The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Wednesday, January 28, 2004 — 9:15 a.m. to 12:15 p.m., only

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. Use only a No. 2 pencil on the separate answer sheet. Complete the heading on the answer sheet by filling in your name, the name of your teacher, your school district, and your school. Bubble in your grade level.

In the lower left of the answer sheet, write your 9-digit student ID number in the boxes and bubble in the appropriate numbers. If you do not know your 9-digit ID number, ask your proctor. Write the day and year of your birth date in the boxes provided. Then bubble in the appropriate month, day, and year.

On the back of the answer sheet, write the 12-digit BEDS Code for your school, which the proctor will provide. Then bubble in the appropriate numbers.

The answer booklet for Part B-2 and Part C is stapled in the center of this examination booklet. Open the examination booklet, carefully remove the answer booklet, and close the examination booklet. Then fill in the heading of your answer booklet. Write your answers to the Part B-2 and Part C questions in your answer booklet. Answers to the Part B-2 and Part C questions may be written in pencil or ink. Graphs and drawings 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 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 *2002 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.

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, choose the word or expression that, of those given, best completes the statement or answers the question and fill in the circle for that choice in the appropriate row of the separate answer sheet.

1 A girl leaves a history classroom and walks 10. meters north to a drinking fountain. Then she turns and walks 30. meters south to an art classroom. What is the girl's total displacement from the history classroom to the art classroom?

(1) 20. m south
(2) 20. m north
(3) 40. m south
(4) 40. m north

2 One car travels 40. meters due east in 5.0 seconds, and a second car travels 64 meters due west in 8.0 seconds. During their periods of travel, the cars definitely had the same

(1) average velocity
(2) total displacement
(3) change in momentum
(4) average speed

3 A skater increases her speed uniformly from 2.0 meters per second to 7.0 meters per second over a distance of 12 meters. The magnitude of her acceleration as she travels this 12 meters is

(1) 1.9 m/s^2
(2) 2.2 m/s^2
(3) 2.4 m/s^2
(4) 3.8 m/s^2

4 A ball thrown vertically upward reaches a maximum height of 30. meters above the surface of Earth. At its maximum height, the speed of the ball is

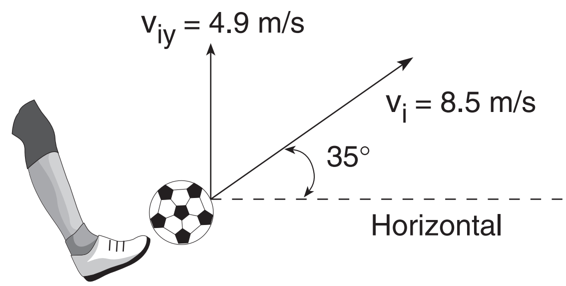
(1) 0.0 m/s
(2) 3.1 m/s
(3) 9.8 m/s
(4) 24 m/s

5 Which object has the most inertia?

(1) a 0.001-kilogram bumblebee traveling at 2 meters per second
(2) a 0.1-kilogram baseball traveling at 20 meters per second
(3) a 5-kilogram bowling ball traveling at 3 meters per second
(4) a 10.-kilogram sled at rest

Base your answers to questions 6 and 7 on the information and diagram below.

A child kicks a ball with an initial velocity of 8.5 meters per second at an angle of 35° with the horizontal, as shown. The ball has an initial vertical velocity of 4.9 meters per second and a total time of flight of 1.0 second. [Neglect air resistance.]



6 The horizontal component of the ball's initial velocity is approximately

(1) 3.6 m/s
(2) 4.9 m/s
(3) 7.0 m/s
(4) 13 m/s

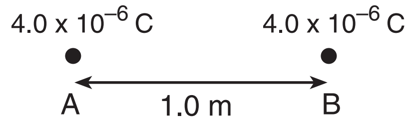
7 The maximum height reached by the ball is approximately

(1) 1.2 m
(2) 2.5 m
(3) 4.9 m
(4) 8.5 m

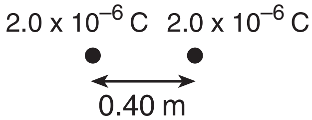
8 A ball of mass M at the end of a string is swung in a horizontal circular path of radius R at constant speed V. Which combination of changes would require the greatest increase in the centripetal force acting on the ball?

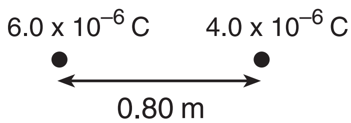
(1) doubling V and doubling R
(2) doubling V and halving R
(3) halving V and doubling R
(4) halving V and halving R

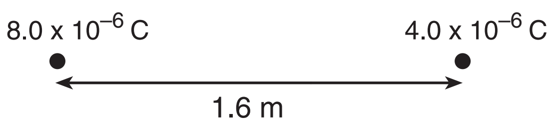
9 The diagram below shows two small metal spheres, *A* and *B*. Each sphere possesses a net charge of 4.0×10^{-6} coulomb. The spheres are separated by a distance of 1.0 meter.

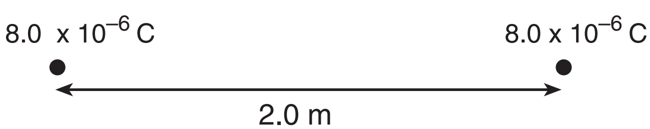


Which combination of charged spheres and separation distance produces an electrostatic force of the same magnitude as the electrostatic force between spheres *A* and *B*?

(1)


(2)


(3)


(4)


10 A box is pushed toward the right across a classroom floor. The force of friction on the box is directed toward the

(1) left (3) ceiling
(2) right (4) floor

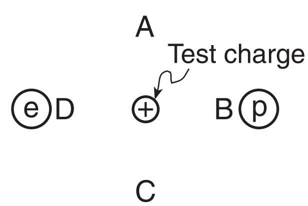
11 A 40.-kilogram mass is moving across a horizontal surface at 5.0 meters per second. What is the magnitude of the net force required to bring the mass to a stop in 8.0 seconds?

(1) 1.0 N (3) 25 N
(2) 5.0 N (4) 40. N

12 What is the speed of a 1.0×10^3-kilogram car that has a momentum of 2.0×10^4 kilogram•meters per second east?

(1) 5.0×10^{-2} m/s (3) 1.0×10^4 m/s
(2) 2.0×10^1 m/s (4) 2.0×10^7 m/s

13 A positive test charge is placed between an electron, *e*, and a proton, *p*, as shown in the diagram below.



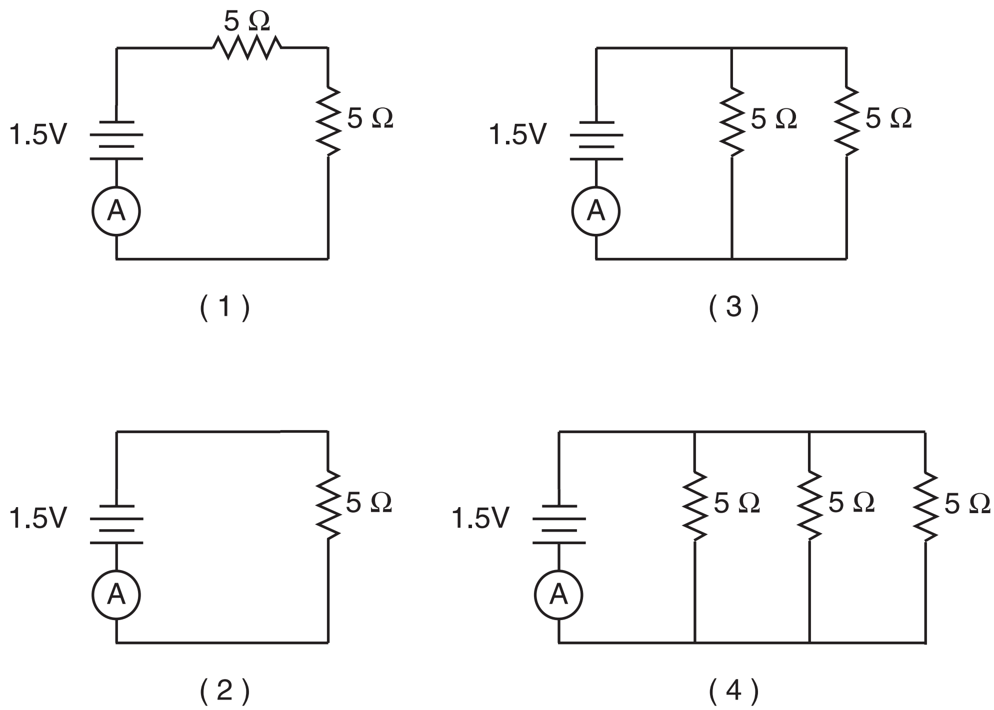
When the test charge is released, it will move toward

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

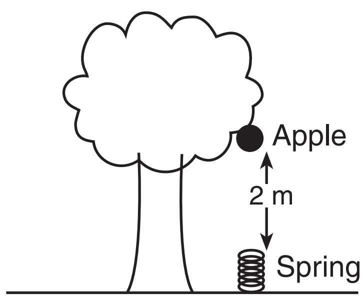
14 If the speed of a car is doubled, the kinetic energy of the car is

(1) quadrupled (3) doubled
(2) quartered (4) halved

15 In which circuit would ammeter *A* show the greatest current?



16 The diagram below shows a 0.1-kilogram apple attached to a branch of a tree 2 meters above a spring on the ground below.



The apple falls and hits the spring, compressing it 0.1 meter from its rest position. If all of the gravitational potential energy of the apple on the tree is transferred to the spring when it is compressed, what is the spring constant of this spring?

(1) 10 N/m (3) 100 N/m
(2) 40 N/m (4) 400 N/m

17 A 1-kilogram rock is dropped from a cliff 90 meters high. After falling 20 meters, the kinetic energy of the rock is approximately

(1) 20 J (3) 700 J
(2) 200 J (4) 900 J

18 A student does 60. joules of work pushing a 3.0-kilogram box up the full length of a ramp that is 5.0 meters long. What is the magnitude of the force applied to the box to do this work?

(1) 20. N (3) 12 N
(2) 15 N (4) 4.0 N

19 A boat weighing 9.0×10^2 newtons requires a horizontal force of 6.0×10^2 newtons to move it across the water at 1.5×10^1 meters per second. The boat's engine must provide energy at the rate of

(1) 2.5×10^{-2} J (3) 7.5×10^3 J
(2) 4.0×10^1 W (4) 9.0×10^3 W

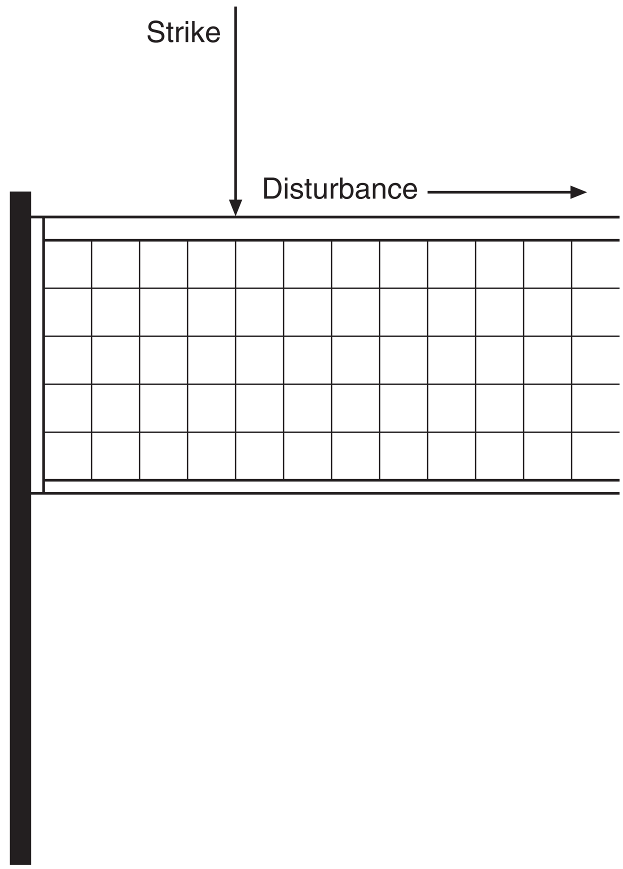
20 In order to produce a magnetic field, an electric charge must be

(1) stationary (3) positive
(2) moving (4) negative

21 In a simple electric circuit, a 110-volt electric heater draws 2.0 amperes of current. The resistance of the heater is

(1) 0.018 Ω (3) 55 Ω
(2) 28 Ω (4) 220 Ω

22 A student strikes the top rope of a volleyball net, sending a single vibratory disturbance along the length of the net, as shown in the diagram below.



This disturbance is best described as

(1) a pulse
(2) a periodic wave
(3) a longitudinal wave
(4) an electromagnetic wave

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23 A 10.-meter length of wire with a cross-sectional area of 3.0×10^{-6} square meter has a resistance of 9.4×10^{-2} ohm at 20° Celsius. The wire is most likely made of

(1) silver
(2) copper
(3) aluminum
(4) tungsten

24 A potential drop of 50. volts is measured across a 250-ohm resistor. What is the power developed in the resistor?

(1) 0.20 W
(2) 5.0 W
(3) 10. W
(4) 50. W

25 If the frequency of a periodic wave is doubled, the period of the wave will be

(1) halved
(2) doubled
(3) quartered
(4) quadrupled

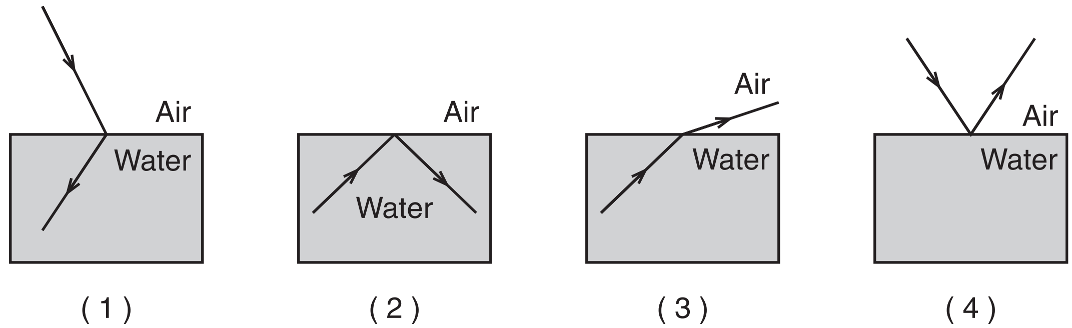
26 How much time does it take light from a flash camera to reach a subject 6.0 meters across a room?

(1) 5.0×10^{-9} s
(2) 2.0×10^{-8} s
(3) 5.0×10^{-8} s
(4) 2.0×10^{-7} s

27 What happens to the frequency and the speed of an electromagnetic wave as it passes from air into glass?

(1) The frequency decreases and the speed increases.
(2) The frequency increases and the speed decreases.
(3) The frequency remains the same and the speed increases.
(4) The frequency remains the same and the speed decreases.

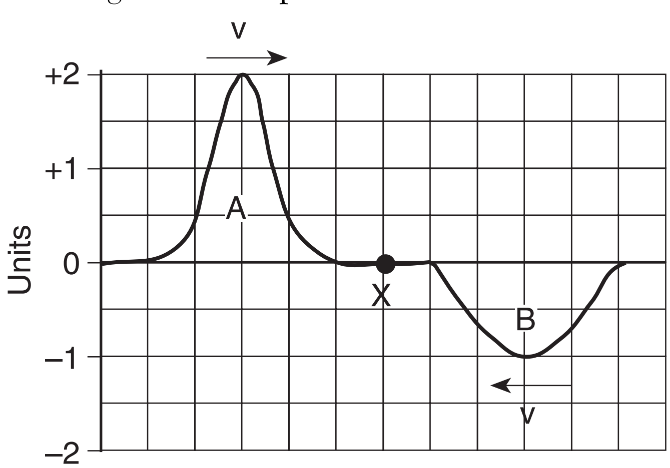
28 Which ray diagram best represents the phenomenon of refraction?



29 Which wave phenomenon makes it possible for a player to hear the sound from a referee's whistle in an open field even when standing behind the referee?

(1) diffraction
(2) Doppler effect
(3) reflection
(4) refraction

30 Two pulses, *A* and *B*, travel toward each other along the same rope, as shown below.



When the centers of the two pulses meet at point *X*, the amplitude at the center of the resultant pulse will be

(1) +1 unit
(2) +2 units
(3) 0
(4) –1 unit

31 A photon of light carries

(1) energy, but not momentum
(2) momentum, but not energy
(3) both energy and momentum
(4) neither energy nor momentum

32 The superposition of two waves traveling in the same medium produces a standing wave pattern if the two waves have

(1) the same frequency, the same amplitude, and travel in the same direction
(2) the same frequency, the same amplitude, and travel in opposite directions
(3) the same frequency, different amplitudes, and travel in the same direction
(4) the same frequency, different amplitudes, and travel in opposite directions

33 The charge-to-mass ratio of an electron is

(1) 5.69×10^{-12} C/kg
(2) 1.76×10^{-11} C/kg
(3) 1.76×10^{11} C/kg
(4) 5.69×10^{12} C/kg

34 The force that holds protons and neutrons together is known as the

(1) gravitational force
(2) strong force
(3) magnetic force
(4) electrostatic force

35 The energy equivalent of 5.0×10^{-3} kilogram is

(1) 8.0×10^{5} J
(2) 1.5×10^{6} J
(3) 4.5×10^{14} J
(4) 3.0×10^{19} J

Part B–1

Answer all questions in this part.

Directions (36–48): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question and fill in the circle for that choice in the appropriate row of the separate answer sheet.

Base your answers to questions 36 and 37 on the information and table below.

The weight of an object was determined at five different distances from the center of Earth. The results are shown in the table below. Position *A* represents results for the object at the surface of Earth.

Position	**Distance from Earth's Center** (m)	**Weight** (N)
A	6.37×10^6	1.0×10^3
B	1.27×10^7	2.5×10^2
C	1.91×10^7	1.1×10^2
D	2.55×10^7	6.3×10^1
E	3.19×10^7	4.0×10^1

36 The approximate mass of the object is

(1) 0.01 kg (3) 100 kg
(2) 10 kg (4) 1,000 kg

37 At what distance from the center of Earth is the weight of the object approximately 28 newtons?

(1) 3.5×10^7 m (3) 4.1×10^7 m
(2) 3.8×10^7 m (4) 4.5×10^7 m

38 A high school physics student is sitting in a seat reading this question. The magnitude of the force with which the seat is pushing up on the student to support him is closest to

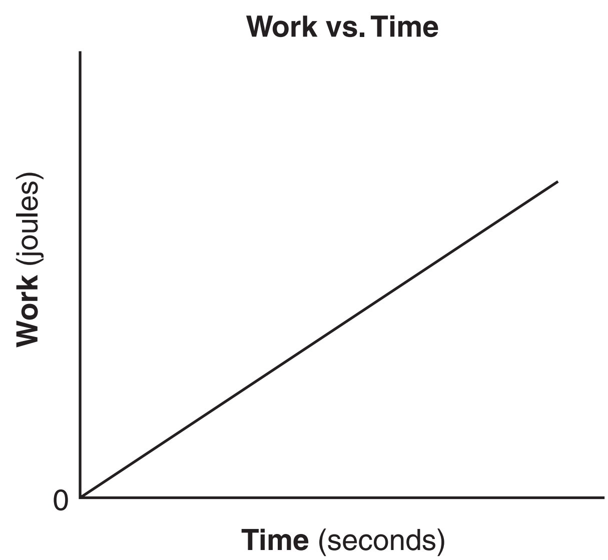
(1) 0 N (3) 600 N
(2) 60 N (4) 6,000 N

39 The diagram below represents a 5.0-newton force and a 12-newton force acting on point *P*.

The resultant of the two forces has a magnitude of

(1) 5.0 N (3) 12 N
(2) 7.0 N (4) 13 N

40 The graph below represents the relationship between the work done by a student running up a flight of stairs and the time of ascent.

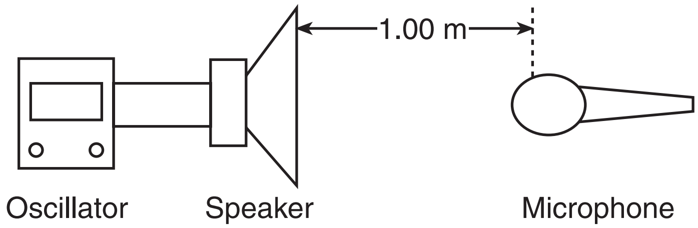


What does the slope of this graph represent?

(1) impulse (3) speed
(2) momentum (4) power

Base your answers to questions 41 through 43 on the information and diagram below.

A system consists of an oscillator and a speaker that emits a 1,000.-hertz sound wave. A microphone detects the sound wave 1.00 meter from the speaker.



41 Which type of wave is emitted by the speaker?

(1) transverse
(2) longitudinal
(3) circular
(4) electromagnetic

42 The microphone is moved to a new fixed location 0.50 meter in front of the speaker. Compared to the sound waves detected at the 1.00-meter position, the sound waves detected at the 0.50-meter position have a different

(1) wave speed
(2) frequency
(3) wavelength
(4) amplitude

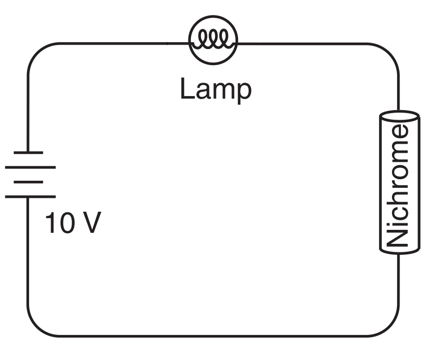
Note that question 43 has only three choices.

43 The microphone is moved at constant speed from the 0.50-meter position back to its original position 1.00 meter from the speaker. Compared to the 1,000.-hertz frequency emitted by the speaker, the frequency detected by the moving microphone is

(1) lower
(2) higher
(3) the same

Note that question 44 has only three choices.

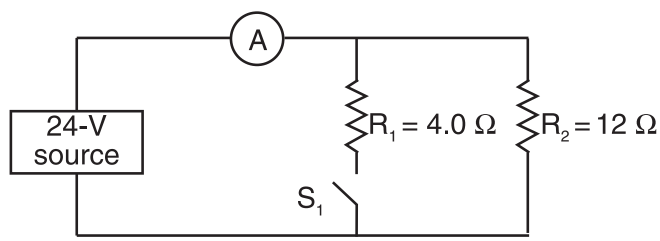
44 The diagram below represents a lamp, a 10-volt battery, and a length of nichrome wire connected in series.



As the temperature of the nichrome is decreased, the brightness of the lamp will

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

Base your answers to questions 45 and 46 on the circuit diagram below.



45 If switch S_1 is open, the reading of ammeter A is

(1) 0.50 A
(2) 2.0 A
(3) 1.5 A
(4) 6.0 A

46 If switch S_1 is closed, the equivalent resistance of the circuit is

(1) 8.0 Ω
(2) 2.0 Ω
(3) 3.0 Ω
(4) 16 Ω

47 An electron in a mercury atom drops from energy level *i* to the ground state by emitting a single photon. This photon has an energy of

(1) 1.56 eV
(2) 8.82 eV
(3) 10.38 eV
(4) 11.94 eV

48 Excited hydrogen atoms are all in the $n = 3$ state. How many different photon energies could possibly be emitted as these atoms return to the ground state?

(1) 1
(2) 2
(3) 3
(4) 4

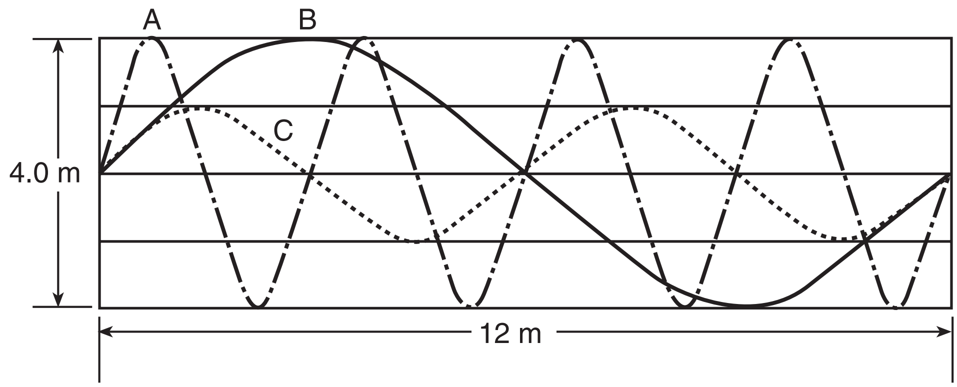
Part B–2

Answer all questions in this part.

Directions (49–62): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 49 through 51 on the information and diagram below.

Three waves, *A*, *B*, and *C*, travel 12 meters in 2.0 seconds through the same medium as shown in the diagram below.



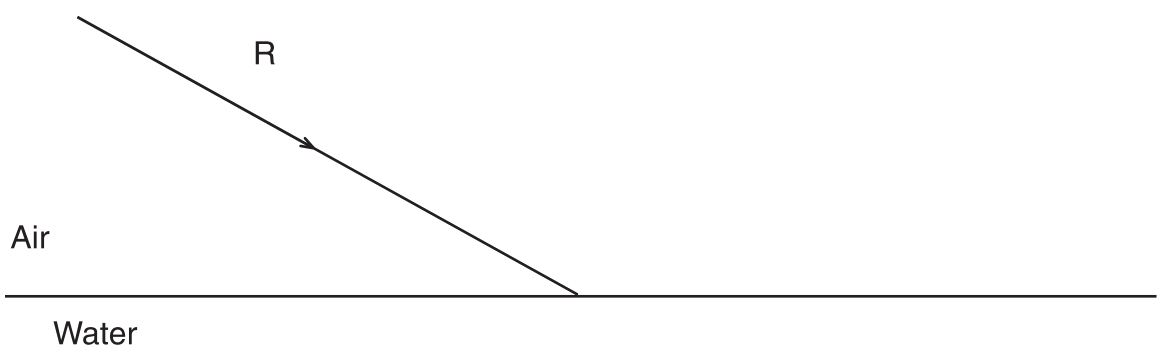
49 What is the amplitude of wave *C*? [1]

50 What is the period of wave *A*? [1]

51 What is the speed of wave *B*? [1]

Base your answers to questions 52 and 53 on the information and diagram below.

In the diagram, a light ray, *R*, strikes the boundary of air and water.



52 Using a protractor, determine the angle of incidence. [1]

53 Using a protractor and straightedge, draw the reflected ray on the diagram *in your answer booklet.* [1]

Base your answers to questions 54 and 55 on the information below.

A soccer player accelerates a 0.50-kilogram soccer ball by kicking it with a net force of 5.0 newtons.

54 Calculate the magnitude of the acceleration of the ball. [Show all work, including the equation and substitution with units.] [2]

55 What is the magnitude of the force of the soccer ball on the player's foot? [1]

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56 State the *two* general characteristics that are used to define a vector quantity. [2]

57 An airplane is moving with a constant velocity in level flight. Compare the magnitude of the forward force provided by the engines to the magnitude of the backward frictional drag force. [1]

Base your answers to questions 58 and 59 on the information below.

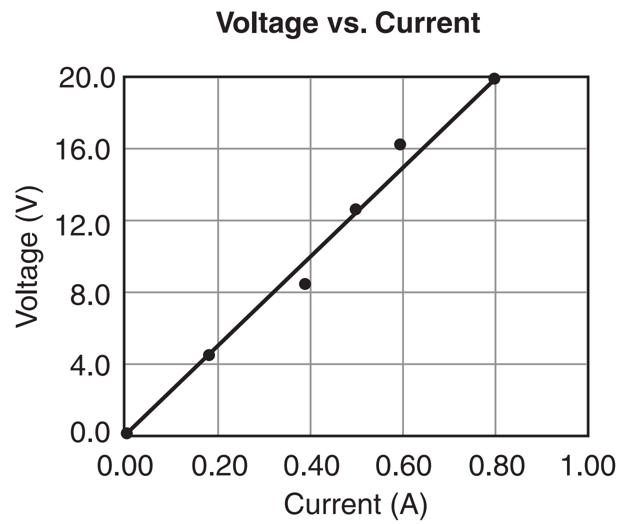
A proton starts from rest and gains 8.35×10^{-14} joule of kinetic energy as it accelerates between points *A* and *B* in an electric field.

58 What is the final speed of the proton?

(1) 7.07×10^{6} m/s
(2) 1.00×10^{7} m/s
(3) 4.28×10^{8} m/s
(4) 5.00×10^{13} m/s

59 Calculate the potential difference between points *A* and *B* in the electric field. [Show all work, including the equation and substitution with units.] [2]

60 A long copper wire was connected to a voltage source. The voltage was varied and the current through the wire measured, while temperature was held constant. The collected data are represented by the graph below.



Using the graph, determine the resistance of the copper wire. [1]

Base your answers to questions 61 and 62 on the information and equation below.

During the process of beta (β^-) emission, a neutron in the nucleus of an atom is converted into a proton, an electron, an electron antineutrino, and energy.

neutron → proton + electron +
electron antineutrino + energy

61 Based on conservation laws, how does the mass of the neutron compare to the mass of the proton? [1]

62 Since charge must be conserved in the reaction shown, what charge must an electron antineutrino carry? [1]

Part C

Answer all questions in this part.

Directions (63–75): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 63 and 64 on the information below.

A lightweight sphere hangs by an insulating thread. A student wishes to determine if the sphere is neutral or electrostatically charged. She has a negatively charged hard rubber rod and a positively charged glass rod. She does not touch the sphere with the rods, but runs tests by bringing them near the sphere one at a time.

63 Describe the test result that would prove that the sphere is neutral. [1]

64 Describe the test result that would prove that the sphere is positively charged. [1]

Base your answers to questions 65 through 69 on the information below.

A manufacturer's advertisement claims that their 1,250-kilogram (12,300-newton) sports car can accelerate on a level road from 0 to 60.0 miles per hour (0 to 26.8 meters per second) in 3.75 seconds.

65 Determine the acceleration, in meters per second^2, of the car according to the advertisement. [1]

66 Calculate the net force required to give the car the acceleration claimed in the advertisement. [Show all work, including the equation and substitution with units.] [2]

67 What is the normal force exerted by the road on the car? [1]

68 The coefficient of friction between the car's tires and the road is 0.80. Calculate the maximum force of friction between the car's tires and the road. [Show all work, including the equation and substitution with units.] [2]

69 Using the values for the forces you have calculated, explain whether or not the manufacturer's claim for the car's acceleration is possible. [1]

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

The light of the "alpha line" in the Balmer series of the hydrogen spectrum has a wavelength of 6.58×10^{-7} meter.

70 Calculate the energy of an "alpha line" photon in joules. [Show all work, including the equation and substitution with units.] [2]

71 What is the energy of an "alpha line" photon in electronvolts? [1]

72 Using your answer to question 71, explain whether or not this result verifies that the "alpha line" corresponds to a transition from energy level $n = 3$ to energy level $n = 2$ in a hydrogen atom. [1]

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73 Two physics students have been selected by NASA to accompany astronauts on a future mission to the Moon. The students are to design and carry out a simple experiment to measure the acceleration due to gravity on the surface of the Moon.

Describe an experiment that the students could conduct to measure the acceleration due to gravity on the Moon. Your description must include:

- the equipment needed [1]
- what quantities would be measured using the equipment [1]
- what procedure the students should follow in conducting their experiment [1]
- what equations and/or calculations the students would need to do to arrive at a value for the acceleration due to gravity on the Moon [1]

Base your answers to questions 74 and 75 on the passage below.

Shattering Glass

An old television commercial for audio recording tape showed a singer breaking a wine glass with her voice. The question was then asked if this was actually her voice or a recording. The inference is that the tape is of such high quality that the excellent reproduction of the sound is able to break glass.

This is a demonstration of resonance. It is certainly possibly to break a wine glass with an amplified singing voice. If the frequency of the voice is the same as the natural frequency of the glass, and the sound is loud enough, the glass can be set into a resonant vibration whose amplitude is large enough to surpass the elastic limit of the glass. But the inference that high-quality reproduction is necessary is not justified. All that is important is that the frequency is recorded and played back correctly. The waveform of the sound can be altered as long as the frequency remains the same. Suppose, for example, that the singer sings a perfect sine wave, but the tape records it as a square wave. If the tape player plays the sound back at the right speed, the glass will still receive energy at the resonance frequency and will be set into vibration leading to breakage, even though the tape reproduction was terrible. Thus, this phenomenon does not require high-quality reproduction and, thus, does not demonstrate the quality of the recording tape. What it does demonstrate is the quality of the tape player, in that it played back the tape at an accurate speed!

74 List *two* properties that a singer's voice must have in order to shatter a glass. [2]

75 Explain why the glass would not break if the tape player did not play back at an accurate speed. [1]

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
PHYSICS

Wednesday, January 28, 2004 — 9:15 a.m. to 12:15 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	43 . . . .
37	44 . . . .
38	45 . . . .
39	46 . . . .
40	47 . . . .
41	48 . . . .
42	**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

Tear Here

Tear Here

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING PHYSICS

Wednesday, January 28, 2004 — 9:15 a.m. to 12:15 p.m., only

ANSWER BOOKLET

Student . . . . Sex: ☐ Male ☐ Female

Teacher. . . . .

School . . . . Grade . . . .

Answer all questions in Part B–2 and Part C. Record your answers in this booklet.

Part	Maximum Score	Student's Score
A	35	
B–1	13	
B–2	17	
C	20	

Total Written Test Score (Maximum Raw Score: 85) ☐

Final Score (From Conversion Chart) ☐

Raters' Initials:

Rater 1 . . . . **Rater 2** . . . .

Part B–2

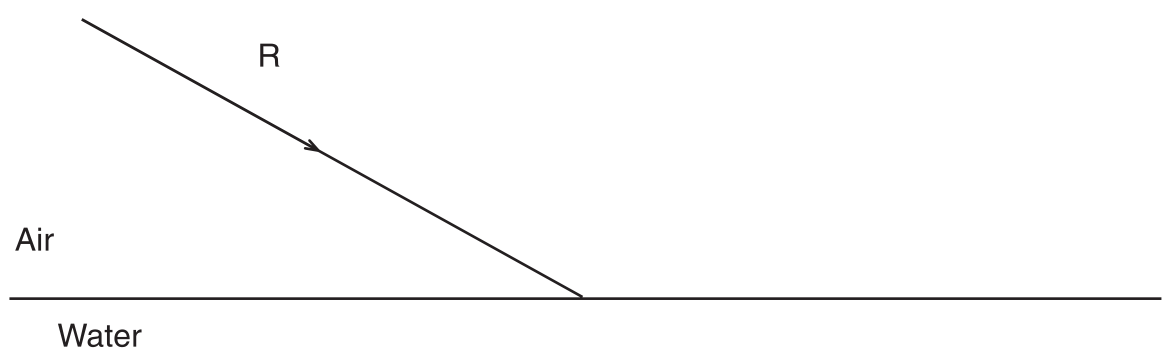
49 ____________________ **m**

50 ____________________ **s**

51 ____________________ **m/s**

52 ____________________ **°**

53



54

55 ____________________ N

56 ____

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57 ____

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58 ____________________

59

60 ________________ Ω

61 ____

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62 __________________________________

Part C

63 ____

____

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64 ____

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65 ________________ m/s^2

66

67 ________________ N

68

69 ____

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70

71 ____________________ eV

72 ____

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73 ____

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74 ____________________

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75 ____

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