

MCAS Introductory Physics Computer-based Practice Test Answer Key

The practice test is approximately equal to what students experience (common items and matrix items) in a single session of the MCAS Introductory Physics test. Information about the test design is posted [here](#). To allow for more familiarity with the new question types that will be on the Next Generation tests, this practice test has a larger percentage of technology enhanced questions compared to the operational MCAS test.

The following pages include the reporting category, [standard alignment](#), practice (if applicable), and point value for each question on the practice test. An answer is also provided for each selected-response item. A rubric and sample student responses are included for each constructed-response item.

Item Number	Reporting Category	2016 Standard	Practice	Points	Correct Answer																				
1	Energy	HS-PS3-3	Evidence, Reasoning, & Modeling	1	For maximum efficiency, the device must minimize <input type="text" value="thermal"/> energy while maximizing <input type="text" value="mechanical"/> energy.																				
2	Motion, Forces, & Interactions	HS-PS2-4	Evidence, Reasoning, & Modeling	1	<table border="1"> <thead> <tr> <th>Force Description</th> <th>Only Newton's Universal Law of Gravitation</th> <th>Only Coulomb's Law</th> <th>Both Laws</th> </tr> </thead> <tbody> <tr> <td>The force can be repulsive.</td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input checked="" type="radio"/></td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>The force can be attractive.</td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input checked="" type="radio"/></td> </tr> <tr> <td>The force increases if the mass of both of the objects increases.</td> <td style="text-align: center;"><input checked="" type="radio"/></td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input type="radio"/></td> </tr> <tr> <td>The force decreases if the distance between the objects increases.</td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input type="radio"/></td> <td style="text-align: center;"><input checked="" type="radio"/></td> </tr> </tbody> </table>	Force Description	Only Newton's Universal Law of Gravitation	Only Coulomb's Law	Both Laws	The force can be repulsive.	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	The force can be attractive.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	The force increases if the mass of both of the objects increases.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	The force decreases if the distance between the objects increases.	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
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5	Energy	HS-PS3-5	Evidence, Reasoning, & Modeling	1	D																				
6	Motion, Forces, & Interactions	HS-PS2-1	Mathematics & Data	2	Part A D																				
					Part B If the mass of the object is increased to 6 kg and the net force remains the same, the acceleration of the object will <input type="text" value="decrease"/> .																				
7	Waves	HS-PS4-3	None	1	<table border="1"> <thead> <tr> <th>Observation</th> <th>Wave Evidence</th> <th>Particle Evidence</th> </tr> </thead> <tbody> <tr> <td>A pattern of bright and dark spots is seen when light passes through two slits.</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>The higher the frequency of the light shined on a metal surface, the greater the kinetic energy of the electrons that are knocked off the surface.</td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> </tr> </tbody> </table>	Observation	Wave Evidence	Particle Evidence	A pattern of bright and dark spots is seen when light passes through two slits.	<input checked="" type="radio"/>	<input type="radio"/>	The higher the frequency of the light shined on a metal surface, the greater the kinetic energy of the electrons that are knocked off the surface.	<input type="radio"/>	<input checked="" type="radio"/>											
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8	Energy	HS-PS3-4a	Mathematics & Data	1	<p>Least heat released $\xrightarrow{\hspace{2cm}}$ Most heat released</p> <table border="1"> <tr> <td>Sample X</td> <td>Sample W</td> <td>Sample Y</td> </tr> </table>	Sample X	Sample W	Sample Y																	
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9	Motion, Forces, & Interactions	HS-PS2-10 (MA)	Evidence, Reasoning, & Modeling	1	A																				
10	Energy	HS-PS1-8	Evidence, Reasoning, & Modeling	1	When an atomic nucleus splits into fragments, a nuclear <input type="text" value="fission"/> process has occurred. The fragments initially have <input type="text" value="kinetic"/> energy, which is transferred to the surrounding medium as <input type="text" value="thermal energy"/> .																				
11	Waves	HS-PS4-1	Mathematics & Data	1	D																				
12	Motion, Forces, & Interactions	HS-PS2-3	Evidence, Reasoning, & Modeling	1	<table border="1"> <thead> <tr> <th>Device</th> <th>Mass of Egg (kg)</th> <th>Velocity of Egg before Impact (m/s)</th> <th>Time to Stop Egg (s)</th> <th>Result</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0.05</td> <td>14</td> <td>0.01</td> <td><input type="text" value="egg broke"/></td> </tr> <tr> <td>2</td> <td>0.05</td> <td>14</td> <td>0.05</td> <td><input type="text" value="egg did not break"/></td> </tr> <tr> <td>3</td> <td>0.05</td> <td>14</td> <td>0.10</td> <td><input type="text" value="egg did not break"/></td> </tr> </tbody> </table>	Device	Mass of Egg (kg)	Velocity of Egg before Impact (m/s)	Time to Stop Egg (s)	Result	1	0.05	14	0.01	<input type="text" value="egg broke"/>	2	0.05	14	0.05	<input type="text" value="egg did not break"/>	3	0.05	14	0.10	<input type="text" value="egg did not break"/>
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Module: Students read about a scientific scenario or phenomenon and then answered three 1-point questions, one 2-point question, and one constructed response question worth 3 points. Some modules will have five 1-point questions and one 3-point constructed response question instead.

Item Number	Reporting Category	2016 Standard	Practice	Points	Correct Answer								
14	Motion, Forces, & Interactions	HS-PS2-2	Mathematics & Data	1	B								
15	Motion, Forces, & Interactions	HS-PS2-10 (MA)	Evidence, Reasoning, & Modeling	1	C								
16	Energy	HS-PS3-1	Evidence, Reasoning, & Modeling	1	<p style="text-align: center;">Energy When Carts Were Closest Together</p> <table border="1"> <caption>Data from Bar Chart: Energy When Carts Were Closest Together</caption> <thead> <tr> <th>Type of Energy</th> <th>Amount of Energy (J)</th> </tr> </thead> <tbody> <tr> <td>Gravitational Potential Energy</td> <td>0.25</td> </tr> <tr> <td>Kinetic Energy</td> <td>0</td> </tr> <tr> <td>Magnetic Potential Energy</td> <td>1.0</td> </tr> </tbody> </table>	Type of Energy	Amount of Energy (J)	Gravitational Potential Energy	0.25	Kinetic Energy	0	Magnetic Potential Energy	1.0
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17	Motion, Forces, & Interactions	HS-PS2-2	Mathematics & Data	2	<p>Part A</p> <p>During the collision in trial 1, momentum was <input type="text" value="conserved"/> and kinetic energy was <input type="text" value="not conserved"/>.</p> <p>During the collision in trial 2, momentum was <input type="text" value="conserved"/> and kinetic energy was <input type="text" value="conserved"/>.</p>								
					<p>Part B</p> <p style="text-align: center;">D, E</p>								
18	Motion, Forces, & Interactions	HS-PS2-1	Mathematics & Data	3	See scoring guide and sample student responses below. (Maximum of 3 points)								

Item Number	Reporting Category	2016 Standard	Practice	Points	Correct Answer				
19	Motion, Forces, & Interactions	HS-PS2-4	Mathematics & Data	1					
20	Motion, Forces, & Interactions	HS-PS2-9 (MA)	Mathematics & Data	1	<p>One of the following:</p>				
21	Energy	HS-PS3-2	None	1	A				
22	Waves	HS-PS4-1	Mathematics & Data	2	<table border="1"> <tr> <td>Part A</td> <td>B</td> </tr> <tr> <td>Part B</td> <td> <p>Sound waves travel through air at a speed that is <input type="text" value="slower than"/> the speed at which they travel through brick.</p> <p>The 400 Hz sound wave traveling through air has a <input type="text" value="shorter"/> wavelength than the 400 Hz sound wave traveling through brick.</p> </td> </tr> </table>	Part A	B	Part B	<p>Sound waves travel through air at a speed that is <input type="text" value="slower than"/> the speed at which they travel through brick.</p> <p>The 400 Hz sound wave traveling through air has a <input type="text" value="shorter"/> wavelength than the 400 Hz sound wave traveling through brick.</p>
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23	Energy	HS-PS3-1	Mathematics & Data	2	<p>Just before both objects hit the ground, object W's kinetic energy was <input type="text" value="greater than"/> object X's kinetic energy.</p> <p>Just before both objects hit the ground, object W's velocity was <input type="text" value="equal to"/> object X's velocity.</p>				

Item Number	Reporting Category	2016 Standard	Practice	Points	Correct Answer						
24	Energy	HS-PS3-5	Evidence, Reasoning, & Modeling	1							
25	Motion, Forces, & Interactions	HS-PS2-10 (MA)	Evidence, Reasoning, & Modeling	1	B						
26	Waves	HS-PS4-5	Evidence, Reasoning, & Modeling	1	<table border="1"> <tr> <td>First, the wave pulses moved toward each other.</td> <td>Second, the wave pulses met in the middle.</td> <td>Third, the wave pulses moved away from each other.</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </table>	First, the wave pulses moved toward each other.	Second, the wave pulses met in the middle.	Third, the wave pulses moved away from each other.			
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27	Motion, Forces, & Interactions	HS-PS2-2	Mathematics & Data	1							
28	Energy	HS-PS3-4a	Mathematics & Data	4	See scoring guide and sample student responses below. (Maximum of 4 points)						
29	Motion, Forces, & Interactions	HS-PS2-9 (MA)	Evidence, Reasoning, & Modeling	4	See scoring guide and sample student responses below. (Maximum of 4 points)						

Question 18: Scoring Guide

Score	Description
3	The response demonstrates a thorough understanding of how to analyze the forces that act on objects during collisions and how these forces affect the motion of each object. The response correctly compares the forces between carts X and Y and explains the answer. The response also correctly calculates the acceleration of cart X and the force on cart X during the collision.
2	The response demonstrates a partial understanding of how to analyze the forces that act on objects during collisions and how these forces affect the motion of each object.
1	The response demonstrates a minimal understanding of how to analyze the forces that act on objects during collisions and how these forces affect the motion of each object.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

Question 18: Sample Student Responses (Actual Student Responses)

Score	Part	Student Response
3	A	They are the same because of Newton's 3 rd law: for every action there is an equal and opposite reaction.
	B	$a = \frac{\Delta v}{\Delta t}$ $a = - \frac{.4}{.1}$ $a = -4 \cdot \frac{m}{s^2}$
	C	$f = ma$ $f = .5 \times (-4)$ $f = -2 \text{ newtons}$
2	A	X and Y exerted the forces of the same magnitude on each other as according to Newton's 3 rd law which states that for every action there is an equal and opposite reaction.
	B	$vf = vi + a\Delta t$ $(vf - vi) \div t = a$ $(0.2 - 0.6) \div 0.1 = a$ $a = -4 \cdot \frac{m}{s^2}$
	C	$f = ma$ $f = 0.5 \times (-4)$ $f = -8N$

1	A	The magnitude of the forces that cart X and cart Y exerted on each other during the collision were different because cart Y was not moving but cart X was so Cart X exerted more force.
	B	$a = \frac{v}{t}$ $a = \frac{.2 - .6}{.1}$ $a = -\frac{.4}{.1}$ $a = -4 \cdot \frac{m}{s^2}$
	C	$F = ma$ $F = 1 \times (-4)$ $F = -4 \text{ N}$
0	A	Since Cart Y is .5 kilograms bigger than Cart X the force exerted was greater on cart X from Y than from X on Y.
	B	$A = \frac{v}{T}$ $A = 12$ <p>meters per second squared</p> $v = 6 \text{ meters per second}$ $T = .5 \text{ seconds}$ $A = \frac{6}{0.5}$
	C	The Magnitude exerted on cart Y by X is .5 newtons

Question 28: Scoring Guide

Score	Description
4	The response demonstrates a thorough understanding of the relationship between thermal energy, temperature change, mass, and specific heat. The response correctly calculates the thermal energy absorbed by the water. The response clearly describes what happens to the temperature of the water as it boils and explains the answer. The response correctly compares the amount of thermal energy absorbed by the water in the first and second experiments and clearly explains the answer. The response also clearly describes how using a material with a greater specific heat will affect the time it takes to heat the block.
3	The response demonstrates a general understanding of the relationship between thermal energy, temperature change, mass, and specific heat.
2	The response demonstrates a limited understanding of the relationship between thermal energy, temperature change, mass, and specific heat.
1	The response demonstrates a minimal understanding of the relationship between thermal energy, temperature change, mass, and specific heat.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

Question 28: Sample Student Responses (Actual Student Responses)

Score	Part	Student Response
4	A	$m = 200 \text{ g}$ $\Delta t = 80 - 20 = 60^\circ\text{C}$ $c = 4.18 \text{ J/g}\cdot^\circ\text{C}$ $Q = ?$ $Q = mc\Delta T$ $Q = 200(60)4.18$ $Q = 50160\text{J}$ The thermal energy absorbed by the water is 50160J. I used the heat equation to find this answer.
	B	As the water starts to boil, or change from a liquid to a gas state, it under goes a phase change. Instead of heat increasing the temperature of the water as it does when matter is not in a phase change, the heat is used to change the state of the water and therefore is not used to increase the water's temperature. For this reason, the water does not increase in temperature as it boils.
	C	in this experiment, the water absorbs the same amount of thermal energy as in part (a). This is because the change in temperature (ΔT), specific heat (c) and mass (m) of the water do not change, so the solution of the heat equation, $Q = mc\Delta T$, will be the same as in part (a).
	D	If the block in experiment 2 were to have a higher specific heat, it will take more time to heat the block. This is because specific heat is the amount of heat it takes per gram to raise one degree Celcius, so if the specific heat is higher, it takes more energy to heat a certain amount, therefore taking more time as the mass of the block is changing.

Question 29: Scoring Guide

Score	Description
4	The response demonstrates a thorough understanding of current and resistance in series and parallel circuits. The response correctly compares the brightness of bulbs X and Y when the switch is open, and clearly describes what will happen to bulbs X and Y when the switch is closed. The response also clearly describes one change that occurs when another bulb is added at point Z and correctly calculates the current in this circuit.
3	The response demonstrates a general understanding of current and resistance in series and parallel circuits.
2	The response demonstrates a limited understanding of current and resistance in series and parallel circuits.
1	The response demonstrates a minimal understanding of current and resistance in series and parallel circuits.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

Question 29: Sample Student Responses (Actual Student Responses)

Score	Part	Student Response
4	A	When the switch is open bulb X and bulb Y both have the same brightness. They are each half as bright as they would be if there was only one bulb.
	B	When the switch is closed both bulbs do not have the same brightness anymore. Bulb X will become brighter and bulb Y will turn off.
	C	One way this circuit functions differently is when an extra bulb is added. each bulb is less bright. Since there are now 3 bulbs, each bulb becomes 1/3 as bright as it would be if there was only one bulb.
	D	When the switch is open, this circuit has a current of 2 Amps. To get my answer I divided the 30 V from the battery by the total of 15 Ω of resistance to get 2 A of current. $I = \frac{V}{R}$ $I = \frac{30 \text{ V}}{15 \Omega}$ $\underline{I = 2 \text{ A}}$

3	A	When the switch is open Bulbs X & Y are both equally bright.
	B	When the switch is closed, Bulb X gets brighter & bulb Y turns off completely.
	C	When Bulb Z was added Bulb X & Y both got dimmer, & an equal amount of current went to Bulb Z, making all 3 lightbulbs have the same brightness.
	D	<p>Bulb X: $V = 30 \text{ V}$ $R = 5\Omega$ $I = ?$ $I = \frac{V}{R} = \frac{30}{5} = 6 \text{ A}$</p> <p>Bulb Y: $V = 30 \text{ V}$ $R = 5\Omega$ $I = ?$ $I = \frac{V}{R} = \frac{30}{5} = 6 \text{ A}$</p> <p>Bulb Z: $V = 30 \text{ V}$ $R = 5\Omega$ $I = ?$ $I = \frac{V}{R} = \frac{30}{5} = 6 \text{ A}$</p>
2	A	Bulb X is brighter than bulb Y when the switch is open.
	B	When the switch is closed, both bulbs X and Y are unaffected.
	C	The total resistance is now 15Ω , and is no longer 10Ω .
	D	<p>$V = IR$ $30\text{V} = I(15\Omega)$ $\frac{30\text{V}}{15} = \frac{I(15\Omega)}{15}$ $2 = I$ Current is 2 amps</p>
1	A	Bulb X and bulb Y would not be lit up because the switch is open, which doesn't allow electrical current to flow.
	B	When the switch is closed both bulbs X and Y would light up because electric current is flowing through the circuit.
	C	The circuit functions differently from when the switch was open because now the battery provides voltage for three bulbs.
	D	<p>$I = ?$ $V = 30 \text{ V}$ $R = 15 \Omega$ $I = \frac{V}{R}$ $I = \frac{30}{15}$ $I = 2 \text{ Amps}$</p>
0	A	Bulb X will be brighter than Bulb Y when the switch is open
	B	Current will flow through both bulbs X and Y when the switch is closed
	C	The current in the circuit flows through a lightbulb more quickly. The circuit uses up its energy quickly
	D	Bulbs X, Y and Z