

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING PHYSICS

Thursday, January 29, 2009 — 1:15 to 4:15 p.m., only

The answer sheet for Part A and Part B–1 is the last page of this examination booklet. Turn to the last page and fold it along the perforations. Then, slowly and carefully, tear off the answer sheet and fill in the heading.

The answers to the questions in Part B–2 and Part C are to be written in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

You are to answer *all* questions in all parts of this examination according to the directions provided in the examination booklet. Record your answers to the Part A and Part B–1 multiple-choice questions on your separate answer sheet. Write your answers to the Part B–2 and Part C questions in your answer booklet. All work should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on the answer sheet and in the answer booklet.

When you have completed the examination, you must sign the statement printed at the end of your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice. . .

A scientific or graphing calculator, a centimeter ruler, a protractor, and a copy of the *2006 Edition Reference Tables for Physical Setting/Physics*, which you may need to answer some questions in this examination, must be available for your use while taking this examination.

The use of any communications device is strictly prohibited when taking this examination. If you use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

- 1 A force of 25 newtons east and a force of 25 newtons west act concurrently on a 5.0-kilogram cart. What is the acceleration of the cart?

(1) 1.0 m/s² west (3) 5.0 m/s² east
(2) 0.20 m/s² east (4) 0 m/s²

- 2 An unstretched spring has a length of 10. centimeters. When the spring is stretched by a force of 16 newtons, its length is increased to 18 centimeters. What is the spring constant of this spring?

(1) 0.89 N/cm (3) 1.6 N/cm
(2) 2.0 N/cm (4) 1.8 N/cm

- 3 What is the acceleration due to gravity at a location where a 15.0-kilogram mass weighs 45.0 newtons?

(1) 675 m/s² (3) 3.00 m/s²
(2) 9.81 m/s² (4) 0.333 m/s²

- 4 As a car is driven south in a straight line with *decreasing* speed, the acceleration of the car must be

(1) directed northward
(2) directed southward
(3) zero
(4) constant, but not zero

- 5 A baseball dropped from the roof of a tall building takes 3.1 seconds to hit the ground. How tall is the building? [Neglect friction.]

(1) 15 m (3) 47 m
(2) 30. m (4) 94 m

- 6 Which object has the greatest inertia?

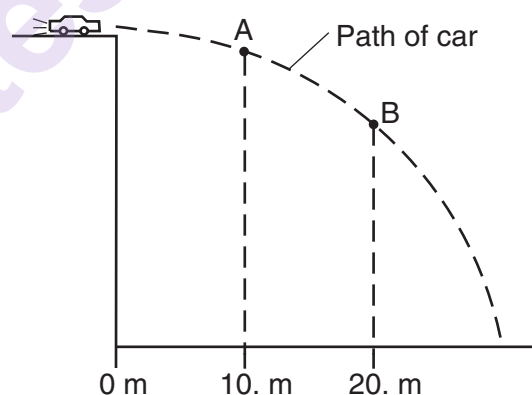
(1) a falling leaf
(2) a softball in flight
(3) a seated high school student
(4) a rising helium-filled toy balloon

- 7 Centripetal force F_c acts on a car going around a curve. If the speed of the car were twice as great, the magnitude of the centripetal force necessary to keep the car moving in the same path would be

(1) F_c (3) $\frac{F_c}{2}$
(2) $2F_c$ (4) $4F_c$

Note that question 8 has only three choices.

- 8 The diagram below represents the path of a stunt car that is driven off a cliff, neglecting friction.



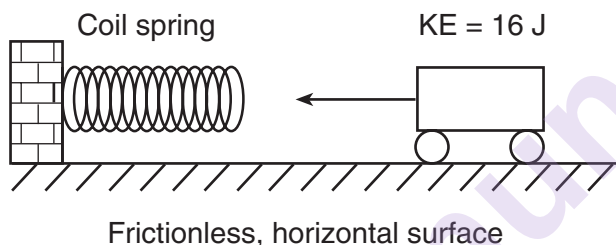
Compared to the horizontal component of the car's velocity at point A, the horizontal component of the car's velocity at point B is

(1) smaller
(2) greater
(3) the same

- 9 What is the average power required to raise a 1.81×10^4 -newton elevator 12.0 meters in 22.5 seconds?

(1) 8.04×10^2 W (3) 2.17×10^5 W
(2) 9.65×10^3 W (4) 4.89×10^6 W

- 10 If the speed of a moving object is doubled, the kinetic energy of the object is
- halved
 - doubled
 - unchanged
 - quadrupled
- 11 Which statement best explains why a “wet saw” used to cut through fine optical crystals is constantly lubricated with oil?
- Lubrication decreases friction and minimizes the increase of internal energy.
 - Lubrication decreases friction and maximizes the increase of internal energy.
 - Lubrication increases friction and minimizes the increase of internal energy.
 - Lubrication increases friction and maximizes the increase of internal energy.
- 12 The diagram below shows a toy cart possessing 16 joules of kinetic energy traveling on a frictionless, horizontal surface toward a horizontal spring.

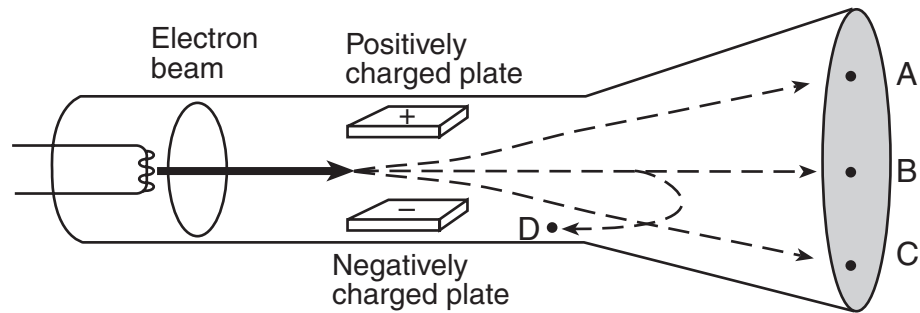


If the cart comes to rest after compressing the spring a distance of 1.0 meter, what is the spring constant of the spring?

- 32 N/m
 - 16 N/m
 - 8.0 N/m
 - 4.0 N/m
- 13 How much work is required to lift a 10.-newton weight from 4.0 meters to 40. meters above the surface of Earth?
- 2.5 J
 - 3.6 J
 - 3.6×10^2 J
 - 4.0×10^2 J

- 14 Which situation describes a system with *decreasing* gravitational potential energy?
- a girl stretching a horizontal spring
 - a bicyclist riding up a steep hill
 - a rocket rising vertically from Earth
 - a boy jumping down from a tree limb
- 15 If 20 joules of work is used to transfer 20 coulombs of charge through a 20-ohm resistor, the potential difference across the resistor is
- 1 V
 - 20 V
 - 0.05 V
 - 400 V
- 16 At 20°C, four conducting wires made of different materials have the same length and the same diameter. Which wire has the *least* resistance?
- aluminum
 - gold
 - nichrome
 - tungsten
- 17 Three identical lamps are connected in parallel with each other. If the resistance of each lamp is X ohms, what is the equivalent resistance of this parallel combination?
- $X \Omega$
 - $\frac{X}{3} \Omega$
 - $3X \Omega$
 - $\frac{3}{X} \Omega$
- 18 A 2.0-ohm resistor and a 4.0-ohm resistor are connected in series with a 12-volt battery. If the current through the 2.0-ohm resistor is 2.0 amperes, the current through the 4.0-ohm resistor is
- 1.0 A
 - 2.0 A
 - 3.0 A
 - 4.0 A

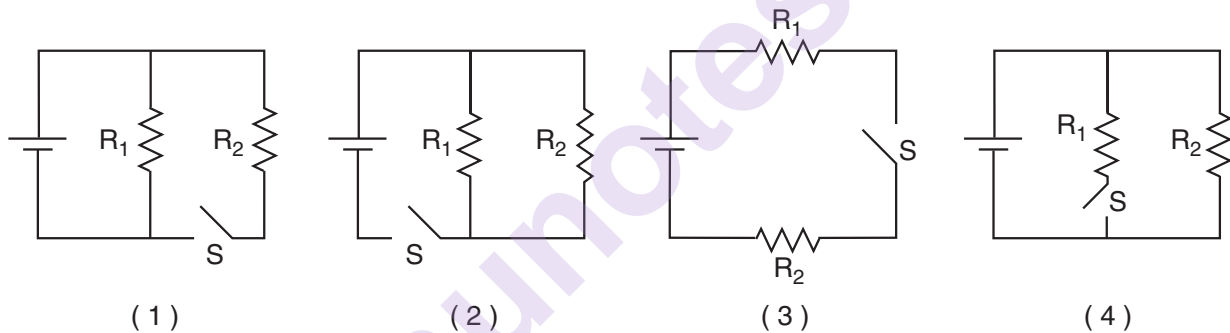
- 19 The diagram below shows a beam of electrons fired through the region between two oppositely charged parallel plates in a cathode ray tube.



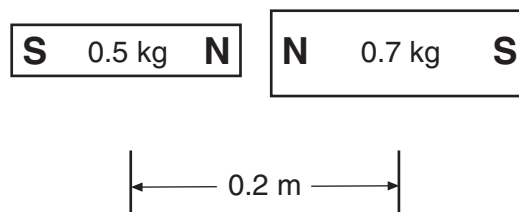
After passing between the charged plates, the electrons will most likely travel path

- (1) A (3) C
(2) B (4) D

- 20 In which circuit would current flow through resistor R_1 , but *not* through resistor R_2 while switch S is open?



- 21 The diagram below represents a 0.5-kilogram bar magnet and a 0.7-kilogram bar magnet with a distance of 0.2 meter between their centers.



Which statement best describes the forces between the bar magnets?

- (1) Gravitational force and magnetic force are both repulsive.
(2) Gravitational force is repulsive and magnetic force is attractive.
(3) Gravitational force is attractive and magnetic force is repulsive.
(4) Gravitational force and magnetic force are both attractive.

22 A dampened fingertip rubbed around the rim of a crystal stemware glass causes the glass to vibrate and produce a musical note. This effect is due to

- (1) resonance
- (2) refraction
- (3) reflection
- (4) rarefaction

23 Which type of wave requires a material medium through which to travel?

- (1) radio wave
- (2) microwave
- (3) light wave
- (4) mechanical wave

Note that question 24 has only three choices.

24 Compared to the speed of a sound wave in air, the speed of a radio wave in air is

- (1) less
- (2) greater
- (3) the same

Note that question 25 has only three choices.

25 If the amplitude of a wave is increased, the frequency of the wave will

- (1) decrease
- (2) increase
- (3) remain the same

26 Which unit is equivalent to meters per second?

- (1) Hz•s
- (2) Hz•m
- (3) s/Hz
- (4) m/Hz

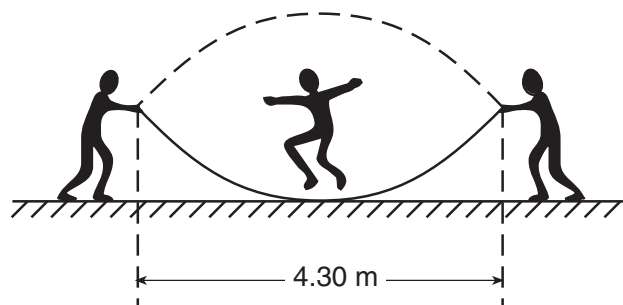
27 Which characteristic is the same for every color of light in a vacuum?

- (1) energy
- (2) frequency
- (3) speed
- (4) period

28 What is the speed of light ($f = 5.09 \times 10^{14}$ Hz) in flint glass?

- (1) 1.81×10^8 m/s
- (2) 1.97×10^8 m/s
- (3) 3.00×10^8 m/s
- (4) 4.98×10^8 m/s

29 While playing, two children create a standing wave in a rope, as shown in the diagram below. A third child participates by jumping the rope.



What is the wavelength of this standing wave?

- (1) 2.15 m
- (2) 4.30 m
- (3) 6.45 m
- (4) 8.60 m

30 A television remote control is used to direct pulses of electromagnetic radiation to a receiver on a television. This communication from the remote control to the television illustrates that electromagnetic radiation

- (1) is a longitudinal wave
- (2) possesses energy inversely proportional to its frequency
- (3) diffracts and accelerates in air
- (4) transfers energy without transferring mass

Note that question 31 has only three choices.

31 A wave of constant wavelength diffracts as it passes through an opening in a barrier. As the size of the opening is increased, the diffraction effects

- (1) decrease
- (2) increase
- (3) remain the same

32 A car's horn produces a sound wave of constant frequency. As the car speeds up going away from a stationary spectator, the sound wave detected by the spectator

- (1) decreases in amplitude and decreases in frequency
- (2) decreases in amplitude and increases in frequency
- (3) increases in amplitude and decreases in frequency
- (4) increases in amplitude and increases in frequency

33 An electron in a mercury atom drops from energy level f to energy level c by emitting a photon having an energy of

- (1) 8.20 eV
- (2) 5.52 eV
- (3) 2.84 eV
- (4) 2.68 eV

34 If an object has a net negative charge of 4.0 coulombs, the object possesses

- (1) 6.3×10^{18} more electrons than protons
- (2) 2.5×10^{19} more electrons than protons
- (3) 6.3×10^{18} more protons than electrons
- (4) 2.5×10^{19} more protons than electrons

35 Moving electrons are found to exhibit properties of

- (1) particles, only
- (2) waves, only
- (3) both particles and waves
- (4) neither particles nor waves

Part B-1

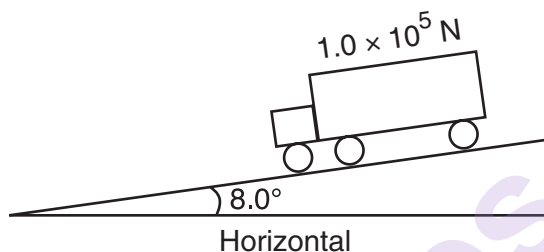
Answer all questions in this part.

Directions (36–46): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question.

36 The weight of a typical high school physics student is closest to

- (1) 1500 N (3) 120 N
(2) 600 N (4) 60 N

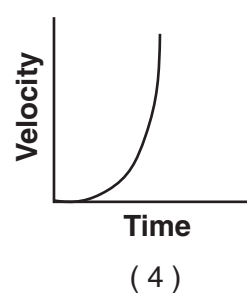
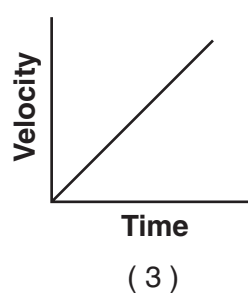
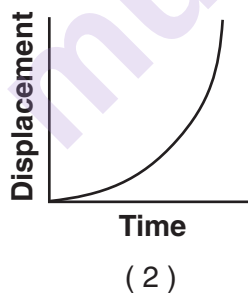
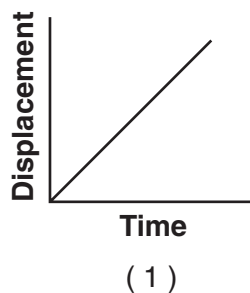
37 The diagram below shows a 1.0×10^5 -newton truck at rest on a hill that makes an angle of 8.0° with the horizontal.



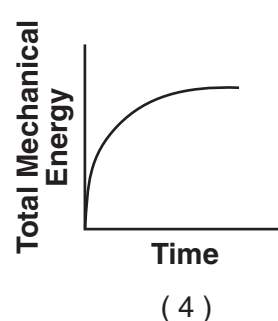
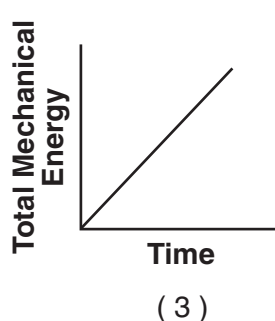
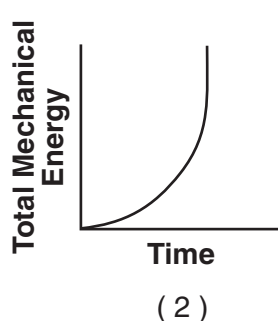
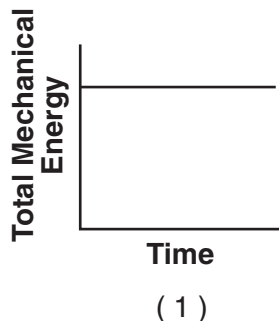
What is the component of the truck's weight parallel to the hill?

- (1) $1.4 \times 10^3 \text{ N}$ (3) $1.4 \times 10^4 \text{ N}$
(2) $1.0 \times 10^4 \text{ N}$ (4) $9.9 \times 10^4 \text{ N}$

38 Which graph best represents the motion of an object in equilibrium?



39 A wooden crate is pushed at constant speed across a level wooden floor. Which graph best represents the relationship between the total mechanical energy of the crate and the duration of time the crate is pushed?



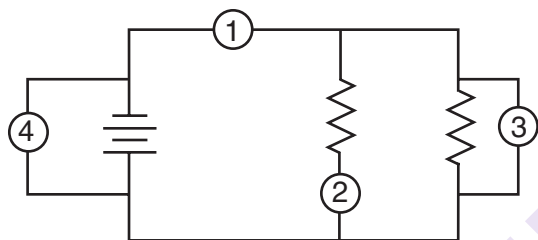
40 A child does 0.20 joule of work to compress the spring in a pop-up toy. If the mass of the toy is 0.010 kilogram, what is the maximum vertical height that the toy can reach after the spring is released?

- (1) 20. m
- (2) 2.0 m
- (3) 0.20 m
- (4) 0.020 m

41 A book of mass m falls freely from rest to the floor from the top of a desk of height h . What is the speed of the book upon striking the floor?

- (1) $\sqrt{2gh}$
- (2) $2gh$
- (3) mgh
- (4) mh

42 In the electric circuit diagram below, possible locations of an ammeter and a voltmeter are indicated by circles 1, 2, 3, and 4.



Where should an ammeter be located to correctly measure the total current and where should a voltmeter be located to correctly measure the total voltage?

- (1) ammeter at 1 and voltmeter at 4
- (2) ammeter at 2 and voltmeter at 3
- (3) ammeter at 3 and voltmeter at 4
- (4) ammeter at 1 and voltmeter at 2

43 What is the current in a 100.-ohm resistor connected to a 0.40-volt source of potential difference?

- (1) 250 mA
- (2) 40. mA
- (3) 2.5 mA
- (4) 4.0 mA

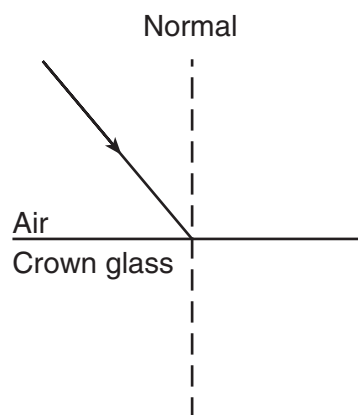
44 A 150-watt lightbulb is brighter than a 60.-watt lightbulb when both are operating at a potential difference of 110 volts. Compared to the resistance of and the current drawn by the 150-watt lightbulb, the 60.-watt lightbulb has

- (1) less resistance and draws more current
- (2) less resistance and draws less current
- (3) more resistance and draws more current
- (4) more resistance and draws less current

45 What is the minimum equipment needed to determine the power dissipated in a resistor of unknown value?

- (1) a voltmeter, only
- (2) an ammeter, only
- (3) a voltmeter and an ammeter, only
- (4) a voltmeter, an ammeter, and a stopwatch

46 A ray of light ($f = 5.09 \times 10^{14}$ Hz) traveling in air is incident at an angle of $40.^\circ$ on an air-crown glass interface as shown below.



What is the angle of refraction for this light ray?

- (1) 25°
- (2) 37°
- (3) 40°
- (4) 78°

Part B-2

Answer all questions in this part.

Directions (47–58): Record your answers in the spaces provided in your answer booklet.

- 47 A person walks 150. meters due east and then walks 30. meters due west. The entire trip takes the person 10. minutes. Determine the magnitude and the direction of the person's total displacement. [2]

Base your answers to questions 48 and 49 on the information below.

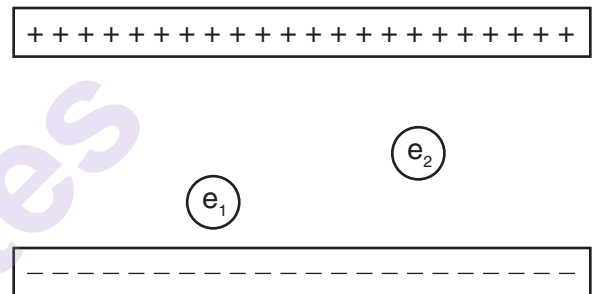
The instant before a batter hits a 0.14-kilogram baseball, the velocity of the ball is 45 meters per second west. The instant after the batter hits the ball, the ball's velocity is 35 meters per second east. The bat and ball are in contact for 1.0×10^{-2} second.

- 48 Determine the magnitude and direction of the average acceleration of the baseball while it is in contact with the bat. [2]
- 49 Calculate the magnitude of the average force the bat exerts on the ball while they are in contact. [Show all work, including the equation and substitution with units.] [2]
- _____

- 50 A car travels at constant speed around a section of horizontal, circular track. On the diagram *in your answer booklet*, draw an arrow at point *P* to represent the direction of the centripetal acceleration of the car when it is at point *P*. [1]

- 51 Calculate the magnitude of the impulse applied to a 0.75-kilogram cart to change its velocity from 0.50 meter per second east to 2.00 meters per second east. [Show all work, including the equation and substitution with units.] [2]

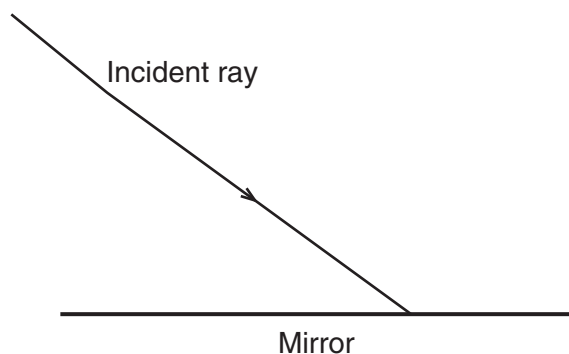
- 52 The diagram below represents two electrons, e_1 and e_2 , located between two oppositely charged parallel plates.



Compare the magnitude of the force exerted by the electric field on e_1 to the magnitude of the force exerted by the electric field on e_2 . [1]

- 53 A length of copper wire and a 1.00-meter-long silver wire have the same cross-sectional area and resistance at 20°C . Calculate the length of the copper wire. [Show all work, including the equation and substitution with units.] [2]

- 54 The diagram below represents a ray of light incident on a plane mirror.



Using a protractor and straightedge, on the diagram *in your answer booklet*, construct the reflected ray for the incident ray shown. [1]

- 55 A periodic wave travels at speed v through medium A . The wave passes with all its energy into medium B . The speed of the wave through medium B is $\frac{v}{2}$. On the diagram *in your answer booklet*, draw the wave as it travels through medium B . [Show at least one full wave.] [1]

- 56 A beam of monochromatic light has a wavelength of 5.89×10^{-7} meter in air. Calculate the wavelength of this light in diamond. [Show all work, including the equation and substitution with units.] [2]

- 57 Calculate the wavelength of a photon having 3.26×10^{-19} joule of energy. [Show all work, including the equation and substitution with units.] [2]

- 58 A box at the top of a rough incline possesses 981 joules more gravitational potential energy than it does at the bottom. As the box slides to the bottom of the incline, 245 joules of heat is produced. Determine the kinetic energy of the box at the bottom of the incline. [1]

Part C

Answer all questions in this part.

Directions (59–72): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 59 and 60 on the information below.

A 1200-kilogram car moving at 12 meters per second collides with a 2300-kilogram car that is waiting at rest at a traffic light. After the collision, the cars lock together and slide. Eventually, the combined cars are brought to rest by a force of kinetic friction as the rubber tires slide across the dry, level, asphalt road surface.

- 59 Calculate the speed of the locked-together cars immediately after the collision. [Show all work, including the equation and substitution with units.] [2]
- 60 Calculate the magnitude of the frictional force that brings the locked-together cars to rest. [Show all work, including the equation and substitution with units.] [2]

Base your answers to questions 61 through 63 on the information below.

The centers of two small charged particles are separated by a distance of 1.2×10^{-4} meter. The charges on the particles are $+8.0 \times 10^{-19}$ coulomb and $+4.8 \times 10^{-19}$ coulomb, respectively.

- 61 Calculate the magnitude of the electrostatic force between these two particles. [Show all work, including the equation and substitution with units.] [2]
- 62 On the axes *in your answer booklet*, sketch a graph showing the relationship between the magnitude of the electrostatic force between the two charged particles and the distance between the centers of the particles. [1]
- 63 On the diagram *in your answer booklet*, draw *at least four* electric field lines in the region between the two positively charged particles. [1]

Base your answers to questions 64 through 66 on the information below.

A stationary research ship uses sonar to send a 1.18×10^3 -hertz sound wave down through the ocean water. The reflected sound wave from the flat ocean bottom 324 meters below the ship is detected 0.425 second after it was sent from the ship.

- 64 Calculate the speed of the sound wave in the ocean water. [Show all work, including the equation and substitution with units.] [2]
- 65 Calculate the wavelength of the sound wave in the ocean water. [Show all work, including the equation and substitution with units.] [2]
- 66 Determine the period of the sound wave in the ocean water. [1]
-

Base your answers to questions 67 through 69 on the information below.

A 5.0-ohm resistor, a 10.0-ohm resistor, and a 15.0-ohm resistor are connected in parallel with a battery. The current through the 5.0-ohm resistor is 2.4 amperes.

- 67 In the space *in your answer booklet*, using the circuit symbols found in the *Reference Tables for Physical Setting/Physics*, draw a diagram of this electric circuit. [1]
- 68 Calculate the amount of electrical energy expended in the 5.0-ohm resistor in 2.0 minutes. [Show all work, including the equation and substitution with units.] [2]
- 69 A 20.0-ohm resistor is added to the circuit in parallel with the other resistors. Describe the effect the addition of this resistor has on the amount of electrical energy expended in the 5.0-ohm resistor in 2.0 minutes. [1]
-

Base your answers to questions 70 through 72 on the passage below.

For years, theoretical physicists have been refining a mathematical method called lattice quantum chromodynamics to enable them to predict the masses of particles consisting of various combinations of quarks and antiquarks. They recently used the theory to calculate the mass of the rare B_c particle, consisting of a charm quark and a bottom antiquark. The predicted mass of the B_c particle was about six times the mass of a proton.

Shortly after the prediction was made, physicists working at the Fermi National Accelerator Laboratory, Fermilab, were able to measure the mass of the B_c particle experimentally and found it to agree with the theoretical prediction to within a few tenths of a percent. In the experiment, the physicists sent beams of protons and antiprotons moving at 99.999% the speed of light in opposite directions around a ring 1.0 kilometer in radius. The protons and antiprotons were kept in their circular paths by powerful electromagnets. When the protons and antiprotons collided, their energy produced numerous new particles, including the elusive B_c .

These results indicate that lattice quantum chromodynamics is a powerful tool not only for confirming the masses of existing particles, but also for predicting the masses of particles that have yet to be discovered in the laboratory.

- 70 Identify the class of matter to which the B_c particle belongs. [1]
- 71 Determine both the sign and the magnitude of the charge of the B_c particle in elementary charges. [1]
- 72 Explain how it is possible for a colliding proton and antiproton to produce a particle with six times the mass of either. [1]
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The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Thursday, January 29, 2009 — 1:15 to 4:15 p.m., only

ANSWER SHEET

Student Sex: ☐ Male ☐ Female Grade

Teacher School

Record your answers to Part A and Part B–1 on this answer sheet.

Part A

- | | | |
|----------|----------|----------|
| 1 | 13 | 25 |
| 2 | 14 | 26 |
| 3 | 15 | 27 |
| 4 | 16 | 28 |
| 5 | 17 | 29 |
| 6 | 18 | 30 |
| 7 | 19 | 31 |
| 8 | 20 | 32 |
| 9 | 21 | 33 |
| 10 | 22 | 34 |
| 11 | 23 | 35 |
| 12 | 24 | |

Part A Score

Part B–1

- | | |
|----------|----------|
| 36 | 42 |
| 37 | 43 |
| 38 | 44 |
| 39 | 45 |
| 40 | 46 |
| 41 | |

Part B–1 Score

Write your answers to Part B–2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

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