

MASSACHUSETTS Department of Elementary and Secondary Education

# Release of February 2025 MCAS Biology and Introductory Physics Test Information

April 2025 Massachusetts Department of Elementary and Secondary Education



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### Table of Contents

I. Document Purpose and Structure	1
II. February 2025 Biology Test.	3
III. February 2025 Introductory Physics Test.	11

I. Document Purpose and Structure

### Document Purpose and Structure

#### Purpose

The purpose of this document is to share with educators and the public information regarding the February 2025 MCAS Biology and Introductory Physics tests, including the reporting category and standard associated with each item. The Department does not currently release items from the February Biology and Introductory Physics tests. All items continue to be released for the spring Biology and Introductory Physics tests.

#### Structure

Chapters II and III of this document contain, respectively, information for the February 2025 Biology and Introductory Physics tests. Each of these chapters has two sections.

The **first section** provides a brief overview of the test, including test format and item types. The Introductory Physics Reference Sheet used by students during MCAS Introductory Physics test sessions appears at the end of the first section of the Introductory Physics chapter.

The **second section** of each chapter are tables that cross-reference each item on the computer-based test and the paper-based test with its MCAS reporting category and with the *Framework* standard it assesses. The tables show how the items on the test assess standards in the 2016 *Massachusetts Science and Technology/ Engineering Curriculum Framework*.

## II. February 2025 Biology Test

### February 2025 High School Biology Test

The February 2025 high school Biology test was administered in two formats: a computer-based version and a paper-based version. Most students took the computer-based test. The paper-based test was offered as an accommodation for eligible students who were unable to use a computer. More information can be found on the MCAS Test Administration Resources page at <a href="http://www.doe.mass.edu/mcas/admin.html">www.doe.mass.edu/mcas/admin.html</a>.

Most of the operational items on the high school Biology test were the same, regardless of whether a student took the computerbased version or the paper-based version. In places where a technology-enhanced item was used on the computer-based test, an adapted version of the item was created for use on the paper test. These adapted paper items were multiple-choice or multipleselect items that tested the same Science content and assessed the same standard as the technology-enhanced item.

### **Test Sessions and Content Overview**

The high school Biology test was made up of two separate test sessions. Each session included selected-response questions and constructed-response questions. On the paper-based test, the selected-response questions were multiple-choice items and multiple-select items, in which students select the correct answer(s) from among several answer options.

### **Standards and Reporting Categories**

The high school MCAS Biology test was based on learning standards in the 2016 *Massachusetts Science and Technology/ Engineering Curriculum Framework*. The Framework is available on the Department website at www.doe.mass.edu/frameworks/current.html.

The biology standards are grouped under the four content reporting categories listed below.

- Molecules to Organisms
- Heredity
- Evolution
- Ecosystems

Most items on the high school Biology test are also reported as aligning to one of three MCAS Science Practice Categories. The three practice categories are listed below.

- Practice Category A: Investigations and Questioning
- Practice Category B: Mathematics and Data
- · Practice Category C: Evidence, Reasoning, and Modeling

More information about the practice categories is available on the Department website at <a href="http://www.doe.mass.edu/mcas/tdd/practice-categories.html">www.doe.mass.edu/mcas/tdd/practice-categories.html</a>.

The tables at the conclusion of this chapter provides the following information about each released operational item: reporting category, standard covered, science practice category covered (if any), item type, and item description.

### **Spanish-Language Edition**

Since approximately 55% of English learner students in Massachusetts public schools are native Spanish speakers, a Spanishlanguage edition of the February Biology test was made available to eligible Spanish-speaking students. The computer-based version of the Spanish-language edition presented the Spanish translation above the English text for each item. The booklets for the paper-based version of the Spanish-language edition were issued in side-by-side English/Spanish format: pages on the left side of each booklet presented items in Spanish; pages on the right side presented the same items in English.

#### **Reference Materials and Tools**

Each student taking the high school Biology test had sole access to a calculator.

During both Biology test sessions, the use of authorized bilingual word-to-word dictionaries and glossaries was allowed for students who are currently or were ever reported as English learners.

### February 2025 Biology Computer-Based Operational Items

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
1	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Use a model of two parent diploid cells to determine possible genotypes of the offspring.
2	Ecology	HS.LS.2.2	None	SR	Determine the ecological relationship between two organisms.
3	Evolution	HS.LS.4.1	None	SR	Explain why organisms that are not closely related have structures with similar functions.
4	Heredity	HS.LS.3.2	A. Investigations and Questioning	SR	Identify a question in which the answer would determine whether a mutation could be passed from parent to offspring.
5	Molecules to Organisms	HS.LS.1.6	None	SR	Identify the element that animal tissues are primarily composed of.
6	Evolution	HS.LS.4.5	None	SR	Compare the genetic diversity of a population that is geographically isolated to the genetic diversity of other populations and describe evidence that the populations are the same species.
7	Molecules to Organisms	HS.LS.1.3	None	SR	Identify an example of an organism maintaining homeostasis.
8	Evolution	HS.LS.4.4	None	SR	Identify a characteristic that allows bacteria to populate a wide variety of environments.
9	Heredity	HS.LS.3.1	None	SR	Describe how zygotes inherit alleles from each parent.
10	Heredity	HS.LS.3.3	B. Mathematics and Data	SR	Calculate the probability of offspring inheriting a certain phenotype based on a given cross.
11	Molecules to Organisms	HS.LS.1.5	B. Mathematics and Data	SR	Analyze graphs to determine when plants produce the most carbon dioxide.
12	Molecules to Organisms	HS.LS.1.6	None	SR	Classify an organic molecule based on its function.
13	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Complete a model of meiosis to show the segregation of alleles.
14	Molecules to Organisms	HS.LS.1.4	B. Mathematics and Data	SR	Interpret a graph to explain how a hormone affects human growth.
15	Heredity	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Analyze a pedigree to determine the pattern of inheritance of a trait and calculate the probability of an individual inheriting the trait.
16	Molecules to Organisms	HS.LS.1.1	None	CR	Determine the mRNA and amino acid sequences for DNA sequences with and without a genetic mutation and analyze the information to determine how the mutation affects the protein produced.
17	Evolution	HS.LS.4.4	B. Mathematics and Data	SR	Interpret a graph to explain the growth of a bacteria population.
18	Heredity	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Determine the combination of alleles for a dihybrid cross that would produce offspring with a particular phenotype.
19	Evolution	HS.LS.4.5	C. Evidence, Reasoning, and Modeling	SR	Determine two pieces of evidence that support a claim that two populations are different species.
20	Ecology	HS.LS.2.7	C. Evidence, Reasoning, and Modeling	CR	Describe two characteristics of an invasive species and analyze information to describe how the invasive species affects the population sizes of native species.

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
21	Molecules to Organisms	HS.LS.1.7	C. Evidence, Reasoning, and Modeling	CR	Identify the cellular process that produces usable energy and where the energy is produced, complete a model of the reactants and products of the process, and explain how a cellular function requires energy.
22	Evolution	HS.LS.4.1	C. Evidence, Reasoning, and Modeling	SR	Interpret a cladogram to determine the most closely related species.
23	Heredity	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Determine which evidence best supports a claim that the inheritance pattern for a trait is codominance.
24	Molecules to Organisms	HS.LS.1.1	None	SR	Describe a function of enzymes in a plant.
25	Heredity	HS.LS.3.3	B. Mathematics and Data	SR	Complete a Punnett square to show a cross for a sex-linked genetic condition and analyze the Punnett square to describe the expected phenotypes of the offspring from the cross.
26	Molecules to Organisms	HS.LS.1.2	None	SR	Describe how the digestive system is affected when a digestive organ does not function properly.
27	Heredity	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Determine which chromosomes show evidence of crossing over.
28	Molecules to Organisms	HS.LS.1.5	C. Evidence, Reasoning, and Modeling	SR	Describe a change that would improve a model of photosynthesis.
29	Molecules to Organisms	HS.LS.1.3	B. Mathematics and Data	SR	Interpret a graph to determine how the activity of a gene changes to maintain homeostasis in an organism when the environment changes.
30	Molecules to Organisms	HS.LS.1.7	None	SR	Identify the molecule that provides energy for a cellular process.
31	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Determine the drawing that should be added to complete a model of fertilization.
32	Molecules to Organisms	HS.LS.1.6	None	SR	Identify the molecular building blocks of a protein.
33	Evolution	HS.LS.4.5	None	SR	Explain how mating behaviors affect genetic diversity in a population.
34	Heredity	HS.LS.3.4	B. Mathematics and Data	SR	Analyze a graph to determine how a population will be affected by a change in temperature.
35	Heredity	HS.LS.3.1	None	SR	Interpret a diagram to determine which chromosomes are passed from parent to offspring.
36	Ecology	HS.LS.2.4	B. Mathematics and Data	SR	Analyze a food web to complete an energy pyramid and to calculate the percentage of energy stored in a trophic level.
37	Evolution	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	CR	Describe how organisms are able to carry out life functions with variations in traits and explain how the traits evolved over time through natural selection.
38	Evolution	HS.LS.4.1	A. Investigations and Questioning	SR	Determine which question could be investigated to provide evidence that supports the endosymbiotic theory.
39	Ecology	HS.LS.2.7	C. Evidence, Reasoning, and Modeling	SR	Interpret a map showing the migration of an animal to determine which human activity had the largest impact on the animal.
40	Molecules to Organisms	HS.LS.1.4	C. Evidence, Reasoning, and Modeling	SR	Interpret a model to identify a cellular process and describe the purpose of the cellular process.

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
41	Molecules to Organisms	HS.LS.1.2	C. Evidence, Reasoning, and Modeling	SR	Interpret a model to identify parts of the respiratory and circulatory systems and describe how a gas exchanged between the systems is used in the body.
42	Ecology	HS.LS.2.5	C. Evidence, Reasoning, and Modeling	CR	Analyze a model to identify two processes in the carbon cycle, explain the reasoning for identifying the processes, and explain how a human activity affects the carbon cycle.

### February 2025 Biology Paper-Based Operational Items

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
1	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Use a model of two parent diploid cells to determine possible genotypes of the offspring.
2	Ecology	HS.LS.2.2	None	SR	Determine the ecological relationship between two organisms.
3	Evolution	HS.LS.4.1	None	SR	Explain why organisms that are not closely related have structures with similar functions.
4	Heredity	HS.LS.3.2	A. Investigations and Questioning	SR	Identify a question in which the answer would determine whether a mutation could be passed from parent to offspring.
5	Molecules to Organisms	HS.LS.1.6	None	SR	Identify the element that animal tissues are primarily composed of.
6	Evolution	HS.LS.4.5	None	SR	Compare the genetic diversity of a population that is geographically isolated to the genetic diversity of other populations and describe evidence that the populations are the same species.
7	Molecules to Organisms	HS.LS.1.3	None	SR	Identify an example of an organism maintaining homeostasis.
8	Evolution	HS.LS.4.4	None	SR	Identify a characteristic that allows bacteria to populate a wide variety of environments.
9	Heredity	HS.LS.3.1	None	SR	Describe how zygotes inherit alleles from each parent.
10	Heredity	HS.LS.3.3	B. Mathematics and Data	SR	Calculate the probability of offspring inheriting a certain phenotype based on a given cross.
11	Molecules to Organisms	HS.LS.1.5	B. Mathematics and Data	SR	Analyze graphs to determine when plants produce the most carbon dioxide.
12	Molecules to Organisms	HS.LS.1.6	None	SR	Classify an organic molecule based on its function.
13	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Complete a model of meiosis to show the segregation of alleles.
14	Molecules to Organisms	HS.LS.1.4	B. Mathematics and Data	SR	Interpret a graph to explain how a hormone affects human growth.
15	Heredity	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Analyze a pedigree to determine the pattern of inheritance of a trait and calculate the probability of an individual inheriting the trait.
16	Molecules to Organisms	HS.LS.1.1	None	CR	Determine the mRNA and amino acid sequences for DNA sequences with and without a genetic mutation and analyze the information to determine how the mutation affects the protein produced.
17	Evolution	HS.LS.4.4	B. Mathematics and Data	SR	Interpret a graph to explain the growth of a bacteria population.
18	Heredity	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Determine the combination of alleles for a dihybrid cross that would produce offspring with a particular phenotype.
19	Evolution	HS.LS.4.5	C. Evidence, Reasoning, and Modeling	SR	Determine two pieces of evidence that support a claim that two populations are different species.
20	Ecology	HS.LS.2.7	C. Evidence, Reasoning, and Modeling	CR	Describe two characteristics of an invasive species and analyze information to describe how the invasive species affects the population sizes of native species.

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
21	Molecules to Organisms	HS.LS.1.7	C. Evidence, Reasoning, and Modeling	CR	Identify the cellular process that produces usable energy and where the energy is produced, complete a model of the reactants and products of the process, and explain how a cellular function requires energy.
22	Evolution	HS.LS.4.1	C. Evidence, Reasoning, and Modeling	SR	Interpret a cladogram to determine the most closely related species.
23	Heredity	HS.LS.3.3	C. Evidence, Reasoning, and Modeling	SR	Determine which evidence best supports a claim that the inheritance pattern for a trait is codominance.
24	Molecules to Organisms	HS.LS.1.1	None	SR	Describe a function of enzymes in a plant.
25	Heredity	HS.LS.3.3	B. Mathematics and Data	SR	Determine which Punnett square shows a cross for a sex-linked genetic condition and analyze the Punnett square to describe the expected phenotypes of the offspring from the cross.
26	Molecules to Organisms	HS.LS.1.2	None	SR	Describe how the digestive system is affected when a digestive organ does not function properly.
27	Heredity	HS.LS.3.2	C. Evidence, Reasoning, and Modeling	SR	Determine which chromosomes show evidence of crossing over.
28	Molecules to Organisms	HS.LS.1.5	C. Evidence, Reasoning, and Modeling	SR	Describe a change that would improve a model of photosynthesis.
29	Molecules to Organisms	HS.LS.1.3	B. Mathematics and Data	SR	Interpret a graph to determine how the activity of a gene changes to maintain homeostasis in an organism when the environment changes.
30	Molecules to Organisms	HS.LS.1.7	None	SR	Identify the molecule that provides energy for a cellular process.
31	Heredity	HS.LS.3.1	C. Evidence, Reasoning, and Modeling	SR	Determine the drawing that should be added to complete a model of fertilization.
32	Molecules to Organisms	HS.LS.1.6	None	SR	Identify the molecular building blocks of a protein.
33	Evolution	HS.LS.4.5	None	SR	Explain how mating behaviors affect genetic diversity in a population.
34	Heredity	HS.LS.3.4	B. Mathematics and Data	SR	Analyze a graph to determine how a population will be affected by a change in temperature.
35	Heredity	HS.LS.3.1	None	SR	Interpret a diagram to determine which chromosomes are passed from parent to offspring.
36	Ecology	HS.LS.2.4	B. Mathematics and Data	SR	Analyze a food web to determine an energy pyramid and to calculate the percentage of energy stored in a trophic level.
37	Evolution	HS.LS.4.2	C. Evidence, Reasoning, and Modeling	CR	Describe how organisms are able to carry out life functions with variations in traits and explain how the traits evolved over time through natural selection.
38	Evolution	HS.LS.4.1	A. Investigations and Questioning	SR	Determine which question could be investigated to provide evidence that supports the endosymbiotic theory.
39	Ecology	HS.LS.2.7	C. Evidence, Reasoning, and Modeling	SR	Interpret a map showing the migration of an animal to determine which human activity had the largest impact on the animal.
40	Molecules to Organisms	HS.LS.1.4	C. Evidence, Reasoning, and Modeling	SR	Interpret a model to identify a cellular process and describe the purpose of the cellular process.

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
41	Molecules to Organisms	HS.LS.1.2	C. Evidence, Reasoning, and Modeling	SR	Interpret a model to identify parts of the respiratory and circulatory systems and describe how a gas exchanged between the systems is used in the body.
42	Ecology	HS.LS.2.5	C. Evidence, Reasoning, and Modeling	CR	Analyze a model to identify two processes in the carbon cycle, explain the reasoning for identifying the processes, and explain how a human activity affects the carbon cycle.

III. February 2025 Introductory Physics Test

### February 2025 High School Introductory Physics Test

The February 2025 high school Introductory Physics test was administered in two formats: a computer-based version and a paper-based version. Most students took the computer-based test. The paper-based test was offered as an accommodation for eligible students who were unable to use a computer. More information can be found on the MCAS Test Administration Resources page at <a href="http://www.doe.mass.edu/mcas/admin.html">www.doe.mass.edu/mcas/admin.html</a>.

Most of the operational items on the high school Introductory Physics test were the same, regardless of whether a student took the computer-based version or the paper-based version. In places where a technology-enhanced item was used on the computer-based test, an adapted version of the item was created for use on the paper test. These adapted paper items were multiple-choice or multiple-select items that tested the same Science content and assessed the same standard as the technology-enhanced item.

### **Test Sessions and Content Overview**

The high school Introductory Physics test was made up of two separate test sessions. Each session included selected-response questions and constructed-response questions. On the paper-based test, the selected-response questions were multiple-choice items and multiple-select items, in which students select the correct answer(s) from among several answer options.

### **Standards and Reporting Categories**

The high school Introductory Physics test was based on learning standards in the 2016 *Massachusetts Science and Technology/ Engineering Curriculum Framework*. The Framework is available on the Department website at www.doe.mass.edu/frameworks/current.html.

The introductory physics standards are grouped under the three content reporting categories listed below. Note that standard HS.PHY.1.8 is included in the Energy reporting category.

- Motion, Forces, and Interactions
- Energy
- Waves

Most items on the high school Introductory Physics test are also reported as aligning to one of three MCAS Science Practice Categories. The three practice categories are listed below.

- Practice Category A: Investigations and Questioning
- Practice Category B: Mathematics and Data
- Practice Category C: Evidence, Reasoning, and Modeling

More information about the practice categories is available on the Department website at <a href="http://www.doe.mass.edu/mcas/tdd/practice-categories.html">www.doe.mass.edu/mcas/tdd/practice-categories.html</a>.

The tables at the conclusion of this chapter provides the following information about each released operational item: reporting category, standard covered, science practice category covered (if any), item type, and item description.

### **Spanish-Language Edition**

Since approximately 55% of English learner students in Massachusetts public schools are native Spanish speakers, a Spanishlanguage edition of the February Introductory Physics test was made available to eligible Spanish-speaking students. The computer-based version of the Spanish-language edition presented the Spanish translation above the English text for each item. The booklets for the paper-based version of the Spanish-language edition were issued in side-by-side English/Spanish format: pages on the left side of each booklet presented items in Spanish; pages on the right side presented the same items in English.

### **Reference Materials**

Each student taking the high school Introductory Physics test was provided with an Introductory Physics Reference Sheet. A copy of the reference sheet is provided on the next page. Each student also had sole access to a calculator.

During both high school Introductory Physics test sessions, the use of authorized bilingual word-to-word dictionaries and glossaries was allowed for students who are currently or were ever reported as English learners.

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### Formulas

$S_{average} = \frac{d}{\Delta t}$	p = mv	$F_{e} = k \frac{q_1 q_2}{d^2}$	Q = mc∆T
$v_{average} = \frac{\Delta x}{\Delta t}$	$F\Delta t = \Delta p$	$KE = \frac{1}{2}mv^2$	$v = \lambda f$
$a_{average} = \frac{\Delta v}{\Delta t}$	F <sub>net</sub> = ma	∆PE = mg∆h	$T = \frac{1}{f}$
v <sub>f</sub> = v <sub>i</sub> + a∆t	F <sub>g</sub> = mg	$W = \Delta E = Fd$	V = IR
$\Delta \mathbf{x} = \mathbf{v}_{i} \Delta \mathbf{t} + \frac{1}{2} \mathbf{a} \Delta \mathbf{t}^{2}$	$F_{g} = G \frac{m_{1}m_{2}}{d^{2}}$	$eff = \frac{E_{out}}{E_{in}}$	

### Variables

a = acceleration	KE = kinetic energy	s = speed
c = specific heat	$\lambda$ = wavelength	$\Delta t$ = change in time
d = distance	m = mass	T = period
E = energy	p = momentum	$\Delta T$ = change in temperature
eff = efficiency	$\Delta PE = change in$	v = velocity
f = frequency	gravitational potential energy	V = potential difference (voltage)
F = force	q = charge of particle	W = work
g = acceleration due to gravity	Q = heat added or removed	$\Delta x = change in position$
$\Delta h$ = change in height	R = resistance	(displacement)
I = current		

### **Unit Symbols**

ampere, A	hertz, Hz	meter, m	second, s
coulomb, C	joule, J	newton, N	volt, V
degree Celsius, °C	kilogram, kg	ohm, Ω	

### Definitions

speed of electromagnetic waves in a vacuum =  $3 \times 10^8$  m/s

$$\begin{split} & G = \text{Universal gravitational constant} = 6.7 \times 10^{-11} \frac{\text{N} \cdot \text{m}^2}{\text{kg}^2} \\ & \text{k} = \text{Coulomb's constant} = 9 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \\ & \text{g} \approx 10 \text{ m/s}^2 \text{ at Earth's surface} \qquad 1 \text{ N} = 1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2} \qquad 1 \text{ J} = 1 \text{ N} \cdot \text{m} \end{split}$$

### February 2025 Introductory Physics Computer-Based Operational Items

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
1	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Complete a model to show the forces acting on an object at rest.
2	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Determine how resistance and current are affected by increasing the voltage in a parallel circuit.
3	Motion, Forces, and Interactions	HS.PHY.2.1	B. Mathematics and Data	SR	Determine the position vs. time graph that represents an object with unbalanced forces acting on it.
4	Energy	HS.PHY.3.5	C. Evidence, Reasoning, and Modeling	SR	Determine a change to a system that would decrease the strength of the electric field between two charges.
5	Energy	HS.PHY.3.4	B. Mathematics and Data	SR	Calculate the amount of thermal energy transferred to an object.
6	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Interpret a velocity vs. time graph to determine how far an object traveled.
7	Waves	HS.PHY.4.3	C. Evidence, Reasoning, and Modeling	SR	Explain how changing the intensity and frequency of light shining on a metal plate each affects the electrons ejected from the plate.
8	Waves	HS.PHY.4.5	B. Mathematics and Data	SR	Interpret a model of two waves to determine the resulting destructive interference model.
9	Energy	HS.PHY.3.1	C. Evidence, Reasoning, and Modeling	SR	Describe how the gravitational potential energy and kinetic energy of an object change as the object falls with negligible air resistance.
10	Energy	HS.PHY.1.8	C. Evidence, Reasoning, and Modeling	SR	Identify the nuclear process represented by a model, that energy is released during the process, and that the process occurred because the nucleus was unstable.
11	Motion, Forces, and Interactions	HS.PHY.2.5	None	SR	Interpret the setup of an investigation to describe the relationship between an electric current and a magnetic field.
12	Motion, Forces, and Interactions	HS.PHY.2.2	B. Mathematics and Data	SR	Describe the direction and speed of two carts after they collide and stick together.
13	Motion, Forces, and Interactions	HS.PHY.2.4	C. Evidence, Reasoning, and Modeling	SR	Order the gravitational force that Earth's gravitational field exerts on three objects from least to greatest.
14	Energy	HS.PHY.3.1	B. Mathematics and Data	SR	Calculate the kinetic energy of an object.
15	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Determine the direction of the net force on an object, and compare the magnitude of the net force on the object at different times.
16	Motion, Forces, and Interactions	HS.PHY.2.10	None	SR	Describe the air resistance force acting on an object moving directly downward.
17	Motion, Forces, and Interactions	HS.PHY.2.10	A. Investigations and Questioning	CR	Explain how an object's mass affects the magnitude of the gravitational force acting on the object and the object's motion, and explain how a change to an investigation would reduce experimental error.
18	Motion, Forces, and Interactions	HS.PHY.2.3	B. Mathematics and Data	SR	Calculate the average force exerted on an object during a collision.
19	Energy	HS.PHY.3.3	B. Mathematics and Data	SR	Calculate the percent efficiency of a device.
20	Energy	HS.PHY.3.4	B. Mathematics and Data	CR	Explain how increasing a substance's temperature changes its average molecular kinetic energy, calculate the amount of heat transferred to the substance, calculate the efficiency of a device, and explain why thermal energy moves in a certain direction between two substances.

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
21	Waves	HS.PHY.4.1	B. Mathematics and Data	CR	Classify waves by their type and wave motion, describe longitudinal and transverse wave motion, calculate the distance a wave travels, compare the speeds of a sound wave traveling through two media, and explain how a medium's phase affects a mechanical wave's speed.
22	Waves	HS.PHY.4.1	C. Evidence, Reasoning, and Modeling	SR	Determine which model shows a wave with the highest frequency.
23	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Identify the voltage drop across two resistors that are in series.
24	Motion, Forces, and Interactions	HS.PHY.2.3	A. Investigations and Questioning	SR	Determine the question that students were trying to answer by dropping an object onto different materials.
25	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Analyze the position of objects over time to compare the accelerations of the objects and the net forces on the objects.
26	Motion, Forces, and Interactions	HS.PHY.2.4	B. Mathematics and Data	SR	Describe how to decrease the gravitational force between two objects.
27	Motion, Forces, and Interactions	HS.PHY.2.3	B. Mathematics and Data	SR	Calculate the change in an object's momentum during a collision.
28	Motion, Forces, and Interactions	HS.PHY.2.1	B. Mathematics and Data	SR	Interpret a velocity vs. time graph to determine when there was zero net force on an object.
29	Motion, Forces, and Interactions	HS.PHY.2.5	None	SR	Describe how a temporary magnetic field is created by a battery-powered device.
30	Waves	HS.PHY.4.3	None	SR	Interpret the setup and results of an investigation to describe evidence of light behaving like a wave.
31	Motion, Forces, and Interactions	HS.PHY.2.2	C. Evidence, Reasoning, and Modeling	SR	Determine which claim is best supported about two carts before and after a collision, and describe how changing the setup of an investigation would affect the motion of the carts.
32	Energy	HS.PHY.3.5	C. Evidence, Reasoning, and Modeling	SR	Determine which free-body force diagrams best model the forces on two charged objects.
33	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Interpret a diagram of a marble's position over time to describe the net force on the marble and the marble's velocity.
34	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Determine the resistance of three resistors that are in parallel based on the current through each resistor.
35	Waves	HS.PHY.4.5	None	SR	Identify the wave behavior that a device used to transmit energy.
36	Energy	HS.PHY.3.1	None	SR	Describe how a device converted one form of energy into another form of energy.
37	Energy	HS.PHY.3.4	C. Evidence, Reasoning, and Modeling	SR	Interpret a temperature vs. time graph to describe the direction of energy flow in a system.
38	Energy	HS.PHY.3.2	C. Evidence, Reasoning, and Modeling	CR	Analyze several molecular motion models and a temperature vs. time graph to explain two errors in the models and to explain how the graph shows when the molecules had the greatest average kinetic energy.
39	Waves	HS.PHY.4.1	B. Mathematics and Data	SR	Calculate the wavelength of electromagnetic radiation with a given frequency.
40	Energy	HS.PHY.3.1	B. Mathematics and Data	SR	Calculate the kinetic energy of a toy car.

CBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
41	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Analyze a distance vs. time graph to determine the average speed of an object.
42	Waves	HS.PHY.4.1	None	SR	Compare the speeds of a sound wave as it travels through a solid, a liquid, and a gas.
43	Motion, Forces, and Interactions	HS.PHY.2.3	C. Evidence, Reasoning, and Modeling	CR	Calculate the change in momentum and the average collision force on an object during a collision, and analyze the design of an object to explain how a change in the design would reduce the collision force on the object.

### February 2025 Introductory Physics Paper-Based Operational Items

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
1	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Select the model that shows the forces acting on an object at rest.
2	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Determine how resistance and current are affected by increasing the voltage in a parallel circuit.
3	Motion, Forces, and Interactions	HS.PHY.2.1	B. Mathematics and Data	SR	Determine the position vs. time graph that represents an object with unbalanced forces acting on it.
4	Energy	HS.PHY.3.5	C. Evidence, Reasoning, and Modeling	SR	Determine a change to a system that would decrease the strength of the electric field between two charges.
5	Energy	HS.PHY.3.4	B. Mathematics and Data	SR	Calculate the amount of thermal energy transferred to an object.
6	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Interpret a velocity vs. time graph to determine how far an object traveled.
7	Waves	HS.PHY.4.3	C. Evidence, Reasoning, and Modeling	SR	Explain how changing the intensity and frequency of light shining on a metal plate each affects the electrons ejected from the plate.
8	Waves	HS.PHY.4.5	B. Mathematics and Data	SR	Interpret a model of two waves to determine the resulting destructive interference model.
9	Energy	HS.PHY.3.1	C. Evidence, Reasoning, and Modeling	SR	Describe how the gravitational potential energy and kinetic energy of an object change as the object falls with negligible air resistance.
10	Energy	HS.PHY.1.8	C. Evidence, Reasoning, and Modeling	SR	Identify the nuclear process represented by a model, that energy is released during the process, and that the process occurred because the nucleus was unstable.
11	Motion, Forces, and Interactions	HS.PHY.2.5	None	SR	Interpret the setup of an investigation to describe the relationship between an electric current and a magnetic field.
12	Motion, Forces, and Interactions	HS.PHY.2.2	B. Mathematics and Data	SR	Describe the direction and speed of two carts after they collide and stick together.
13	Motion, Forces, and Interactions	HS.PHY.2.4	C. Evidence, Reasoning, and Modeling	SR	Order the gravitational force that Earth's gravitational field exerts on three objects from least to greatest.
14	Energy	HS.PHY.3.1	B. Mathematics and Data	SR	Calculate the kinetic energy of an object.
15	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Determine the direction of the net force on an object, and compare the magnitude of the net force on the object at different times.
16	Motion, Forces, and Interactions	HS.PHY.2.10	None	SR	Describe the air resistance force acting on an object moving directly downward.
17	Motion, Forces, and Interactions	HS.PHY.2.10	A. Investigations and Questioning	CR	Explain how an object's mass affects the magnitude of the gravitational force acting on the object and the object's motion, and explain how a change to an investigation would reduce experimental error.
18	Motion, Forces, and Interactions	HS.PHY.2.3	B. Mathematics and Data	SR	Calculate the average force exerted on an object during a collision.
19	Energy	HS.PHY.3.3	B. Mathematics and Data	SR	Calculate the percent efficiency of a device.
20	Energy	HS.PHY.3.4	B. Mathematics and Data	CR	Explain how increasing a substance's temperature changes its average molecular kinetic energy, calculate the amount of heat transferred to the substance, calculate the efficiency of a device, and explain why thermal energy moves in a certain direction between two substances.

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
21	Waves	HS.PHY.4.1	B. Mathematics and Data	CR	Classify waves by their type and wave motion, describe longitudinal and transverse wave motion, calculate the distance a wave travels, compare the speeds of a sound wave traveling through two media, and explain how a medium's phase affects a mechanical wave's speed.
22	Waves	HS.PHY.4.1	C. Evidence, Reasoning, and Modeling	SR	Determine which model shows a wave with the highest frequency.
23	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Identify the voltage drop across two resistors that are in series.
24	Motion, Forces, and Interactions	HS.PHY.2.3	A. Investigations and Questioning	SR	Determine the question that students were trying to answer by dropping an object onto different materials.
25	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Analyze the position of objects over time to compare the accelerations of the objects and the net forces on the objects.
26	Motion, Forces, and Interactions	HS.PHY.2.4	B. Mathematics and Data	SR	Describe how to decrease the gravitational force between two objects.
27	Motion, Forces, and Interactions	HS.PHY.2.3	B. Mathematics and Data	SR	Calculate the change in an object's momentum during a collision.
28	Motion, Forces, and Interactions	HS.PHY.2.1	B. Mathematics and Data	SR	Interpret a velocity vs. time graph to determine when there was zero net force on an object.
29	Motion, Forces, and Interactions	HS.PHY.2.5	None	SR	Describe how a temporary magnetic field is created by a battery-powered device.
30	Waves	HS.PHY.4.3	None	SR	Interpret the setup and results of an investigation to describe evidence of light behaving like a wave.
31	Motion, Forces, and Interactions	HS.PHY.2.2	C. Evidence, Reasoning, and Modeling	SR	Determine which claim is best supported about two carts before and after a collision, and describe how changing the setup of an investigation would affect the motion of the carts.
32	Energy	HS.PHY.3.5	C. Evidence, Reasoning, and Modeling	SR	Determine which free-body force diagrams best model the forces on two charged objects.
33	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Interpret a diagram of a marble's position over time to describe the net force on the marble and the marble's velocity.
34	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Determine the resistance of three resistors that are in parallel based on the current through each resistor.
35	Waves	HS.PHY.4.5	None	SR	Identify the wave behavior that a device used to transmit energy.
36	Energy	HS.PHY.3.1	None	SR	Describe how a device converted one form of energy into another form of energy.
37	Energy	HS.PHY.3.4	C. Evidence, Reasoning, and Modeling	SR	Interpret a temperature vs. time graph to describe the direction of energy flow in a system.
38	Energy	HS.PHY.3.2	C. Evidence, Reasoning, and Modeling	CR	Analyze several molecular motion models and a temperature vs. time graph to explain two errors in the models and to explain how the graph shows when the molecules had the greatest average kinetic energy.
39	Waves	HS.PHY.4.1	B. Mathematics and Data	SR	Calculate the wavelength of electromagnetic radiation with a given frequency.
40	Energy	HS.PHY.3.1	B. Mathematics and Data	SR	Calculate the kinetic energy of a toy car.

PBT Item No.	Reporting Category	Standard	Science Practice Category	Item Type*	Item Description
41	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Analyze a distance vs. time graph to determine the average speed of an object.
42	Waves	HS.PHY.4.1	None	SR	Compare the speeds of a sound wave as it travels through a solid, a liquid, and a gas.
43	Motion, Forces, and Interactions	HS.PHY.2.3	C. Evidence, Reasoning, and Modeling	CR	Calculate the change in momentum and the average collision force on an object during a collision, and analyze the design of an object to explain how a change in the design would reduce the collision force on the object.