

Computer-Based Released Items High School Introductory Physics MCAS Spring 2022

The spring 2022 High School Introductory Physics test was administered in two primary formats: a computer-based version and a paper-based version. The vast majority of students took the computer-based test. The paper-based test was offered as an accommodation for students with disabilities who are unable to use a computer, as well as for English learners who are new to the country and are unfamiliar with technology.

The Department of Elementary and Secondary Education is releasing items from both versions of the test to provide information about the knowledge and skills that students are expected to demonstrate.

- Released items from the **computer-based test** are available online at mcas.pearsonsupport.com/released-items. The computer-based released items are collected in a “mini test” called an ePAT (electronic practice assessment tool). Items in the ePAT are displayed in TestNav 8, the testing platform for the computer-based tests.
- Released items from the **paper-based test** are available in PDF format on the Department’s website at www.doe.mass.edu/mcas/release.html.

This document provides information about each released item from the *computer-based test*, including reporting category, standard covered, practice category covered (if any), item type, and item description. Answers are provided for selected-response items only. Sample student responses and scoring guides for constructed-response items will be posted at www.doe.mass.edu/mcas/student/.

A Note about Testing Mode

Most of the operational items on the 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 STE content and assessed the same standard as the technology-enhanced item.

High School Introductory Physics
Spring 2022 Computer-Based Released Operational Items

CBT Item No.	Reporting Category	Standard	Science and Engineering Practice Category	Item Type*	Item Description	Correct Answer (SR)**
1	Motion, Forces, and Interactions	HS.PHY.2.10	C. Evidence, Reasoning, and Modeling	SR	Analyze a speed vs. time graph for an object to determine the position of the object at different times.	A
2	Motion, Forces, and Interactions	HS.PHY.2.4	C. Evidence, Reasoning, and Modeling	SR	Compare the electric forces between two pairs of charges.	A
3	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Determine which change to a circuit would reduce the total current in the circuit by half.	C
4	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Analyze a speed vs. time graph for an object and identify the free-body force diagram that represents the forces acting on the object.	C
5	Motion, Forces, and Interactions	HS.PHY.2.2	B. Mathematics and Data	SR	Calculate the final momentum of an object that is accelerated from rest.	B
6	Energy	HS.PHY.3.5	C. Evidence, Reasoning, and Modeling	SR 2 pt.	Describe how the energy between two charged objects changes when one of the objects moves and determine which model represents an electric field around two charged objects.	Part A: <i>see page 5</i> Part B: C
7	Motion, Forces, and Interactions	HS.PHY.2.5	C. Evidence, Reasoning, and Modeling	SR	Identify that an electric current produces a magnetic field, based on evidence from an investigation.	A
8	Energy	HS.PHY.3.3	B. Mathematics and Data	SR	Calculate the efficiency of a device.	B
9	Waves	HS.PHY.4.5	C. Evidence, Reasoning, and Modeling	SR	Interpret a diagram of light passing from air into glass and describe the angle of refraction.	C
10	Waves	HS.PHY.4.1	None	SR	Explain why some particles of light have more energy than other particles of light.	C
11	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Calculate the current in a series circuit with multiple resistors.	A
12	Energy	HS.PHY.3.1	None	SR	Describe how the energy of an object changes as it falls.	C
13	Motion, Forces, and Interactions	HS.PHY.2.10	C. Evidence, Reasoning, and Modeling	SR	Complete a model to show the magnitudes of a force acting on an object during multiple trials of an investigation.	<i>see page 5</i>
14	Energy	HS.PHY.3.1	B. Mathematics and Data	SR	Calculate the kinetic energy of an object.	A
15	Motion, Forces, and Interactions	HS.PHY.2.10	C. Evidence, Reasoning, and Modeling	SR 2 pt.	Identify the free-body force diagram for an accelerating object and describe how the speed of the object changes as it accelerates.	Part A: C Part B: <i>see page 5</i>

16	Motion, Forces, and Interactions	HS.PHY.2.1	A. Investigations and Questioning	CR 3 pt.	Calculate an object's acceleration, describe how changing the distance over which a force is applied to the object affects its velocity, and describe one way to change the object's acceleration.	
17	Motion, Forces, and Interactions	HS.PHY.2.3	B. Mathematics and Data	SR	Calculate the change in momentum of an object.	A
18	Motion, Forces, and Interactions	HS.PHY.2.4	C. Evidence, Reasoning, and Modeling	SR	Describe a change to a pair of charges that would increase the distance between them.	A
19	Motion, Forces, and Interactions	HS.PHY.2.1	C. Evidence, Reasoning, and Modeling	SR	Determine which velocity vs. time graph represents the motion of an object with zero net force acting on it.	D
20	Energy	HS.PHY.3.1	B. Mathematics and Data	CR 4 pt.	Interpret a diagram to determine where an object has its greatest amount of gravitational potential energy (GPE), calculate the object's GPE, compare the object's kinetic energy (KE) at two positions, and determine the object's position when its KE and GPE are equal.	
21	Waves	HS.PHY.4.1	B. Mathematics and Data	CR 4 pt.	Calculate the speed of a sound wave and compare the characteristics of mechanical and electromagnetic waves.	
22	Motion, Forces, and Interactions	HS.PHY.2.10	B. Mathematics and Data	SR	Interpret a velocity vs. time graph to determine the distance a car travels.	B
23	Motion, Forces, and Interactions	HS.PHY.2.1	B. Mathematics and Data	SR	Using a model of the horizontal forces acting on an object, calculate the velocity of the object.	B
24	Motion, Forces, and Interactions	HS.PHY.2.2	None	SR	Describe how the momentum of a system is affected by a collision.	A
25	Motion, Forces, and Interactions	HS.PHY.2.10	C. Evidence, Reasoning, and Modeling	SR 2 pt.	Interpret a position vs. time graph to determine when a person was farthest from the starting position and to identify the time interval when the person had the greatest speed.	<i>see page 5</i>
26	Waves	HS.PHY.4.1	B. Mathematics and Data	SR	Calculate the frequency of a wave.	C
27	Energy	HS.PHY.1.8	C. Evidence, Reasoning, and Modeling	SR	Describe how the mass and energy of a nucleus change during a radioactive decay process.	<i>see page 6</i>
28	Waves	HS.PHY.4.5	C. Evidence, Reasoning, and Modeling	SR	Interpret a model of two wave pulses to determine the resulting destructive interference model.	B
29	Motion, Forces, and Interactions	HS.PHY.2.4	B. Mathematics and Data	SR	Interpret a data table to determine which pair of objects has the greatest gravitational attraction between them.	A
30	Waves	HS.PHY.4.1	B. Mathematics and Data	SR	Interpret a graph of the speed of sound in three media to determine which medium is a solid, which is a liquid, and which is a gas.	B

31	Motion, Forces, and Interactions	HS.PHY.2.2	B. Mathematics and Data	SR	Complete a model to show the velocities of two spheres after a collision.	<i>see page 6</i>
32	Motion, Forces, and Interactions	HS.PHY.2.3	C. Evidence, Reasoning, and Modeling	SR	Describe how extending the time interval over which a force acts on an object during a collision reduces the impact of the collision.	B
33	Energy	HS.PHY.3.4	B. Mathematics and Data	SR	Interpret a temperature vs. time graph for two objects in thermal contact to determine when the objects reached thermal equilibrium.	<i>see page 6</i>
34	Energy	HS.PHY.3.4	C. Evidence, Reasoning, and Modeling	SR	Determine the observation that best supports a student's prediction about the direction of thermal energy transfer.	D
35	Energy	HS.PHY.3.4	B. Mathematics and Data	SR	Calculate the final temperature of an object after thermal energy is added.	C
36	Energy	HS.PHY.3.4	B. Mathematics and Data	SR 2 pt.	Calculate the amount of thermal energy transferred to a liquid and determine how the temperature change of the liquid would have been different if the mass of the liquid was greater.	A;B
37	Energy	HS.PHY.3.2	C. Evidence, Reasoning, and Modeling	CR 3 pt.	Describe how the average molecular motion of molecules changed in two containers, use data to support a claim that energy was conserved, and explain why the average molecular motion of molecules was the same when thermal equilibrium was reached.	
38	Motion, Forces, and Interactions	HS.PHY.2.5	None	SR	Explain why a magnetic field is present near a wire.	C
39	Waves	HS.PHY.4.1	None	SR	Determine the additional information needed to calculate the wavelength of a sound.	A
40	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	SR	Calculate the voltage of the battery in a series circuit.	B
41	Waves	HS.PHY.4.5	C. Evidence, Reasoning, and Modeling	SR 2 pt.	Identify the wave behavior used by a device and explain how the wave produced by the device could be changed to be effective in a new situation.	B;C
42	Motion, Forces, and Interactions	HS.PHY.2.9	B. Mathematics and Data	CR 4 pt.	Identify a circuit component and describe its function, calculate the total resistance of a circuit, compare the current through two resistors, and calculate the voltage drop across a resistor.	

* STE item types are selected-response (SR) and constructed-response (CR). All selected-response items are worth 1 point unless otherwise noted.

** Answers are provided here for selected-response items only. Pages 5 and 6 of this document provide correct answers for technology-enhanced (TE) items. Sample student responses and scoring guides for constructed-response items will be posted at www.doe.mass.edu/mcas/student/.

Correct Answer for CBT Item #6 Part A: Technology-Enhanced Item

Select from the drop-down menus to correctly complete the sentences.

Object Y is released so that it is free to move. Just before it is released, object Y has

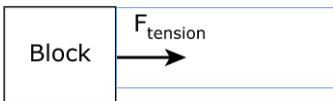
energy as a result of the of object X.

After object Y is released, its energy is converted into energy as it moves

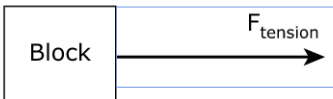
object X.

Correct Answer for CBT Item #13: Technology-Enhanced Item

Trial 1 at Position Y



Trial 5 at Position Y



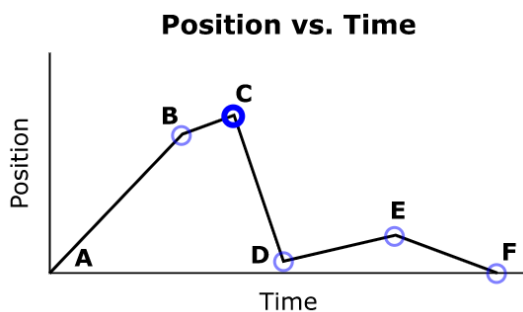
Correct Answer for CBT Item #15 Part B: Technology-Enhanced Item

As the block accelerated across the table, the speed of the block

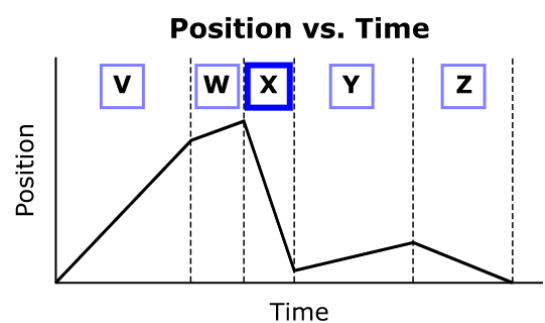
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Correct Answer for CBT Item #25: Technology-Enhanced Item

Part A:



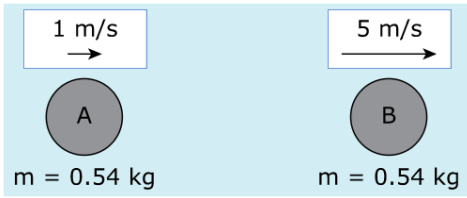
Part B:



Correct Answer for CBT Item #27: Technology-Enhanced Item

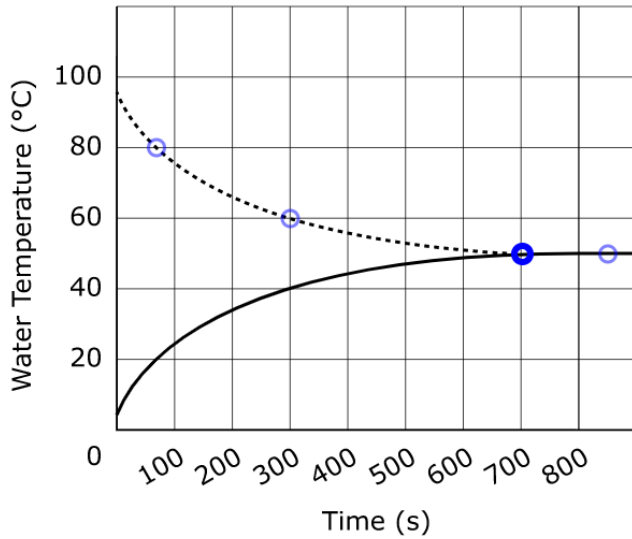
During the decay process, the mass of the original nucleus , and the original nucleus energy.

Correct Answer for CBT Item #31: Technology-Enhanced Item



Correct Answer for CBT Item #33: Technology-Enhanced Item

Water Temperature vs. Time



Key	
.....	Container 1
—	Container 2