TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

TIMSS

TIMSS Advanced 2008 User Guide

for the International Database

Released Items

Physics

TIMSS & PIRLS
International Study Center
Lynch School of Education, Boston College

TIMSS Advanced 2008 User Guide for the International Database

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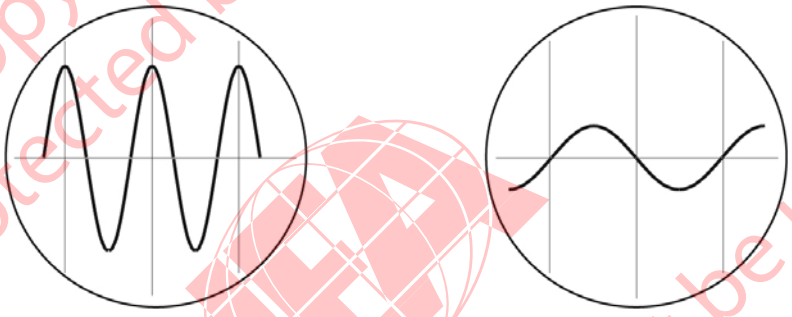
TIMSS & PIRLS
International Study Center
Lynch School of Education, Boston College

Item ID	Subject	Block	Block Seq	Content Domain	Cognitive Domain	Maximum Points	Key
PA13001	Physics	P1	01	Mechanics	Applying	1	A
PA13002	Physics	P1	02	Atomic and Nuclear Physics	Applying	1	B
PA13003	Physics	P1	03	Mechanics	Applying	1	C
PA13004	Physics	P1	04	Electricity and Magnetism	Applying	1	D
PA13005	Physics	P1	05	Mechanics	Applying	1	C
PA13006	Physics	P1	06	Electricity and Magnetism	Applying	1	D
PA13007	Physics	P1	07	Atomic and Nuclear Physics	Reasoning	1	B
PA13009	Physics	P1	09	Electricity and Magnetism	Reasoning	1	A
PA13021	Physics	P3	01	Electricity and Magnetism	Knowing	1	A
PA13022	Physics	P3	02	Heat and Temperature	Applying	2	See scoring guide
PA13023	Physics	P3	03	Mechanics	Applying	1	See scoring guide
PA13024	Physics	P3	04	Electricity and Magnetism	Applying	2	See scoring guide
PA13025	Physics	P3	05	Atomic and Nuclear Physics	Reasoning	2	See scoring guide
PA13026	Physics	P3	06	Electricity and Magnetism	Reasoning	1	See scoring guide
PA13027A	Physics	P3	07	Mechanics	Reasoning	1	See scoring guide
PA13027B	Physics	P3	07	Mechanics	Reasoning	1	See scoring guide
PA23050	Physics	P6	01	Heat and Temperature	Applying	1	C
PA23056	Physics	P6	02	Heat and Temperature	Knowing	1	B
PA23142	Physics	P6	03	Heat and Temperature	Knowing	1	B
PA23072	Physics	P6	04	Mechanics	Applying	1	See scoring guide
PA23022	Physics	P6	05	Mechanics	Reasoning	2	See scoring guide
PA23030	Physics	P6	06	Electricity and Magnetism	Applying	1	B
PA23078	Physics	P6	07	Electricity and Magnetism	Reasoning	1	See scoring guide
PA23113	Physics	P6	08	Electricity and Magnetism	Reasoning	1	D
PA23128	Physics	P6	09	Electricity and Magnetism	Knowing	1	See scoring guide
PA23058	Physics	P6	10	Atomic and Nuclear Physics	Applying	1	C
PA23115	Physics	P6	11	Atomic and Nuclear Physics	Applying	1	D
PA23110	Physics	P7	01	Mechanics	Applying	1	C
PA23014	Physics	P7	02	Mechanics	Knowing	1	See scoring guide
PA23025	Physics	P7	03	Mechanics	Reasoning	2	See scoring guide
PA23028	Physics	P7	04	Mechanics	Applying	1	B
PA23034	Physics	P7	05	Electricity and Magnetism	Applying	1	See scoring guide
PA23044	Physics	P7	06	Electricity and Magnetism	Applying	1	See scoring guide
PA23082	Physics	P7	07	Heat and Temperature	Reasoning	1	See scoring guide
PA23140	Physics	P7	08	Heat and Temperature	Knowing	1	C
PA23084	Physics	P7	09	Heat and Temperature	Reasoning	2	See scoring guide
PA23059	Physics	P7	10	Atomic and Nuclear Physics	Knowing	1	C
PA23138	Physics	P7	11	Atomic and Nuclear Physics	Knowing	1	C
PA23137	Physics	P7	12	Atomic and Nuclear Physics	Knowing	1	See scoring guide

Item ID **PA13001**	Physics	Block_Sequence **P1_01**

An oscilloscope is used to analyze two musical notes (I and II) recorded with a microphone. Two traces are obtained as shown below. The oscilloscope settings are the same in both cases.



Note I Note II

Which one of the following statements is true?

Compared to Note II, Note I is

(A) louder and has higher pitch
(B) louder and has lower pitch
(C) softer and has higher pitch
(D) softer and has lower pitch

PA13001

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Applying

Maximum Points
1

Key
A

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Item ID **PA13002**	Physics	Block_Sequence **P1_02**

PA13002

A 2.0 g mass of radioactive thorium decays over 72 days, leaving 0.25 g of thorium unchanged.

What is the half-life of thorium?

(A) 12 days
(B) 24 days
(C) 48 days
(D) 72 days

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Applying

Maximum Points
1

Key
B

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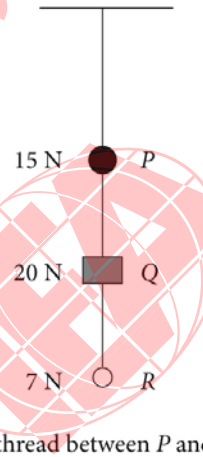
Item ID **PA13003**	Physics	Block_Sequence **P1_03**

The objects P, Q and R of weight 15 N (newtons), 20 N and 7 N, are hung with light threads as shown in the figure.



What is the tension in the thread between P and Q?

Ⓐ 42 N
Ⓑ 35 N
Ⓒ 27 N
Ⓓ 15 N
Ⓔ 7 N

PA13003

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Applying

Maximum Points
1

Key
C

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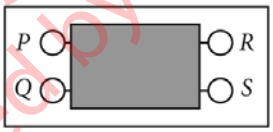
Item ID **PA13004**	Physics	Block_Sequence **P1_04**

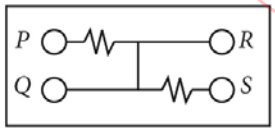
The figure shows a box with four terminals: *P*, *Q*, *R* and *S*. The following observations were made.

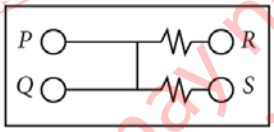


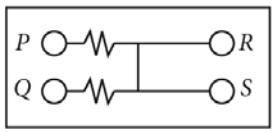
1. There is a measurable resistance between *P* and *Q*.
2. Resistance between *P* and *R* is twice that between *P* and *Q*.
3. There is no measurable resistance between *Q* and *S*.

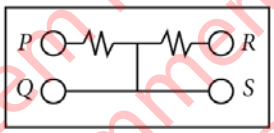
Which of the following circuits is most likely to be within the box?

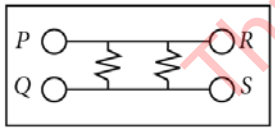
Assume that all the resistances shown are equal.

Ⓐ 

Ⓑ 

Ⓒ 

Ⓓ 

Ⓔ 

PA13004

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Applying

Maximum Points
1

Key
D

Item ID **PA13005**	Physics	Block_Sequence **P1_05**

A stone is dropped from rest down a deep well. It takes 2 s to reach the bottom.

How deep is the well?

Assume that the air resistance on the falling stone is negligible and that the acceleration due to gravity $g = 9.8\ \text{ms}^{-2}$.

Ⓐ 4.9 m
Ⓑ 9.8 m
Ⓒ 19.6 m
Ⓓ 39.2 m
Ⓔ 78.4 m

PA13005

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Applying

Maximum Points
1

Key
C

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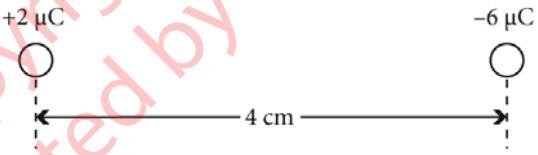
Item ID **PA13006**	Physics	Block_Sequence **P1_06**

Two small charges of +2 μC (microcoulombs) and −6 μC respectively are placed 4 cm apart as shown.



Where should a third charge −8 μC be placed so that there is no net force on the −6 μC charge?

(A) 4 cm left of the −6 μC charge
(B) 16 cm left of the −6 μC charge
(C) 16 cm right of the −6 μC charge
(D) 8 cm left of the −6 μC charge
(E) 8 cm right of the −6 μC charge

PA13006

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

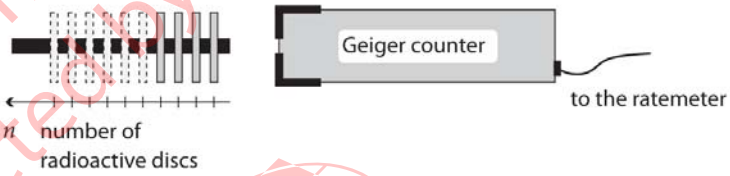
Cognitive Domain
Applying

Maximum Points
1

Key
D

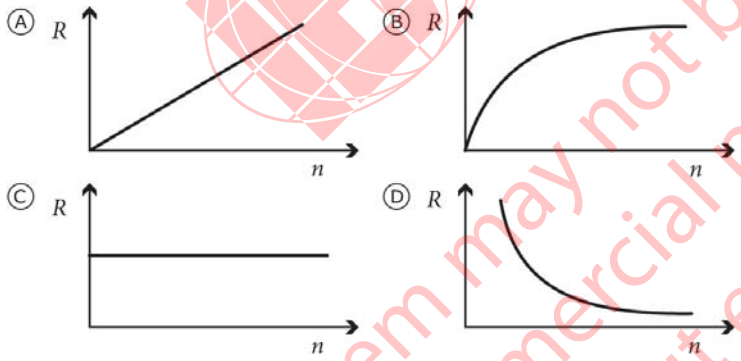
Item ID **PA13007** | Block_Sequence **P1_07**

Small very thin metallic discs of an alloy of ^{90}Sr are mounted on a rod a small distance from a Geiger counter, as shown in the figure.



^{90}Sr is a radioactive isotope producing only beta radiation.

Which one of the following graphs best shows how the reading R of the Geiger counter ratemeter varies with n, the number of discs on the rod?



PA13007

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Reasoning

Maximum Points
1

Key
B

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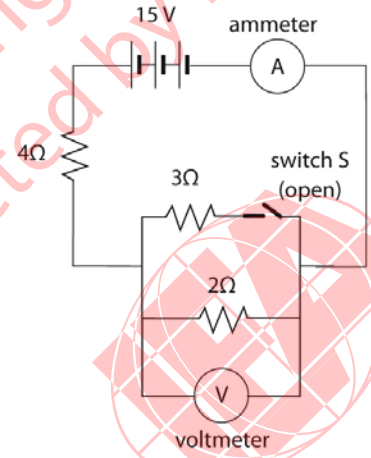
Item ID **PA13009**	Physics	Block_Sequence **P1_09**

In the electric circuit shown below switch S is open.



What is the effect on the ammeter and voltmeter readings when switch S is **closed**?

Ⓐ The ammeter reading increases; the voltmeter reading decreases.
Ⓑ The ammeter reading decreases; the voltmeter reading increases.
Ⓒ The ammeter reading increases; the voltmeter reading increases.
Ⓓ The ammeter reading decreases; the voltmeter reading decreases.

PA13009

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Reasoning

Maximum Points
1

Key
A

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Item ID **PA13021**	Physics	Block_Sequence **P3_01**

PA13021

In the electromagnetic spectrum there are different types of radiation.

Which one of the following lists gives the radiation types in order of increasing wavelength?

(A) γ-radiation, X-rays, visible light, radio waves
(B) X-rays, radio waves, visible light, γ-radiation
(C) radio waves, γ-radiation, visible light, X-rays
(D) γ-radiation, X-rays, radio waves, visible light

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Knowing

Maximum Points
1

Key
A

Item ID **PA13022**	Physics	Block_Sequence **P3_02**

100 g of water with a temperature of 90 °C is poured into an aluminium box with a temperature of 20 °C. The mass of the box is 50 g.

What will the final temperature of the system be? Assume that there is no heat exchange with the environment. Show your work.

The specific heat of water is 4.2 kJ/(kg K). The specific heat of aluminium is 0.92 kJ/(kg K).

PA13022

TIMSS Advanced 2008

Content Domain
Heat and Temperature

Cognitive Domain
Applying

Maximum Points
2

Key
See scoring guide

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Item ID **PA13022**	Physics	Block_Sequence **P3_02**

Note: Accept reasonable roundings.

Code	Response	Item: PA13022
	Correct Response	
20	T = 83 °C due to heat loss by water = heat gain by aluminum. Calculations must be shown. *Example:* $c_1 m_1 \Delta T_1 = c_2 m_2 \Delta T_2$ $(0.1\text{kg})(4200\text{J/kgK})(90°\text{C} - T) = 0.05\text{Kg}(920\text{J/(kgK)}(T - 20°)$ T = 83 °C	
	Partially Correct Response	
10	Correct method but calculation error and/or missing or incorrect units	
11	Correct method but no value for temperature	
19	Other partially correct responses	
	Incorrect Response	
70	Formula for heat loss and for heat gain is applied, otherwise incomplete or incorrect *Example:* $Q(\text{loss}) = 4.2 \times 0.1 \times 70 = 29.4\text{kJ}$	
71	T = 83 °C but no work shown	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA13023**	Physics	Block_Sequence **P3_03**

The speed of waves on the water surface is 0.32 ms^{-1} in deep water and 0.20 ms^{-1} in shallow water.

If the wavelength in deep water is 0.016 m, what is the wavelength in shallow water?

PA13023

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Applying

Maximum Points
1

Key
See scoring guide

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Item ID **PA13023**	Physics	Block_Sequence **P3_03**

Note: Accept responses with reasonable roundings and/or missing units.

Code	Response	Item: PA13023
	Correct Response	
10	$\lambda = 0.010$ m based on constant frequency $(f = \frac{v}{\lambda})$ *Examples:* 1) The frequency is the same. $f = v/\lambda = 0.32/0.016\text{Hz} = 20\text{Hz}$ $\lambda = 0.20/20$ m $= 0.010$ m 2) $\lambda_2 = (\frac{v_2}{v_1})\lambda_1$ $\lambda_2 = (0.20/0.32)\times 0.016$ m $= 0.010$ m	
	Incorrect Response	
70	Correct method (equation) but calculation error	
71	$\lambda = 0.026$ m (uses incorrect ratio of speeds) *Example:* $\lambda = (0.32/0.20)\times 0.016$ m $= 0.026$ m	
72	$\lambda = 0.010$ m but no work shown Note: Only 0.01 or 0.010 without unit is accepted, but no other responses (e.g., 1.0 without unit is coded as 79).	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA13024**	Physics	Block_Sequence **P3_04**

A small charged plastic foam ball is held at rest by the electric field between two large horizontal oppositely charged plates.

If the charge on the ball is 5.7 μC and its mass is 1.4×10^{-4} kg, what is the magnitude of the electric field strength? Show your work.

PA13024

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Applying

Maximum Points
2

Key
See scoring guide

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Item ID **PA13024**	Physics	Block_Sequence **P3_04**

Note: Accept reasonable roundings.

Code	Response	Item: PA 13024
	Correct Response	
20	E = 240N/C or 240V/m. Balanced forces: $mg = qE$ (or $E = \frac{F}{q}$ and $F = mg$), then $E = \frac{mg}{q}$	
	Partially Correct Response	
10	As code 20, but calculation error and/or missing or incorrect units	
19	Other partially correct responses	
	Incorrect Response	
70	The formula $E = \frac{F}{q}$ is stated, no further, or incorrect reasoning (other than Coulomb's law).	
71	Refers to Coulomb's law ($F = k.\frac{q_1 q_2}{r^2}$).	
72	E = 240N/C or 240V/m. No work shown.	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA13025**	Physics	Block_Sequence **P3_05**

The table shows the work-function energy (W) for the photoelectric effect in three different metals.

Metal	W
Ca	4.60×10^{-19} J
Li	4.65×10^{-19} J
Zn	6.94×10^{-19} J

Which of these metals will emit electrons when hit by visible light with wavelength 400 nm? Explain your reasoning.

PA13025

TIMSS Advanced 2008

Content Domain

Atomic and Nuclear Physics

Cognitive Domain

Reasoning

Maximum Points

2

Key

See scoring guide

Item ID **PA13025**	Physics	Block_Sequence **P3_05**

Note: Accept reasonable roundings.

Code	Response	Item: PA 13025
	Correct Response	
20	Ca and Li (not Zn) will emit electrons. Reasoning: compares photon energy with the work function (W). OR: Einstein's equation gives negative kinetic energy for Zn. Calculations must be shown. *Example:* *Einstein's equation:* $hf = W + E_k$ *Photoelectric effect if* $\frac{hc}{\lambda} > W$ $\frac{hc}{\lambda} = 5.0\times10^{-19}\,\text{J}$ *which is less than the work function for Zn, but greater than that for Ca and Li.*	
21	Ca and Li (not Zn) will emit electrons. Reason: compares the threshold frequencies (or wavelengths) with the photon frequency (wavelength). Calculations must be shown.	
	Partially Correct Response	
10	Correct method, but calculation error	
11	$hf = \frac{hc}{\lambda} = 5.0\times10^{-19}\,\text{J}$ correctly calculated, but conclusion missing or incorrect	
12	Correct reasoning, but incorrect conclusion *Example:* *All the metals will emit electrons because light with* $\lambda = 400\ nm$ *has energy greater than the work functions.*	
19	Other correct responses	
	Incorrect Response	
70	Ca will emit electrons because of the smallest W	
71	Ca and Li will emit electrons, and/or Zn will not emit electrons with no adequate work shown.	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA13026**	Physics	Block_Sequence **P3_06**

A particle with charge q and mass m moves at speed v in a uniform magnetic field B at right angles to the direction of the field. The particle moves in a circle.

Show that the period T of the particle's revolution does not depend on v.
Show your work.

PA13026

TIMSS Advanced 2008

Content Domain

Electricity and Magnetism

Cognitive Domain

Reasoning

Maximum Points

1

Key

See scoring guide

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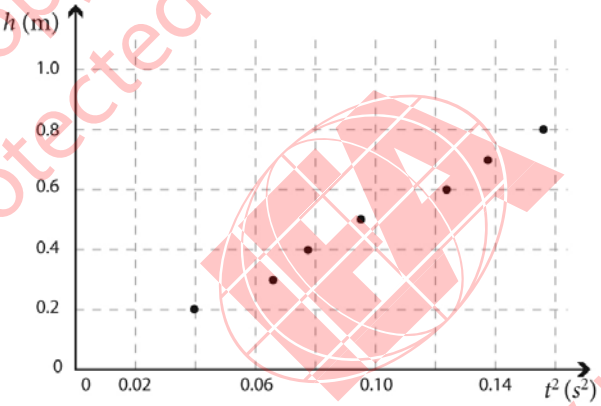
Item ID **PA13026**	Physics	Block_Sequence **P3_06**

Note: Accept reasonable roundings.

Code	Response	Item: PA 13026
	Correct Response	
10	Response refers to relationships based on Newton's 2nd law and containing $T = \frac{2\pi m}{qB}$ *Example:* $qvB = \frac{mv^2}{r}$, *and the speed is* $v = \frac{2\pi r}{T}$. $T = \frac{2\pi m}{qB}$, *(which is independent of v).*	
19	Other correct responses.	
	Incorrect Response	
70	$T = \frac{2\pi m}{qB}$, independent of *v*. No work shown.	
71	Attempt made, but the answer includes *v* or quantities dependent on *v* (for example *r*). *Example:* $T = \sqrt{\frac{m4\pi^2 r}{qvB}}$	
72	Correct reasoning but wrong result for *T*; "independent of *v*" is stated. One formula slightly incorrect, or contains calculation error *Example:* $qvB = \frac{m4\pi^2 r}{T^2}$ *and* $v = \frac{\pi r}{T}$, *then* $T = \frac{4\pi m}{qB}$ *which is independent of v.*	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task) *Example:* Incomplete or incorrect reasoning, but $qvB = \frac{mv^2}{r}\left(\text{or } \frac{m4\pi^2 r}{T^2}\right)$ correctly stated.	
	Nonresponse	
99	Blank	

Item ID **PA13027A**	Physics	Block_Sequence **P3_07**

In an experiment to measure the acceleration due to gravity, g, the time, t (s), taken for a metal ball to fall freely from rest was measured for different starting heights h (m). The graph shows values of h plotted against values of t^2.



Using the data shown in the graph, calculate a value of g and give an estimate of the uncertainty (experimental error) in the value of g. Show your work.

PA13027

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Reasoning

Maximum Points
1

Key
See scoring guide

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Item ID **PA13027A**	Physics	Block_Sequence **P3_07**

Note: Two variables are used for this item, one for the calculation of g, and one for the estimate of uncertainty (experimental error).

Two basic approaches for obtaining the value of *g* from the data are identified in the codes which are based on the equation for the ball in free fall, ($h = \frac{1}{2} g t^2$):

i) Graphically determining a best fit line, or

ii) Calculating the value of *g* for one or more individual data points on the graph.

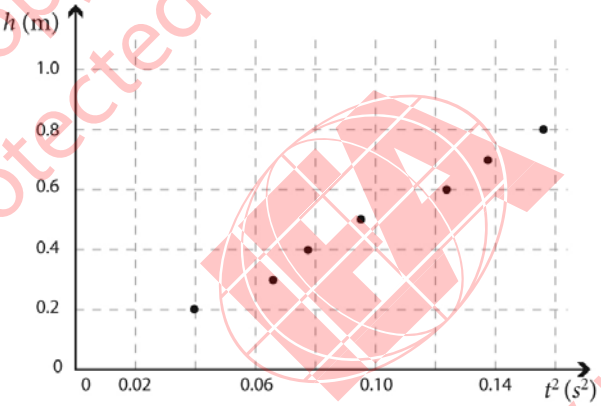
Accept responses with missing or wrong units for this item.

A: The value of *g*

Code	Response	Item: PA 13027A
	Correct Response	
10	g = 10 m/s^2 (9 m/s^2 to 11 m/s^2), based on best fit of line (or average of maximum and minimum lines) and $g = \frac{2h}{t^2}$.	
11	g = 10 m/s^2 (9 m/s^2 to 11 m/s^2), based on only one value or the average of two or more calculated values for $g = \frac{2h}{t^2}$. No explicit use of graph.	
19	g = 10 m/s^2 (9 m/s^2 to 11 m/s^2), based on least squares fit using a calculator or other correct responses	
	Incorrect Response	
70	Incorrect responses based on best fit of line	
71	Incorrect reponses based on only one value or the average of two or more calculated values for *g*	
72	A line is shown in the diagram and/or a formula for *g*. No value for *g*.	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA13027B**	Physics	Block_Sequence **P3_07**

In an experiment to measure the acceleration due to gravity, g, the time, t (s), taken for a metal ball to fall freely from rest was measured for different starting heights h (m). The graph shows values of h plotted against values of t^2.



Using the data shown in the graph, calculate a value of g and give an estimate of the uncertainty (experimental error) in the value of g. Show your work.

PA13027

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Reasoning

Maximum Points
1

Key
See scoring guide

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Item ID **PA13027B**	Physics	Block_Sequence **P3_07**

B: The uncertainty

Note: B can be coded as correct even if $g = 5$ m/s^2

Code	Response	Item: PA 13027B
	Correct Response	
10	Correct, accept 2% to 10% (or absolute value), based on lines with greatest and least slope	
11	Correct, accept 2% to 10% (or absolute value), based on the variation of calculated values of g	
12	Correct, accept 2% to 10% (or absolute value), based on least squares fit using a calculator	
19	Other acceptable responses.	
	Incorrect Response	
70	Acceptable value for the error, but no work or explanation shown	
71	Not an acceptable value for the error, based on lines in the diagram or variation of calculated values of g	
72	Verbal statements of error (uncertainty) sources without any quantitative estimate *Example:* *Error due to air resistance and uncertainty in time measurement.*	
73	Deviation from tabulated value (9.8 m/s^2) used as a measure of uncertainty	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23050**	Physics	Block_Sequence **P6_01**

PA23050

A table with metal legs and a wooden top is inside a room with a temperature of about 20 °C. Which statement explains why the metal legs feel colder than the wooden top?

Ⓐ The heat capacity of the metal legs is lower than the wooden top.

Ⓑ The metal has a lower temperature than the wooden top.

Ⓒ The metal conducts heat better than wood.

Ⓓ The molecules move faster in metal than in wood.

TIMSS Advanced 2008

Content Domain

Heat and Temperature

Cognitive Domain

Applying

Maximum Points

1

Key

C

Item ID **PA23056**	Physics	Block_Sequence **P6_02**

Which statement is the BEST explanation of the greenhouse effect?

(A) Because of holes in the ozone layer, more solar radiation reaches the surface of the Earth, and it gets warmer.

(B) Light rays from the sun pass through the atmosphere and warm the surface of the Earth. Some of the heat radiation from the surface is absorbed by certain gases in the atmosphere and retained.

(C) The release of gas like CO_2 in the atmosphere results in the increase of the temperature of the Earth.

(D) Light from the sun makes the molecules in the atmosphere vibrate, and it gets warmer.

PA23056

TIMSS Advanced 2008

Content Domain

Heat and Temperature

Cognitive Domain

Knowing

Maximum Points

1

Key

B

Item ID **PA23142**	Physics	Block_Sequence **P6_03**

PA23142

A satellite observes the temperatures on Earth. What type of electromagnetic radiation should the sensors be able to detect?

Ⓐ radio waves
Ⓑ infrared light
Ⓒ visible light
Ⓓ ultraviolet light

TIMSS Advanced 2008

Content Domain
Heat and Temperature

Cognitive Domain
Knowing

Maximum Points
1

Key
B

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23072**	Physics	Block_Sequence **P6_04**

A block of mass 2.0 kg travels horizontally at a speed 2.5 m/s towards a massless spring with spring constant 800 N/m. After the block collides with the spring, its speed decreases and the spring compresses. What is the maximum distance that the spring will compress? (Ignore friction and air resistance.)

Show your work.

PA23072

TIMSS Advanced 2008

Content Domain

Mechanics

Cognitive Domain

Applying

Maximum Points

1

Key

See scoring guide

Item ID **PA23072**	Physics	Block_Sequence **P6_04**

Code	Response	Item: PA23072
	Correct Response	
10	Uses conservation of mechanical energy, $\frac{1}{2}mv^2 = \frac{1}{2}kx^2 \rightarrow x = (0.12 - 0.14\ \text{m})$	
11	Correct reasoning but calculation error and/or missing or incorrect units.	
	Incorrect Response	
70	0.025 m, based on $mg = kx$	
71	Correct answer, no work shown	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23022**	Physics	Block_Sequence **P6_05**

PA23022

The planet Venus, like Earth, revolves around the sun in approximately a circular orbit. Venus is closer to the sun than the Earth is.

Using Newton's Second Law and Law of Gravity, show that Venus moves faster than Earth in its orbit.

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Reasoning

Maximum Points
2

Key
See scoring guide

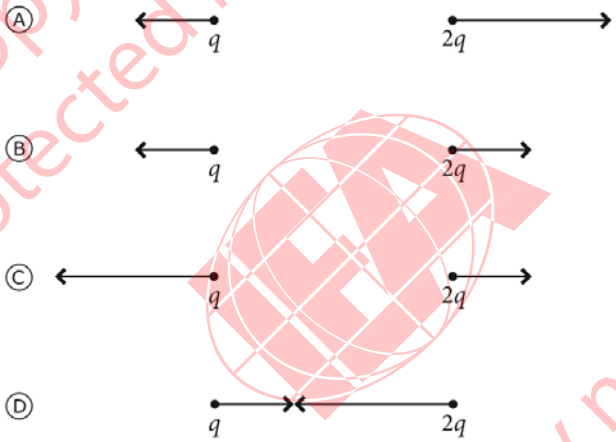
TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23022**	Physics	Block_Sequence **P6_05**

Code	Response	Item: PA23022
	Correct Response	
20	A response that includes the following steps 1. States the two laws in mathematical form Newton's Second Law: $F = ma$ and the Law of Gravity: $F = \frac{GMm}{r^2}$ 2. Applies the formula for centripetal acceleration: $a = \frac{v^2}{r}$, 3. Derives the formula for velocity, $v = \sqrt{\frac{GM}{r}}$ (or equivalent) and uses this to show that v (Venus) is greater than v (Earth).	
	Partially Correct Response	
10	Step 1 and 2 complete but not Step 3	
	Incorrect Response	
70	Step 1 only complete.	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23030**	Physics	Block_Sequence **P6_06**

Two particles have charges q and $2q$, respectively. Which figure BEST describes the electric forces acting on the two particles?



PA23030

TIMSS Advanced 2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Applying

Maximum Points
1

Key
B

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23078**	Physics	Block_Sequence **P6_07**

The figure above shows three point charges, *A*, *B*, and *C*. The combined force from *A* and *B* on *C* is shown as an arrow.

The two charges *A* and *B* are then interchanged. Draw an arrow on the figure below to show what the combined force from *A* and *B* will be on *C*.

PA23078

TIMSS Advanced
2008

Content Domain
Electricity and Magnetism

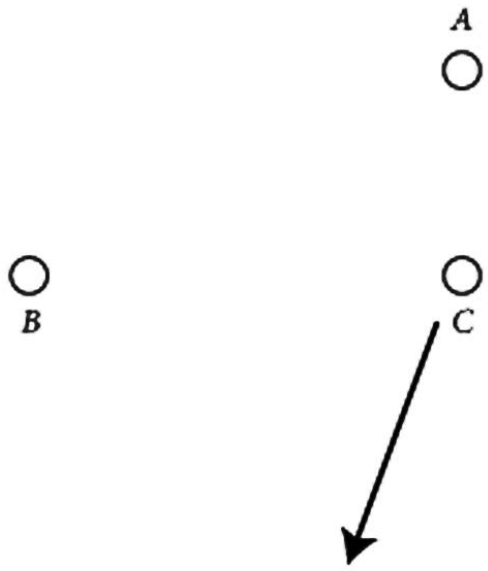
Cognitive Domain
Reasoning

Maximum Points
1

Key
See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23078**	Physics	Block_Sequence **P6_07**

Code	Response	Item: PA23078
	Correct Response	
10	A response that includes all three of the following criteria 1. Arrow pointing down and to the left 2. Closer to the vertical than the original 3. Longer than the original 	
11	A response with 1 and 3 criteria but not 2	
12	A response with 1 and 2 criteria but not 3	
	Incorrect Response	
70	Only criterion 1 is fulfilled	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23113**	Physics	Block_Sequence **P6_08**

Laser Radiation
Caution: Do not stare into the beam.
Class II Laser Product

Suzanne has a red laser pointer of wavelength 630-680 nm and maximum output of less than 1 mW. The label on Suzanne's laser pointer is shown above. Which statement explains how laser light can damage Suzanne's eyes?

Ⓐ The energy of a photon of red light is large enough to damage the light sensitive cells in her eyes.

Ⓑ Red light from a laser has higher photon energy than red light from an incandescent light globe.

Ⓒ The laser pointer produces more photons per second than a 100 W incandescent light globe.

Ⓓ Red light photons in the laser pointer beam are spread over a smaller area than photons from a light globe.

PA23113

TIMSS Advanced
2008

Content Domain
Electricity and Magnetism

Cognitive Domain
Reasoning

Maximum Points
1

Key
D

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23128**	Physics	Block_Sequence **P6_09**

Ultraviolet light is responsible for sunburns. Explain why you don't get sunburned while sitting behind a glass window.

PA23128

TIMSS Advanced 2008

Content Domain

Electricity and Magnetism

Cognitive Domain

Knowing

Maximum Points

1

Key

See scoring guide

Item ID **PA23128**	Physics	Block_Sequence **P6_09**

Note: Code 70 takes precedence over code 71.

Code	Response	Item: PA23128
	Correct Response	
10	Window glass blocks/absorbs most of the ultraviolet light (response may or may not mention reflection)	
	Incorrect Response	
70	Window glass **reflects** ultraviolet light	
71	Window glass **refracts** ultraviolet light	
72	Window glass changes the wavelength of ultraviolet light	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23058**	Physics	Block_Sequence **P6_10**

When a stream of helium nuclei moves towards a very thin, gold foil, most of the nuclei pass through the foil. Which hypothesis is supported by this result?

(A) The nucleus of the gold atom is very heavy compared to the entire atom.
(B) The wave nature of the helium nuclei allows them to penetrate the gold foil.
(C) The nucleus of the gold atom is very small compared to the entire atom.
(D) A helium nucleus has about the same mass as a gold nucleus.

PA23058

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Applying

Maximum Points
1

Key
C

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23115**	Physics	Block_Sequence **P6_11**

PA23115

$$X \rightarrow Y + e$$

The beta (β) decay of a radioactive isotope can be represented by a general reaction, as shown above. The electron emerges at high speed and may completely leave the material containing X and Y. What is the BEST explanation of the origin of the emitted electron?

(A) a transition from a higher to a lower internal electron energy level of X
(B) a proton and neutron combining in the nucleus of Y
(C) an electron knocked out of X by collision with another atom
(D) a neutron changing to a proton and an electron in the nucleus of X

TIMSS Advanced 2008

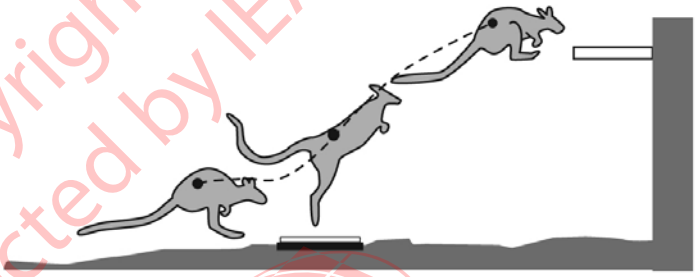
Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Applying

Maximum Points
1

Key
D

Item ID **PA23110**	Physics	Block_Sequence **P7_01**



A kangaroo hops along and then jumps from a flat plate on the ground up to a ledge, as shown above. When a jumping kangaroo is in contact with the plate, its feet exert a force on the plate in the vertical direction, and the plate exerts a force on the kangaroo's feet in the vertical direction. Which statement BEST describes the magnitudes of these forces?

Ⓐ Both forces equal the mass of the kangaroo.

Ⓑ Both forces equal half the mass of the kangaroo.

Ⓒ They vary in size but stay equal to each other.

Ⓓ The force from the plate becomes larger than the force from the feet.

PA23110

TIMSS Advanced
2008

Content Domain
Mechanics

Cognitive Domain
Applying

Maximum Points
1

Key
C

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23014**	Physics	Block_Sequence **P7_02**

PA23014

Lisa threw a small stone straight up into the air.

What forces act on the stone after it was thrown?

TIMSS Advanced 2008

Content Domain

Mechanics

Cognitive Domain

Knowing

Maximum Points

1

Key

See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23014**	Physics	Block_Sequence **P7_02**

Code	Response	Item: PA23014
	Correct Response	
10	Gravity/weight and air resistance	
	Incorrect Response	
70	Gravity/weight mentioned, but not air resistance	
71	Air resistance mentioned, but not gravity/weight	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23025**	Physics	Block_Sequence **P7_03**

Two ice skaters, one with a mass of 80 kg and the other with a mass of 60 kg, are standing on the ice face to face. They push each other so that they slide from each other. After a few seconds, the distance between them is 4 m.

What distance has the skater with a mass of 60 kg moved? (Ignore friction and air resistance.)

Show your work.

PA23025

TIMSS Advanced
2008

Content Domain
Mechanics

Cognitive Domain
Reasoning

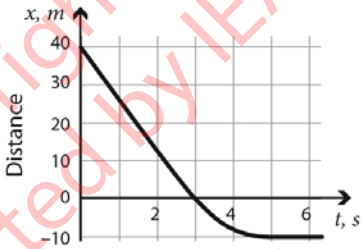
Maximum Points
2

Key
See scoring guide

Item ID **PA23025**	Physics	Block_Sequence **P7_03**

Code	Response	Item: PA23025
	Correct Response	
20	Applies law of conservation of momentum: $m_1v_1 = m_2v_2$ uses $v = \frac{x}{t}$ to get $m_1\frac{x_1}{t} = m_2\frac{x_2}{t}$ $x_1 + x_2 = 4$ $x_2 = 2.3$ m	
	Partially Correct Response	
10	Interchanges the two people giving 1.7 m	
11	Correct physics, but calculation error and/or missing or incorrect units	
	Incorrect Response	
70	Correct answer (2.3 m) but no work shown	
71	3 m (ratio of masses with or without work shown)	
72	2 m (equal distance moved with or without work shown)	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23028**	Physics	Block_Sequence **P7_04**



The graph shown above represents a cyclist approaching and passing the finishing line in a race. If the cyclist weighs 60 kg, what is her momentum as she crosses the finishing line?

Ⓐ 2400 kg·m/s
Ⓑ 800 kg·m/s
Ⓒ 600 kg·m/s
Ⓓ 0 kg·m/s

PA23028

TIMSS Advanced 2008

Content Domain
Mechanics

Cognitive Domain
Applying

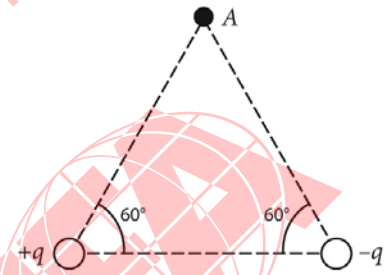
Maximum Points
1

Key
B

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23034**	Physics	Block_Sequence **P7_05**

PA23034



Two point charges are at rest at a certain distance from each other, as shown in the figure above. Draw an arrow from point *A* showing the direction of the total electric field at point *A* produced by these two charges.

TIMSS Advanced 2008

Content Domain

Electricity and Magnetism

Cognitive Domain

Applying

Maximum Points

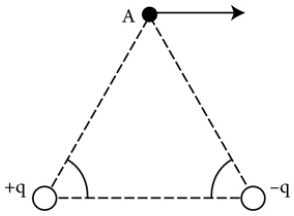
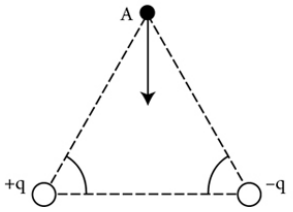
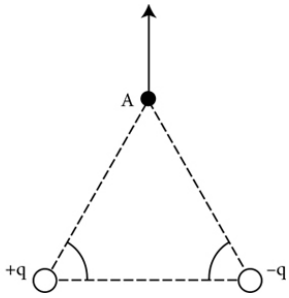
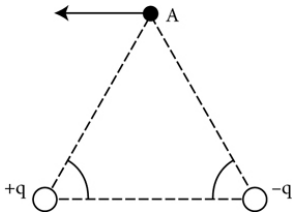
1

Key

See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23034**	Physics	Block_Sequence **P7_05**

Code	Response	Item: PA23034
	Correct Response	
10	 The arrow is directed to the right side and parallel to a line between charges (±10°).	
	Incorrect Response	
70	  The arrow is directed downwards or upwards vertically (±10°).	
71	 The arrow is directed to the left side and parallel to a line between charges (±10°).	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23044**	Physics	Block_Sequence **P7_06**

PA23044

Describe how you would demonstrate "electromagnetic induction" to a group of students. Include a description of the equipment you would use, but do not explain the phenomenon.

TIMSS Advanced 2008

Content Domain

Electricity and Magnetism

Cognitive Domain

Applying

Maximum Points

1

Key

See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23044**	Physics	Block_Sequence **P7_06**

Code	Response	Item: PA23044
	Correct Response	
10	Adequate description using all three of the components described below 1. Equipment—use of magnet and coil/loop of wire 2. Movement of magnet or wire near each other/switching on and off an electromagnet near a coil or loop of wire to change magnetic field 3. Use of a meter or other detector to demonstrate induced current or voltage	
11	A different but adequate demonstration (e.g., ceramic cooktop keeping cold)	
	Incorrect Response	
70	Adequate description of items 1 and 2 from code 10, but inadequate or no description of item 3	
71	Theoretical explanation without any specific equipment or procedure described	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23082**	Physics	Block_Sequence **P7_07**

The sand on a beach is very hot on a warm and sunny day and is cold at night. As a contrast, the temperature of the sea varies very little between day and night. What does this observation tell you about the specific heat capacity of sand compared to that of water?

PA23082

TIMSS Advanced 2008

Content Domain

Heat and Temperature

Cognitive Domain

Reasoning

Maximum Points

1

Key

See scoring guide

Item ID **PA23082**	Physics	Block_Sequence **P7_07**

Code	Response	Item: PA23082
	Correct Response	
10	The specific heat capacity of sand is (much) lower than for water	
	Incorrect Response	
70	The specific heat capacity of sand is higher than for water	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23140**	Physics	Block_Sequence **P7_08**

All bodies send out electromagnetic radiation. The characteristic features of the radiation depend strongly on the temperature of the body. At some temperatures, the emitted radiation is observed by our eyes and called "light". At which temperatures of the emitting body is the electromagnetic radiation, at maximum intensity, in the visible light range?

PA23140

(A) at temperatures of the order of tens of degrees Celsius

(B) at temperatures of the order of hundreds of degrees Celsius

(C) at temperatures of the order of thousands of degrees Celsius

(D) at temperatures of the order of millions of degrees Celsius

TIMSS Advanced 2008

Content Domain

Heat and Temperature

Cognitive Domain

Knowing

Maximum Points

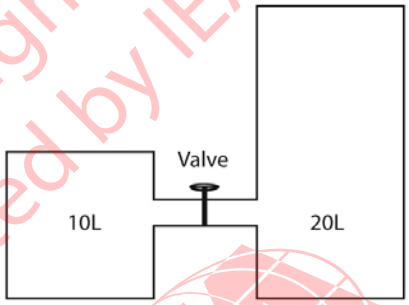
1

Key

C

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23084**	Physics	Block_Sequence **P7_09**



A narrow tube with a closed valve links a 10 liter container filled with a gas at a pressure of 1 atmosphere to a 20 liter container filled with nitrogen at a pressure of 2 atmospheres. Both containers have a temperature of 27 °C. If the valve that separates the two containers is opened, allowing the gases to mix at 27 °C, what will the total pressure (in atmospheres) be in the two containers?

Show your work.

PA23084

TIMSS Advanced 2008

Content Domain

Heat and Temperature

Cognitive Domain

Reasoning

Maximum Points

2

Key

See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23084**	Physics	Block_Sequence **P7_09**

Code	Response	Item: PA23084
	Correct Response	
20	Correct answer ($p_T = 1.66/1.7$ atm) with an adequate explanation. An adequate explanation must involve $pV = nRT$ or pV/T = constant and evidence of adequate work. Since T = constant, response may use Dalton's law for mixtures to get $p_1V_1 + p_2V_2 = p(V_1 + V_2)$ units not required.	
	Partially Correct Response	
10	Correct use of formulas, but calculation error	
11	Correct method, but the answer is given in any other unit for pressure (other than atmosphere)	
	Incorrect Response	
70	Inadequate explanation using pV/T = constant	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

Item ID **PA23059**	Physics	Block_Sequence **P7_10**

PA23059

How many neutrons are there in the nucleus of the atom $^{238}_{92}U$?

Ⓐ 0
Ⓑ 92
Ⓒ 146
Ⓓ 238

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Knowing

Maximum Points
1

Key
C

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23138**	Physics	Block_Sequence **P7_11**

PA23138

Which is the BEST description of an atomic nucleus?

Ⓐ a tight group of electrons, protons, and neutrons
Ⓑ electrons and protons moving around a core of neutrons
Ⓒ a tight group of protons and neutrons
Ⓓ protons moving around a core of neutrons

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Knowing

Maximum Points
1

Key
C

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23137**	Physics	Block_Sequence **P7_12**

PA23137

A particular atomic nucleus is represented by a symbol that includes three labels. What is the correct symbol for a nucleus consisting of six protons and eight neutrons?

(The first elements according to mass are hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, and oxygen.)

TIMSS Advanced 2008

Content Domain
Atomic and Nuclear Physics

Cognitive Domain
Knowing

Maximum Points
1

Key
See scoring guide

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Item ID **PA23137**	Physics	Block_Sequence **P7_12**

Code	Response	Item: PA23137
	Correct Response	
10	$^{14}_{6}\mathrm{C}$	
	Incorrect Response	
70	Correct numbers and element, but numbers not in correct position (e.g., $^{6}_{14}\mathrm{C}$)	
71	Incorrect element, but correct, formal symbol for this element [letter(s) and two numbers in correct position, for example, $^{14}_{6}\mathrm{Be}$]	
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)	
	Nonresponse	
99	Blank	

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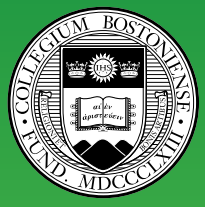

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