Release of Spring 2021 MCAS Test Information

from the

High School Introductory Physics Paper-Based Test

June 2021
Massachusetts Department of Elementary and Secondary Education

This document was prepared by the
Massachusetts Department of Elementary and Secondary Education
Jeffrey C. Riley
Commissioner

Massachusetts Department of Elementary and Secondary Education
75 Pleasant Street, Malden, MA 02148-4906
Phone 781-338-3000 TTY: N.E.T. Relay 800-439-2370
www.doe.mass.edu

High School Introductory Physics Test

The spring 2021 high school Introductory Physics test was a legacy assessment that was based on overlapping learning standards in the October 2006 and April 2016 versions of the *Massachusetts Science and Technology/Engineering Curriculum Framework*. The 2006 and 2016 versions of the framework are available on the Department website at www.doe.mass.edu/frameworks/.

Introductory Physics test results are reported under the following four legacy MCAS reporting categories:

- Motion and Forces
- Heat and Heat Transfer
- Waves and Radiation
- Electromagnetism

The table at the conclusion of this publication indicates each item's reporting category and the 2006 and 2016 framework learning standards each item assesses. In order to support future test development, items from the spring 2021 Introductory Physics test are not included in this publication. The omission of these items will have no impact on the reporting of results.

Test Sessions

The high school Introductory Physics test included two separate test sessions. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

Each student taking the high school Introductory Physics test was provided with an Introductory Physics Reference Sheet. A copy of this reference sheet is displayed on the next page.

Each student also had sole access to a calculator with at least four functions and a square-root key.

During both Introductory Physics test sessions, the use of bilingual word-to-word dictionaries was allowed for current and former English learner students only. No other reference tools or materials were allowed.

MASSACHUSETTS DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION

Massachusetts Comprehensive Assessment System
Introductory Physics Reference Sheet

Formulas

$s_{average} = \frac{d}{\Delta t}$

$v_{average} = \frac{\Delta x}{\Delta t}$

$a_{average} = \frac{\Delta v}{\Delta t}$

$v_f = v_i + a\Delta t$

$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$p = mv$

$F\Delta t = \Delta p$

$F_{net} = ma$

$F_g = mg$

$F_g = G\frac{m_1 m_2}{d^2}$

$F_e = k\frac{q_1 q_2}{d^2}$

$KE = \frac{1}{2}mv^2$

$\Delta PE = mg\Delta h$

$W = \Delta E = Fd$

$eff = \frac{E_{out}}{E_{in}}$

$Q = mc\Delta T$

$v = \lambda f$

$T = \frac{1}{f}$

$V = IR$

Variables

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

Unit Symbols

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

Definitions

speed of electromagnetic waves in a vacuum = 3×10^8 m/s

G = Universal gravitational constant = $6.7 \times 10^{-11} \frac{N \bullet m^2}{kg^2}$

k = Coulomb's constant = $9 \times 10^9 \frac{N \bullet m^2}{C^2}$

g $\approx$ 10 m/s^2 at Earth's surface

1 N = $1\frac{kg \bullet m}{s^2}$

1 J = 1 N • m

Updated June 2018

High School Introductory Physics
Spring 2021 Unreleased Operational Items

Item No.	Legacy Reporting Category	2006 Standard	2016 Standard
1	*Waves and Radiation*	STE.IP.Wave4.1	HS.PHY.4.1
2	*Motion and Forces*	STE.IP.MF1.7	HS.PHY.2.4
3	*Motion and Forces*	STE.IP.MF1.2	HS.PHY.2.10
4	*Motion and Forces*	STE.IP.MF1.5	HS.PHY.2.10
5	*Electromagnetism*	STE.IP.EM5.3	HS.PHY.2.9
6	*Motion and Forces*	STE.IP.CEM2.2	HS.PHY.3.1
7	*Waves and Radiation*	STE.IP.Wave4.5	HS.PHY.4.1
8	*Heat and Heat Transfer*	STE.IP.HHT3.4	HS.PHY.3.4
9	*Heat and Heat Transfer*	STE.IP.HHT3.3	HS.PHY.3.4
10	*Electromagnetism*	STE.IP.EM5.3	HS.PHY.2.9
11	*Waves and Radiation*	STE.IP.Wave4.4	HS.PHY.4.5
12	*Electromagnetism*	STE.IP.EM5.2	HS.PHY.2.9
13	*Motion and Forces*	STE.IP.MF1.2	HS.PHY.2.10
14	*Electromagnetism*	STE.IP.EM5.4	HS.PHY.2.4
15	*Motion and Forces*	STE.IP.MF1.7	HS.PHY.2.4
16	*Waves and Radiation*	STE.IP.Wave4.2	HS.PHY.4.1
17	*Motion and Forces*	STE.IP.MF1.3	HS.PHY.2.10
18	*Motion and Forces*	STE.IP.MF1.4	HS.PHY.2.10
19	*Waves and Radiation*	STE.IP.Wave4.3	HS.PHY.4.1
20	*Electromagnetism*	STE.IP.EM5.6	HS.PHY.2.5
21	*Waves and Radiation*	STE.IP.EM6.1	HS.PHY.4.1
22	*Motion and Forces*	STE.IP.MF1.4	HS.PHY.2.10
23	*Heat and Heat Transfer*	STE.IP.HHT3.2	HS.PHY.3.4
24	*Waves and Radiation*	STE.IP.Wave4.1	HS.PHY.4.1
25	*Heat and Heat Transfer*	STE.IP.HHT3.3	HS.PHY.3.2
26	*Motion and Forces*	STE.IP.CEM2.3	HS.PHY.3.1
27	*Motion and Forces*	STE.IP.CEM2.2	HS.PHY.3.1
28	*Waves and Radiation*	STE.IP.EM6.2	HS.PHY.4.1
29	*Motion and Forces*	STE.IP.CEM2.5	HS.PHY.2.2
30	*Electromagnetism*	STE.IP.EM5.6	HS.PHY.2.5
31	*Electromagnetism*	STE.IP.EM5.2	HS.PHY.2.9
32	*Motion and Forces*	STE.IP.MF1.5	HS.PHY.2.10
33	*Motion and Forces*	STE.IP.CEM2.5	HS.PHY.2.2
34	*Electromagnetism*	STE.IP.EM5.2	HS.PHY.2.9

Item No.	Legacy Reporting Category	2006 Standard	2016 Standard
35	*Waves and Radiation*	STE.IP.Wave4.2	HS.PHY.4.1
36	*Heat and Heat Transfer*	STE.IP.HHT3.2	HS.PHY.3.4
37	*Waves and Radiation*	STE.IP.Wave4.1	HS.PHY.4.1
38	*Waves and Radiation*	STE.IP.Wave4.3	HS.PHY.4.1
39	*Electromagnetism*	STE.IP.EM5.4	HS.PHY.2.4
40	*Motion and Forces*	STE.IP.CEM2.3	HS.PHY.3.1
41	*Motion and Forces*	STE.IP.MF1.3	HS.PHY.2.10
42	*Motion and Forces*	STE.IP.MF1.4	HS.PHY.2.10
43	*Heat and Heat Transfer*	STE.IP.HHT3.4	HS.PHY.3.4
44	*Motion and Forces*	STE.IP.CEM2.1	HS.PHY.3.1
45	*Waves and Radiation*	STE.IP.Wave4.5	HS.PHY.4.1