	14%	18%	59%
Two or more races	2,221	54%	0.54	11%	15%	21%	54%
Migrant							
Migrant	182	31%	0.31	15%	27%	27%	31%
English Learner							
English Learner	2,399	27%	0.27	18%	26%	30%	27%
Economically Disadvantaged							
Economically Disadvantaged	24,590	49%	0.49	11%	18%	22%	49%
Students with Disabilities							
Students with Disabilities	4,516	35%	0.35	16%	23%	25%	35%



6

SCHS1606_07_2

What is the one **most likely** way the findings from Joseph's experiment on the effects of acids on various types of rocks are consistent with the causes of the sinkhole at the National Corvette Museum?

- A** The mechanism by which the building changed was shown in the experiments.
- B** The rock under the museum was changed by acid rain, causing a portion of the museum floor to collapse. The experiment provides evidence that rocks in Kentucky are changed by acid.
- C** The collapse of a portion of the museum floor was due to the way the building was constructed and where the building was located. The experiment provides evidence of the strength of the building construction.
- D** The investigation shows that the rocks can be changed, and the collapse of a portion of the museum floor was caused by the rock beneath the floor changing quickly. The experiment showed that acids can change rocks quickly.



Released Item Performance

Kentucky Summative Assessments

Spring 2026

Grade 11

Science

Item: SCHS1606_07

Book Question Number: 6

Standard: HS-ESS2-5

Item Type: MC

Key: B

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,804	50%	0.50	4%	50%	15%	30%
Gender							
Female	22,534	51%	0.51	3%	51%	14%	32%
Male	23,269	49%	0.49	5%	49%	17%	28%
Ethnicity							
African American	5,038	43%	0.43	7%	43%	20%	30%
American Indian or Alaska Native	67	51%	0.51	6%	51%	15%	28%
Asian	943	60%	0.60	3%	60%	11%	26%
Hispanic or Latino	4,614	46%	0.46	6%	46%	19%	30%
Native Hawaiian or Pacific Islander	72	46%	0.46	3%	46%	18%	33%
White (non-Hispanic)	32,848	52%	0.52	4%	52%	14%	30%
Two or more races	2,220	49%	0.49	5%	49%	16%	29%
Migrant							
Migrant	182	38%	0.38	4%	38%	21%	37%
English Learner							
English Learner	2,401	34%	0.34	9%	34%	25%	32%
Economically Disadvantaged							
Economically Disadvantaged	24,584	46%	0.46	5%	46%	18%	31%
Students with Disabilities							
Students with Disabilities	4,517	37%	0.37	8%	37%	23%	31%



7

SCHS1606_08

Extended Response Directions: Read the question carefully. Then enter your response in the space provided.

Based on Joseph's investigation of the causes of the sinkhole and your knowledge of Earth materials, propose a solution to prevent other buildings from being damaged by sinkholes. Identify two questions you would need to investigate to help you decide if a solution is reasonable.



Released Item Performance

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Spring 2026

Grade 11

Science

Item: SCHS1606_08

Book Question Number: 7

Standard: HS-ETS1-1

Item Type: ER

Key: Rubric

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Score Percentages				
				Score 0 (%)	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)
All Students	40,875	25.4%	1.02	34%	34%	30%	3%	0%
Gender								
Female	20,729	27.4%	1.09	31%	33%	34%	3%	0%
Male	20,145	23.4%	0.93	37%	35%	25%	2%	0%
Ethnicity								
African American	3,995	15.2%	0.61	55%	30%	14%	1%	0%
American Indian or Alaska Native	63	27.0%	1.08	30%	33%	35%	2%	0%
Asian	884	31.4%	1.26	24%	31%	38%	6%	0%
Hispanic or Latino	3,874	18.9%	0.75	47%	32%	20%	1%	0%
Native Hawaiian or Pacific Islander	64	22.7%	0.91	39%	34%	23%	3%	0%
White (non-Hispanic)	30,063	27.5%	1.10	29%	35%	33%	3%	0%
Two or more races	1,930	24.4%	0.97	35%	35%	28%	2%	0%
Migrant								
Migrant	148	8.8%	0.35	71%	23%	6%	0%	0%
English Learner								
English Learner	1,697	6.7%	0.27	78%	18%	4%	0%	0%
Economically Disadvantaged								
Economically Disadvantaged	21,324	21.0%	0.84	42%	34%	23%	2%	0%
Students with Disabilities								
Students with Disabilities	3,709	10.1%	0.41	68%	24%	7%	0%	0%

Anchor Set

Kentucky Academic Standards Science Rubric	
Score	Description
4	There is evidence in this response that the student has a complete and thorough understanding of the multi-dimensional question as evidenced by their explanation of the phenomenon and/or solution to the problem. The response is complete, thorough and correct and based on appropriate knowledge and skills The response does not contain errors or flaws in logical thinking or those flaws are irrelevant to the accuracy of the answer The response reflects complete synthesis and understanding of complex ideas The response is completely coherent and based on effective application of relevant dimensions (SEP and/or DCI and/or CC) The response integrates a solution that is completely correct and based on the principles of engineering design (if applicable).
3	There is evidence in this response that the student has a general understanding of the multi-dimensional question as evidenced by their explanation of the phenomenon and/or solution to the problem. The response is generally complete and the question is answered using appropriate knowledge and skills The response may contain minor errors or flaws in logical thinking and those flaws may or may not be irrelevant to the accuracy of the answer The response reflects a general synthesis and understanding of complex ideas The response is generally coherent and based on application of relevant dimensions (SEP and/or DCI and/or CC) The response integrates a solution that is generally correct and mostly based on the principles of engineering design (if applicable).
2	There is evidence in this response that the student has a limited understanding of the multi-dimensional question as evidenced by their explanation of the phenomenon and/or solution to the problem. The response is partially complete and/or the question is answered using limited understanding of knowledge and skills The response may contain significant errors or flaws in logical thinking The response reflects a limited synthesis and understanding of complex ideas The response may or may not be coherent and based on some application of relevant dimensions (SEP and/or DCI and/or CC) The response integrates a solution that is partly correct and may or may not be based on the principles of engineering design (if applicable).

1	There is evidence in this response that the student has a minimal understanding of the multi-dimensional question as evidenced by their explanation of the phenomenon and/or solution to the problem. The response is minimal and/or the question is answered using minimal understanding of knowledge and skills The response may contain major significant errors or flaws in logical thinking The response reflects a minimal synthesis and understanding of complex ideas The response is not coherent or is not based on application of relevant dimensions (SEP and/or DCI and/or CC) The response integrates a solution that is minimally correct and may or may not be based on the principles of engineering design (if applicable).
0	There is no evidence that the student has an understanding of the material related to the question being asked in terms of science content and logical thinking skills. The response is blank, entirely incorrect and/or irrelevant.

Anchor Set

A1

1. If there is a sink hole underlaying where there gonna build a building at
2. If they should rethink replacing the building.

Anchor Annotation, Paper 1

Score Point 0

The response shows no evidence of understanding of the material related to the question. This response is entirely irrelevant as no solution is proposed on how to prevent other buildings from being damaged by sinkholes. The student does not give a solution in the first statement and the second statement does not address the question. Overall, this response is entirely irrelevant to the question.

A2

Number 7&6 cause it tells you how they are made and what cause the rock to transform into a diffenet color or crumbling and they tell you how the sinkholes create and comes to the suface of the earth. And it aslo tells you what the diffenet chemicals do when they are put on the rocks

Anchor Annotation, Paper 2

Score Point 0

The response shows no evidence of understanding of the material related to the question. This response is entirely irrelevant as no solution is proposed on how to prevent other buildings from being damaged by sinkholes. The student addresses how sinkholes can be made but not the prevention of them. Overall, this response is entirely irrelevant to the question.

A3

to prevent from the sinkhole is changing the material of the building because it was destroyed by rain acid.

Anchor Annotation, Paper 3

Score Point 0

The response shows no evidence of understanding of the material related to the question. This response is entirely incorrect and irrelevant as no reasonable solution is proposed on how to prevent other buildings from being damaged by sinkholes. The student erroneously states that changing the material of the building is the solution to preventing sinkholes. Overall, this response reflects no understanding of the question.

A4

A solution to prevent other buildings from being damaged by sinkholes is before constructing a building, conduct research to determine if that particular area of land is prone to a sinkhole.

Anchor Annotation, Paper 4

Score Point 1

The response shows minimal understanding of the multi-dimensional question. The student gives a minimal design solution to prevent other buildings from being damaged by sinkholes (*before constructing a building, conduct research to determine if that particular area of land is prone to a sinkhole*). The solution reflects minimal synthesis and understanding of complex ideas, and it does not identify two questions to help decide if the solution is reasonable. This response reflects a minimally correct answer.

A solution to the sink hole problem is to figure out a way to keep the acid rain from ever absorbing into the roads.

Question #1: Does this solution efficiently solve the problem?

Question #2: Does this solution effectively solve the problem?

Anchor Annotation, Paper 5

Score Point 1

The response shows minimal understanding of the multi-dimensional question. The student gives a minimal design solution to prevent other buildings from being damaged by sinkholes. The solution reflects minimal synthesis and understanding (*figure out a way to keep the acid rain from ever absorbing into rocks*). The two questions given to help decide if the solution is reasonable are too vague (*Does this solution efficiently... effectively solve the problem?*) to demonstrate further understanding. Overall, the response reflects minimal synthesis and understanding of complex ideas.

I believe once you build over top of rock containing sodium carbonate it will just be a matter of time before it collapses. To be safe from it, don't build a building over this type of rock.

Anchor Annotation, Paper 6

Score Point 1

The response shows minimal understanding of the multi-dimensional question. The student gives a minimal design solution to prevent other buildings from being damaged by sinkholes. The student's solution demonstrates a minimal understanding of knowledge (*once you build over top of rock containing sodium carbonate it will just be a matter of time before it collapses. To be safe from it, don't build a building over this type of rock*). The response does not identify two questions to help decide if the solution is reasonable. Overall, the response reflects minimal synthesis and understanding of complex ideas.

Based on Joseph's investigations you would have to build a building on a non limestone rock and build them as far away from caves as you can get. You would have to ask yourself would this building collapse? Is this building going to be built close to any near by caves?

Anchor Annotation, Paper 7

Score Point 2

The response shows limited understanding of the multi-dimensional question. The student gives a partially complete solution to prevent other buildings from being damaged by sinkholes. The student gives two solutions demonstrating limited understanding of knowledge (*build a building on a non limestone rock and build them as far away from caves as you can get*). The response also provides two questions to help decide if the solutions are reasonable (*would this building collapse? Is this building going to be built close to any near by caves?*) but does not provide further details for the investigation. Overall, this response reflects a limited synthesis and understanding of complex ideas.

The first thing is, there are these tools to check if there are caves under the ground. The tool Palhes into the ground and if it hits something solid then you have on good base if it doesnt hit anything solid than your base is weak. I would at first check if the base is weak, If so then I would find a way to re rough the water from rainfall to another location. Preforably a river. You could reroute the water by making a drain system or a vally type gutter system that runs down hill.

Anchor Annotation, Paper 8
Score Point 2

The response shows limited understanding of the multi-dimensional question. The student gives a partially complete solution to prevent other buildings from being damaged by sinkholes. The solution given reflects limited synthesis (*there are these tools to check if there are caves under the ground. ...if it hits something solid then you have a good base...check if the base is weak, if so... you could reroute the water by making a drain system*). The response also does not identify two questions to help decide if the solution is reasonable. Overall, this response is partially complete.

A solution to prevent other buildings from being damaged by sinkholes could be to use sewage systems to capture extra rainwater. By draining the rainwater rather than letting it all sink under ground would help with the deterioration of the underground rocks. The buildings would remain stable on top. Questions to ask to decide if the solution is reasonable are “Would the system be enough to help the issue?” and “Would the design of the system be affordable and profitable?”

Anchor Annotation, Paper 9
Score Point 2

The response shows limited understanding of the multi-dimensional question. The student gives a partially complete solution to prevent other buildings from being damaged by sinkholes. The solution given demonstrates limited knowledge (*use sewage systems to capture extra rainwater... would help with the deterioration of the underground rocks*) and identifies two questions with limited synthesis to help decide if the solution is reasonable (*Would the system be enough to help the issue?... Would the design of the system be affordable and profitable?*). Overall this response reflects a limited understanding of complex ideas.

For other buildings to not be damaged by sinkholes, is to make a French drain for the buildings so that rainfall could be controlled and funneled away from buildings so rock wouldn't decay underneath.

1 question: on average how much would it cost to do?

(I think \$2,500+)

Another question: in a course of a year how much better does a building with a French drain, compare to a building without one.

other ways of controlling the water could be used depending on the area.

Anchor Annotation, Paper 10

Score Point 3

The response shows general understanding of the multi-dimensional question. The student gives a generally complete solution to prevent other buildings from being damaged by sinkholes. The student gives a solution using appropriate knowledge (*make a French drain for the buildings so that rainfall could be controlled and funneled away from buildings so rock wouldn't decay underneath*) and identifies two questions to help decide if the solution is reasonable (*on average how much would it cost to do?... in a course of a year how much better does a building with a French drain, compare to a building without one?*). The response provides some details in the questions that are provided and gives an estimation for one of them. Overall, this response reflects a general synthesis and understanding of complex ideas.

In order to develop a solution that will help to solve the sink hole problem long term investigators must ask "Does this solution take into account existing damage to the rock layer?" and "Would this solution prevent sudden incidents?" My solution to the sinkhole and cave issue in Kentucky is to map out the caves we already know about even further, use geospatial informatics to search for significant weathering under build sites prior to actually beginning construction, and installing large supports deep into the limestone to anchor buildings allowing for additional support and warning in the event of a collapse. By mapping out cave systems further we can begin to learn patterns in their formation which can then be used to locate spots of concern for collapse from the surface before they even happen. By using geospatial informatics to locate significant damage at build sites we can choose the best places to build for long term security and by installing large supports we can help to hold our buildings up when minor damage occurs and use the supports themselves to gather information on damage as it occurs allowing for relocation prior to significant incidences such as the museum collapse.

Anchor Annotation, Paper 11
Score Point 3

The response shows general understanding of the multi-dimensional question. The student gives a generally complete solution to prevent other buildings from being damaged by sinkholes. The response is generally coherent, identifying two questions to help decide if some of the solutions are reasonable (*Does this solution take into account existing damage to the rock layer?... Would this solution prevent sudden incidents?*), providing solutions (*map out the caves we already know about even further, use geospatial informatics to search for significant weathering under build sites prior to actually beginning construction, and installing large supports deep into the limestone to anchor buildings*), and using appropriate knowledge (*we can choose the best places to build for long term security... we can help to hold our buildings up when minor damage occurs and... gather information on damage as it occurs allowing for relocation prior to significant incidences*). Overall, this response reflects a general synthesis and understanding of complex ideas.

A solution to prevent other buildings from being damaged is to test the ground and rocks before building. Also if the area is prone to forming sinkholes, don't plan to build there. Another solution is to have the buildings and structures monitored often. For example, check for any cracks in the ceilings or floors. This means that the structure is "settling" into the ground. But in states such as Kentucky and Florida, buildings should be monitored every 3 to 6 months. Another solution is to bring sinkholes up as a topic on the news. For example, weather reporters are always watching for tornadoes, hurricanes, and earthquakes. I think sinkholes should be brought to attention to more people so they can have a safety plan and be more aware. A question that I would need to understand if this is possible is, how much money would it cost for the buildings to be heavily monitored for any change of structure? Another question would be, how many people are actually aware of the dangerous sinkholes beneath them?

Anchor Annotation, Paper 12

Score Point 3

The response shows general understanding of the multi-dimensional question. The student gives a generally complete solution to prevent other buildings from being damaged by sinkholes. The response is generally coherent when providing several solutions (*test the ground and rocks before building. Also, if the area is prone to forming sinkholes, don't plan to build there... have the buildings structures monitored often... I think sinkholes should be brought to attention to more people so they can have a safety plan and be more aware*). This response answers the question using appropriate knowledge for some solutions (*For example, check for any cracks in the ceilings or floors. This means that the structure is "settling" into the ground. Another solution is to bring sinkholes up as a topic on the news. For example, weather reporters are always watching for tornadoes, hurricanes, and earthquakes*), and identifies two questions to help decide if some of the solutions are reasonable (*how much money would it cost for the buildings to be heavily monitored for any change of structure? ... how many people are actually aware of the dangerous sinkholes beneath them?*). Overall, this response reflects a general synthesis and understanding of complex ideas.

Through Joesph's experiment, we know that the rainwater that mixes with slightly acidic Carbon Dioxide can cause changes in naturally occuring limestone through reactions with calcium carbonate. These reactions cause the rock to bubble up and sometimes collapse as the structure is deformed. In order to prevent further buildings from having sinkholes collapse portions of them, we need to either ensure the existing structure will not deform, or create a structure that will not deform.

The first step to creating sinkhole-safe buildings is ensuring that the rock structure being built on will not collapse with the building. This can be done with geological surveys before construction that can determine the type and nature of the rocks beneath the potential construction zone. If the rocks are determined to be very unstable and sinkhole-prone, it would be best not to build on top of them.

If the area for building is not entirely safe from sinkholes, then another possible solution would be to reinforce the rock structure before building. This can be achieved by creating more stable foundations for buildings in sinkhole prone areas. Either extending metal rods deep into the rock to stabilize or by making foundations out of reinforced concrete that wont dissolve as easily will greatly stabilize both the building being built and the surrounding rock structure by preventing as much deformation.

In order to ensure that these solutions would work on a larger scale, we would need to answer at least two questions. 1 - Do the solutions presented cost a reasonable amount of money? 2 - Do the solutions actually create less sinkhole-prone buildings? We would need to ensure monetary security because if we impose regulations that cost excess amounts people will stop trying to adhere to them and just move elsewhere. This would lead to a loss of business and other potential economic detriments if we continued forcing regulation. We also need to ensure that the solutions actually make buildings safer from sinkholes. If we create solutions that aren't actually solutions then they are ultimately a waste of time and money for all involved. However if both of these questions are addressed propoerly, then we can create much safer and more reliable buildings in the future.

Anchor Annotation, Paper 13
Score Point 4

The response shows complete and thorough understanding of the multi-dimensional question. The student gives a complete solution to prevent other buildings from being damaged by sinkholes. The response is completely coherent when providing a solution (*ensuring that the rock structure being built on will not collapse with the building. This can be done with geological surveys ... If the rocks are determined to be very unstable and sinkhole-prone, it would be best not to build on top of them... reinforce the rock structure before building. This can be achieved by creating more stable foundations for buildings in sinkhole prone areas*). The response is thorough and uses appropriate knowledge (*geological surveys before construction that can determine the type and nature of the rocks beneath the potential construction zone ... Either extending metal rods deep into the rock to stabilize or by making foundations out of reinforced concrete that won't dissolve as easily will greatly stabilize both the building being built and the surrounding rock structure by preventing as much deformation*). The response reflects complete synthesis to explain the two questions to help decide if some of the solutions are reasonable (*1 - Do the solutions presented cost a reasonable amount of money? 2 - Do the solutions actually create less sinkhole-prone buildings? We would need to ensure monetary security because if we impose regulations that cost excess amounts people will stop trying to adhere to them and just move elsewhere. This would lead to a loss of business and other potential economic detriments if we continued forcing regulation. We also need to ensure that the solutions actually make buildings safer from sinkholes. If we create solutions that aren't actually solutions then they are ultimately a waste of time and money*). Overall, this response reflects a complete synthesis and understanding of complex ideas.

A while back, suddenly a sinkhole opened up in the center floor of the corvette museum in Kentucky. Luckily, nobody was injured, but hundreds of thousands of dollars worth of cars were swallowed up and severely damaged. This seemingly random event caused fear in the public, what if your home was above the next sinkhole? Researchers were determined to get to the bottom of the issue and they found that the carbon dioxide in the air would bind to the water as it rained down. Since carbon dioxide is naturally acidic, when the acid rain hit the ground and was absorbed, the limestone beneath the surface was slowly dissolved away, and it resulted in the weakening of the limestone layer beneath the corvette museum. Joseph's findings are consistent with this conclusion as well, the rocks from Kentucky and Florida- which have an identical chemical makeup- both fizzed and released CO_2 gas when exposed to water mixed with carbon dioxide. Because the rocks released CO_2 when exposed, it meant that a chemical reaction was occurring, the CO_2 trapped in the rocks was being released, and the rocks structure was weakening.

The findings of the researchers is obviously concerning as Kentucky has a large limestone layer beneath its top layer, meaning that this could very well become an issue with rising CO_2 levels in the atmosphere. To prevent buildings from being destroyed, we must find a solution quickly to minimize the damage from the acid rain. Though there are many methods to doing this, not all are cost effective, and not all are a good long term solution to this issue. One solution I can think of is to release something alkaline into the atmosphere to help make the acid rain more basic. If we can find a way to vaporize something basic, like baking soda, we can release those gasses into the atmosphere to help reduce the acid in the rain, and therefore, causing less damage to our limestone layer. Another solution would be to release water into the atmosphere to dilute the acid. Though this may be less favorable, it is still an option. By releasing water vapor into the atmosphere which could be done by nuclear power, and therefore also reducing emissions- we can help to dilute the acid content in the rain, making it less strong and giving us time to find an alternate solution.

Releasing a basic solution into the atmosphere, would this be cost effective, and is this a long term solution? In the long run, it is likely not cost effective, but to prevent further damage at the current moment, it is a great solution to this ongoing issue. Is diluting the acid with water vapor cost effective? Most definitely yes, and it would be a great excuse to focus our state on nuclear energy rather than fossil fuels which would only speed up the building damage and rock structure damage. Is it a long term solution? With rising CO_2 levels, it is likely

not a long term solution, we still need to find a more permanent solution because as water is added to the system, it too is being contaminated by acids.

In conclusion, sinkholes are caused by acid rain, and sinkholes cause building damage. Though these are not perfect solutions, a way to help preserve and prevent future events like the Corvette Museum in Kentucky, we can either add basic solutions into the atmosphere to make the rain basic, and therefore cause less damage to the rock, or we can dilute the acid in the rain which would also help prevent damage to the rock and prevent further sinkholes.

Anchor Annotation, Paper 14
Score Point 4

The response shows complete and thorough understanding of the multi-dimensional question. The student gives a complete solution to prevent other buildings from being damaged by sinkholes. The response is completely coherent when providing a solution (*we must find a solution quickly to minimize the damage from the acid rain ... release something alkaline into the atmosphere to help make the acid rain more basic ... release water into the atmosphere to dilute the acid... making it less strong and giving us time to find an alternate solution*). The response is thorough and uses appropriate knowledge to explain some solutions (*If we can find a way to vaporize something basic, like baking soda, we can release those gasses into the atmosphere to help reduce the acid in the rain, and therefore, causing less damage to our limestone layer... By releasing water vapor into the atmosphere which could be done by nuclear power, and therefore also reducing emissions*). The response reflects complete synthesis to explain the questions to help decide if some of the solutions are reasonable (*Releasing a basic solution into the atmosphere, would this be cost effective, and is this a long term solution? In the long run, it is likely not cost effective, but to prevent further damage at the current moment, it is a great solution to this ongoing issue. Is diluting the acid with water vapor cost effective? Most definitely yes, and it would be a great excuse to focus our state on nuclear energy rather than fossil fuels which would only speed up the building damage and rock structure damage. Is it a long term solution? With rising co2 levels, it is likely not a long term solution, we still need to find a more permanent solution because as water is added to the system, it too is being contaminated by acids*). Overall, this response reflects a complete synthesis and understanding of complex ideas.

This potential solution to prevent buildings from being damaged by sinkholes is twofold, with aspects to benefit new buildings and existing ones.

Firstly, to ensure that new buildings do not suffer from sinkholes, builders could focus on land with bedrock comprised of materials other than limestone. As limestone has a chemical composition of Calcium carbonate, it is susceptible to being changed and dissolved by the slightly acidic rainwater. Builders could also focus on land which is known to have none or fewer underground caves, since sinkholes are formed by the surface land collapsing into the hollows formed by caves under the surface.

Additionally, to benefit existing buildings, there could be a push to reinforce underground caves. This would prevent collapses of the land over caves, which would protect anything constructed on that land. This could also open up a greater number of caves to tourism, which could potentially raise the money to reinforce even more caves. Simultaneously, there should be a movement to ensure that no acid rain is being created by the burning of coal. Not only will this benefit the environment by reducing fossil fuels, it will also improve the condition of the rain seeping through into the bedrock. While the discussed acidity comes from carbon dioxide dissolved in the rain, decreasing the unnatural acidity from sulfuric acid would help the limestone resist dissolving.

Two questions which could be investigated to determine if this solution is reasonable are:

1. Is it feasible to require that builders focus on new regions?

The answer to this question is probably not. The demand for houses and other buildings is high, and construction companies require huge amounts of land. However, it is absolutely possible that the most important buildings, or those that would be most expensive if they collapsed, could be prioritized to be built on land with underlying formations of other, more resistant, rocks.

Responses from construction companies could be investigated to see how willing they would be to make these changes, knowing that it would protect their buildings and the people using them.

2. Is it reasonable to reinforce existing underground caves?

The answer to this question is yes. Caves popular with scientists or tourists are often given more support, by structures like metal or other rocks, to ensure their stability. This could be done to more, which would prevent dangerous sinkholes from collapsing into the hollowed-out underlying formations. The engineering and financial feasibility of this solution could be investigated further.

Anchor Annotation, Paper 15

Score Point 4

The response shows complete and thorough understanding of the multidimensional question. The student gives a complete solution to prevent other buildings from being damaged by sinkholes. The response is completely coherent when providing multiple solutions (*builders could focus on land with bedrock comprised of materials other than limestone... Builders could also focus on land which is known to have none or fewer underground caves... a push to reinforce underground caves... a movement to ensure that no acid rain is being created by the burning of coal*). The response is thorough and uses appropriate knowledge to explain some solutions (*As limestone has a chemical composition of Calcium carbonate, it is susceptible to being changed and dissolved by the slightly acidic rainwater ... since sinkholes are formed by the surface land collapsing into the hollows formed by caves under the surface ... This would prevent collapses of the land over caves, which would protect anything constructed on that land. This could also open up a greater number of caves to tourism... decreasing the unnatural acidity from sulfuric acid would help the limestone resist dissolving*). The response reflects complete synthesis to explain the two questions to help decide if some of the solutions are reasonable (*1. Is it feasible to require that builders focus on new regions?... it is absolutely possible that the most important buildings, or those that would be most expensive if they collapsed, could be prioritized to be built on land with underlying formations of other, more resistant, rocks... 2. Is it reasonable to reinforce existing underground caves?... which would prevent dangerous sinkholes from collapsing into the hollowed-out underlying formations*). Overall, this response reflects a complete synthesis and understanding of complex ideas.



SCHS1606_00c

Acid rain causes buildings made of limestone to weather and adversely affects aquatic wildlife and plants. Acid rain was a more serious problem in the United States for much of the twentieth century. However, at the end of the twentieth century, the United States began to regulate how coal was burned to eliminate much of the sulfur dioxide that results in the most acidic form of acid rain. Now, in the twenty-first century, many developing countries burn coal to generate electricity.

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SCHS1606_09_4

What is one way developing countries could **best** reduce the effects of acid rain formation that have historically resulted from using coal to generate electricity?

- A** The United States could pass stricter laws on the quantity of energy developing countries could produce each year.
- B** The developing countries should change their societal needs and wants to reduce electricity consumption and acid rain pollution.
- C** The developing countries should seek sources of electricity from outside their borders and reduce domestic production of electricity.
- D** The developing countries should use the latest technologies and solutions to help meet societal needs for energy while working for cleaner air.



Released Item Performance

Kentucky Summative Assessments

Spring 2026

Grade 11

Science

Item: SCHS1606_09

Book Question Number: 8

Standard: HS-ETS1-1

Item Type: MC

Key: D

Student Group	Number of Students	Percent Correct	Average Item Score	Item Breakout Statistics - Answer Choice Options			
				A (%)	B (%)	C (%)	D (%)
All Students	45,812	47%	0.47	11%	24%	18%	47%
Gender							
Female	22,535	46%	0.46	11%	25%	18%	46%
Male	23,276	48%	0.48	11%	22%	18%	48%
Ethnicity							
African American	5,042	34%	0.34	14%	29%	22%	34%
American Indian or Alaska Native	67	54%	0.54	9%	24%	13%	54%
Asian	945	54%	0.54	9%	23%	15%	54%
Hispanic or Latino	4,613	39%	0.39	14%	26%	21%	39%
Native Hawaiian or Pacific Islander	72	49%	0.49	14%	17%	21%	49%
White (non-Hispanic)	32,849	50%	0.50	10%	22%	17%	50%
Two or more races	2,222	46%	0.46	10%	26%	18%	46%
Migrant							
Migrant	182	38%	0.38	17%	23%	22%	38%
English Learner							
English Learner	2,400	32%	0.32	19%	28%	22%	32%
Economically Disadvantaged							
Economically Disadvantaged	24,585	43%	0.43	13%	25%	19%	43%
Students with Disabilities							
Students with Disabilities	4,516	38%	0.38	15%	26%	21%	38%



Investing in Kentucky's Future, One Student at a Time