Appendix 14B: TIMSS Advanced 2015 Physics Item Descriptions Developed During the TIMSS Advanced 2015 Benchmarking

Items at Intermediate International Benchmark (475)

Mechanics & Thermodynamics

P1_05	Recognizes the process of energy transfer from the Sun to the Earth
P2_01B	Compares the amount of time it takes an object to reach the apex of its motion from a given point and the time it takes to fall from the apex back to the given point
P3_01	Selects the graph that best represents the potential energy of a ball rolling up and down an inclined plane
P3_02	Describes the direction of the acceleration of a body moving in a circular path with constant speed
P3_08	Identifies the best explanation for the temperature change in a rising air mass
P4_02	Recognizes how the force exerted by the Sun on Planet X compares with the force exerted by the Sun on the Earth, given the masses of the planets and the relationship between their distances to the Sun
P4_03	Calculates the final velocity of two skiers after they collide inelastically (1 of 2 points)
P6_01	Recognizes the relationship between the change in internal energy and the change in temperature of a gas when work is done on it by the environment
P6_02	Calculates the initial height from which a body began moving vertically down (1 of 2 points)
P7_03	Identifies an energy transformation that occurs when a meteor enters Earth's atmosphere and is incinerated
P8_01B	Identifies the diagram that best represents the path of a ball attached to a string after it has been released from circular motion at a constant speed
P9_02	Calculates work done by friction to stop an object sliding along a rough surface

Electricity & Magnetism

P2_05A	Identifies the direction of the force on a point charge in various positions in an electric field
P2_05B	Orders three points in an electric field by increasing field strength
P3_04	Identifies the direction of the electric force on a charged object in an electric field
P3_06	States the meaning of the symbols in a formula for a charged particle moving in a magnetic field
P6_06	Completes a diagram to indicate the direction of current induced in a coil that is moving towards a stationary current-carrying coil
P7_05B	Identifies the path of a negatively charged particle as it passes between two charged plates

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P7_07	Identifies the best explanation for why a fluorescent tube lights up when it is positioned close to a charged balloon
P8_04	Recognizes the changes in magnitude of the magnetic flux through a conducting coil as a magnet enters, moves inside, and leaves the coil
P8_06	Evaluates descriptions of the resistance in an unknown electrical component based on its current-voltage graph
P9_06	Evaluates descriptions of processes by which a flashlight containing a coil of wire and a magnet that can slide through the coil produces light

Wave Phenomena & Atomic/Nuclear Physics

P1_01	Recognizes a correct statement about black lines in the continuous spectrum of sunlight
P1_07	Evaluates reasons for the difference between the input and output energies associated with the photoelectric effect
P2_08	Calculates the wavelength of a sound wave above water
P2_09A	Evaluates descriptions of the result of increasing the temperature of a black body on the radiation it emits
P3_10	Completes a table to indicate the number of protons and neutrons in given isotopes
P4_10	States what happens to the wavelengths of water waves that decrease in speed as they approach the shore
P5_01	Recognizes a range of wavelengths associated with visible light
P6_09	Evaluates experimental set-ups to compare the effect of changing the apex angle of a prism on the angle between incident and refracted rays of light and chooses the best pair
P6_10	Calculates the wavelength of a musical note
P6_11	Recognizes the best explanation for why electromagnetic radiation is characterized by photon energy, radiation frequency, and radiation wavelength
P7_08A	Calculates the speed of a wave moving down an oscillating rope
P8_08	Determines the wavelength of a wave presented as a graphical trace
P8_10	Determines the atomic numbers and mass numbers of 2 isotopes involved in nuclear reactions (1 of 2 points)
P9_08	Evaluates possible factors that account for the differences in interference patterns produced by two different subatomic particles with equal kinetic energies

Items at High International Benchmark (550)

Mechanics & Thermodynamics

| P1_04 | Derives an expression for the speed at the top of the trajectory of an object moving in a vertical circular path |
| P2_01A | Recognizes the acceleration at the apex of an object thrown vertically upward |

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P2_04	Shows the steps in a calculation of the amount of energy required to increase the temperature of water in a given context
P3_03	Recognizes the best explanation for a ball rebounding to a height that is less than the initial height of release
P3_07	Calculates the new volume of an ideal gas when pressure and temperature change (1 of 2 points)
P4_01	Identifies the ratio of the maximum temperature to the minimum temperature of a sample of a gas during a closed cycle represented in a volume-pressure graph
P4_03	Shows the steps in a calculation of the final velocity of two skiers after they collide inelastically (2 of 2 points)
P4_04	Identifies the direction two balls will travel after they collide inelastically
P5_07	Calculates the energy released when a container of water cools
P6_02	Shows the steps in a calculation of the initial height from which a body began moving vertically down (2 of 2 points)
P6_04	Recognizes the equation describing the force of friction acting on an object sliding down an inclined plane
P6_05	Recognizes the information required to calculate the speed of a satellite in orbit around the Earth
P7_01	Identifies the best estimate for the coefficient of friction between an object and the surface along which it is being dragged
P7_02B	Identifies a reason that the height of a spacecraft above the surface of a planet varies during its orbit
P8_01A	Recognizes the diagram that best represents the direction of the net force acting on a ball attached to a string and moving in a circle at constant speed
P8_02	Describes one step in a sequence for checking the calibration of a thermometer, given a list of available equipment (1 of 2 points)
P8_03A	Calculates the magnitude of the normal force on a body sliding on the inside of a smooth cylindrical surface at a specified angle
P9_03	Identifies the best estimate for the acceleration of an elevator
P9_04	Calculates the temperature of a gas after compression (1 of 2 points)

Electricity & Magnetism

P2_06	Evaluates explanations for the increase in temperature of an iron plate positioned near a coil of wire connected to an alternating voltage source
P3_05	Ranks the equivalent resistance for four different combinations of resistors
P5_03	Calculates the resistance in a flashlight bulb using Ohm's Law and Joule's law
P5_04	Recognizes paths of a neutral particle and a positively charged particle in a magnetic field shown in a diagram
P6_08	Completes a diagram to indicate the direction of net force on a point charge influenced by two other point charges
P9_05A	Calculates the magnitude of the magnetic field acting on a proton (1 of 2 points)

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Wave Phenomena & Atomic/Nuclear Physics

P2_07	Recognizes the source of energy used to generate electricity in a nuclear power plant
P4_08B	Compares two types of electromagnetic radiation and explains which type is more harmful to humans in terms of the frequency and energy of the photons, given a diagram of the electromagnetic spectrum
P4_09	Recognizes what accounts for the difference in the mass of an atom before and after a nuclear reaction
P4_11	Explains which semiconductor is appropriate to use in a solar panel, given a graph of the performance of each semiconductor across a range of wavelengths of light
P5_11	Identifies an estimate of the age of an organic specimen, given the concentration of carbon-14 in it
P7_08B	Identifies the relationship between the initial and final frequencies and wavelengths of a wave with a final speed less than its initial speed
P8_07	Identifies the index of refraction of a piece of glass, given a diagram showing the glass, the angle of incidence, and angle of refraction
P8_09	Orders examples of electromagnetic radiation in terms of increasing photon energies

Items at Advanced International Benchmark (625)

Mechanics & Thermodynamics

P2_02	Evaluates a mechanical system run by an electric motor and predicts the difference between the theoretical and actual final temperatures of the system
P5_05	Deduces the tension in the string connecting two unequal masses in freefall
P5_08	Identifies the temperature at which two rods of different metals will have the same length
P7_02A	Calculates an estimate of the mass of a planet given information about the speed of a spacecraft in orbit around it and the radius of the orbit (1 of 2 points)
P8_02	Describes a sequence of steps for checking the calibration of a thermometer, given a list of available equipment (2 of 2 points)
P8_03B	Calculates the speed of a body at the lowest point of its trajectory (1 of 2 points)
P9_04	Shows the steps in a calculation for the temperature of a gas after compression (2 of 2 points)

Electricity & Magnetism

P1_08	Analyzes a complex circuit diagram to determine the power consumption of light bulbs
P4_06	Identifies the distance at which an electric field is four times less than it is at a given distance from the source
P4_07	Identifies the prediction for the change in the path of a horizontal electron beam as a result of the presence of a magnetic field
P5_02	Interprets a current vs. resistance graph to identify the internal resistance of a battery

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P7_05A	Calculates the electric force on a negatively charged particle when it is in between two charged plates (1 of 2 points)
P7_05A	Shows the steps in a calculation of the electric force on a negatively charged particle when it is in between two charged plates (2 of 2 points)
P8_05	Identifies the diagram of an electromagnet that depicts the direction of the current and the polarity, given the orientation of the battery
P9_05A	Shows the steps in a calculation of the magnitude of the magnetic field acting on a proton (2 of 2 points)
P9_05B	Identifies the direction of the magnetic field acting on a proton

Wave Phenomena & Atomic/Nuclear Physics

P3_11	Completes the equation for a nuclear fission reaction
P4_08A	Recognizes the type of radiation associated with a given range of wavelengths in the electromagnetic spectrum
P5_09	States that a red object absorbs light of all wavelengths from a green light source (1 of 2 points)
P5_10	Justifies an argument that it might be more appropriate to indicate that an object is hot by associating it with the color blue
P6_12	Explains which of two heated bars is hotter in terms of the relationship between the color of emitted light and temperature
P7_04	Recognizes a correct statement about an oscillating electric field in a transmitting antenna generating a magnetic field
P8_10	Determines the atomic numbers and mass numbers of 3 isotopes involved in nuclear reactions (2 of 2 points)
P9_07	Recognizes whether the frequency and wavelength of light change as the light passes from air to water
P9_09A	Explains which pair of atomic reactants can most likely be used in a fusion reaction to produce usable energy for humans, given a temperature-reaction rate graph
P9_09B	Recognizes the information needed to calculate the energy production of three pairs of atomic reactants in a fusion reaction
P9_09C	Calculates the mass lost in a fusion reaction (1 of 2 points)

Items Above the Advanced International Benchmark (625)

Mechanics & Thermodynamics

P1_02	Identifies the force recorded on one of two spring balances, given the force recorded on the other spring balance and the relationship between the two spring constants
P2_03	Recognizes the path of motion of the center of mass of a curved bar as it flies through the air
P3_07	Shows the steps in a calculation of the new volume of an ideal gas when pressure and temperature change (2 of 2 points)
P3_09	Interprets the context of a solar cooker and states that food in the cooker comes to equilibrium with its surroundings (1 of 2 points)

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P3_09	Interprets the context of a solar cooker to explain why, when the cooker is placed in the sun, food heats steadily and then stays at a constant temperature (2 of 2 points)
P6_03	Identifies the relationship between two forces exerted on an object at the apex of its curved motion
P7_02A	Shows the steps in a calculation for an estimate of the mass of a planet given information about the speed of a spacecraft in orbit around it and the radius of the orbit (2 of 2 points)
P8_03B	Shows the steps in a calculation for the speed of a body at the lowest point of its trajectory (2 of 2 points)

Electricity & Magnetism

P1_06	Identifies the direction of the force on a current-carrying conductor in a given magnetic field
P4_05	Explains how a charged balloon sticks to a wall
P6_07	Predicts the direction of movement of a foil strip as a permanent magnet approaches it (1 of 2 points)
P6_07	Predicts the direction of movement of a foil strip as a permanent magnet approaches it and explains the prediction (2 of 2 points)
P7_06A	Identifies an explanation for the change in polarity of the induced emf as a magnet passes through a coil of conducting wire
P7_06B	Explains the difference in magnitude of the induced emf at its extrema as a magnet passes through a coil of conducting wire

Wave Phenomena & Atomic/Nuclear Physics

P1_03	Identifies the component of Rutherford's experimental set-up that should be varied to obtain the appropriate data
P1_09	Identifies the effect of a nuclear reaction on the atomic and mass numbers of an atom
P2_09B	Evaluates the conclusion that Wien's Law holds for an object, based on three observations of temperature and wavelength of emitted radiation
P5_09	States that a red object absorbs light of all wavelengths from a green light source and explains the observation (2 of 2 points)
P9_09C	Shows the steps in a calculation of the mass lost in a fusion reaction (2 of 2 points)

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