# PHYSICAL SETTING/PHYSICS REGENTS EXAMINATION

# TEST SAMPLER DRAFT

# Fall 2001

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Office of Curriculum, Instruction, and Assessment
Albany, New York 12234

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**THE STATE EDUCATION DEPARTMENT** / THE UNIVERSITY OF THE STATE OF NEW YORK / ALBANY, NY 12234

Assistant Commissioner for Curriculum, Instruction, and Assessment

November 2001

Dear Colleagues:

Following several years of planning and development, the Physical Setting/Physics Test Sampler Draft is complete. School districts, science teachers, supervisors, and administrators have assisted the State Education Department in the development process in a variety of ways. Teachers have pretested test items with their students and developed and reviewed test items and scoring materials. Administrators have arranged for their students to participate in the pretest and field test process. Teachers and supervisors will continue to write, develop, pretest, and field test questions for future Physical Setting/Physics examinations.

This Test Sampler Draft is being distributed to all secondary schools in the State. Schools are requested to make additional copies available to their physics teachers.

The Test Sampler Draft provides examples of the types and formats of questions and scoring materials that are being developed for the Physical Setting/Physics Regents examination that will be administered for the first time in June 2002. We expect that further refinements of the formats of questions and scoring materials will occur as a result of information gathered from the development process.

We are interested in receiving your feedback on these preliminary materials. A comment sheet is included on the inside back cover of the Test Sampler Draft so that you may forward your responses to us. The comment sheet may be faxed to (518) 473-0858 or mailed to the address listed below:

New York State Education Department
Office of Curriculum and Instruction
Room 674 EBA
Albany, New York 12234

Sincerely,

Roseanne DeFabio

# Acknowledgments

The State Education Department acknowledges the significant contributions made by teachers, supervisors, and other educators who contributed to the development of the Physical Setting/Physics Examination Test Sampler Draft. The contributions include the development and shaping for the Physical Setting/Physics curriculum, the development of the components of the new Physical Setting/Physics Regents examination, the test items, and the scoring rubrics.

| | |
|---|---|
| Joseph M. Akramoff | Columbia High School, East Greenbush |
| Robert Allen | Duanesburg Central School, Duanesburg |
| George Amann | F. D. Roosevelt High School, Hyde Park |
| Angela Cigna-Lukaszewski | Syosset High School, Syosset/Hofstra University |
| Bernadine Hladik Cook | Johnstown High School, Johnstown |
| Steve Dunckel | Morrisville-Easton Jr. Sr. High School, Morrisville |
| Laura J. Dustin | Honeoye Falls Central School, Honeoye |
| Rich Fries | Susquehanna Valley High School, Conklin |
| Michael Herzog | Hilton Central School, Hilton |
| Elizabeth Hokanson | Niskayuna High School, Niskayuna |
| Dennis Hulbert | Plattsburg High School, Plattsburg |
| Jim Iak | Rush Henrietta High School, Henrietta |
| Michael Jabot | Oneida High School, Oneida |
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| Thomas Ladd | Averill Park High School, Averill Park |
| Anthony L. Lamarca | Gates Chili High School, Rochester |
| Miriam Lazar | Roslyn High School, Roslyn Heights |
| William Leacock | W. C. Mepham High School, Bellmore |
| Jim McVeigh | Shenendahowa High School, Clifton Park |
| Nancy Moreau | Roy C. Ketcham High School, Wappingers Falls |
| Edmond Nurse | High School of Transit Technology, Brooklyn |
| Fred Pidgeon | Rensselaer High School, Rensselaer |
| Carl Preske | G. Ray Bodley High School, Fulton |
| Charles Rasweiler | Uniondale High School, Uniondale (formerly) |
| Theodore Reiss | Monroe-Woodbury High School, Central Valley |
| Theresa Rousseau | Ballston Spa High School, Ballston Spa |
| Charlene Rydgren | Franklin Academy High School, Malone |
| Jane Schoch | Kings Park High School, Kings Park |
| Jim Shear | Chenango Forks High School, Binghamton |
| Barbara Speight | Hewlett-Woodmere High School, Hewlett |
| Robert Stewart | Monticello High School, Monticello |
| Valerie J. Suter | Arlington High School, LaGrangeville |
| Lowell Sylwester | West Seneca West Sr. High School, West Seneca |
| Andrew Telesca, Jr. | Johnson City High School, Johnson City/Binghamton University |
| Lesia Thaisz | Gloversville High School, Gloversville |
| Virginia Trombley | AuSable Valley High School, Clintonville |
| Butch Weir | Oneonta High School, Oneonta |
| Joseph Zawicki | Elba Central School, Elba |

The New York State Education Department also wishes to acknowledge the contributions of the following SED staff members:

Evan Murphy, Examinations Editor
Mary Oliver, Assoicate in Educational Testing
Diana Harding, Associate in Science Education
Anthony Costa, Artist Designer

Special thanks go to Jan Christman for her technical expertise.

# Contents

# Introduction

The Physical Setting/Physics Regents Examination has been developed to assess student achievement at the commencement level of Standards 1,2,4,6,and 7 of the Learning Standards for Mathematics, Science and Technology. Items for the examination were developed through the cooperative effort of teachers, school districts, other science educators and New York State Education Department Staff.

The written portion of this examination will be administered in a 3-hour period and will first be administered in June 2002. The written portion of the examination will include three parts: A, B, and C. Students should be prepared to answer questions in multiple-choice, constructed-response, and extended constructed-response formats. Questions will be content- and skills-based and may require students to graph data, complete a data table, label or draw diagrams, design experiments, make calculations, or write short or extended responses. In addition, questions may ask students to hypothesize, interpret, analyze, evaluate data, or apply their scientific knowledge and skills to real-world situations. Some of the questions will require the use of the 2002 edition of the Physical Setting/Physics Reference Tables.

In the future, (not before June 2004) a Part D will be added that will focus on assessment of laboratory skills. Part D will consist of laboratory activities and will be administered at the convenience of local school districts during the last two weeks of the course, but no later than the day before the administration of the written portion of the examination.

**Students will be required to answer ALL questions on the Physical Setting/Physics examination.**

## Physical Setting/Physics Regents Examination Format

| PART | ITEM TYPE(S) | DESCRIPTION OF THE ITEMS | APPROXIMATE PERCENT OF TOTAL TEST RAW SCORE |
|---|---|---|---|
| A | Multiple-choice questions | Content-based questions assessing the student's knowledge and understanding of core material (primarily from Standard 4) | 30–40 % |
| B | Multiple-choice and constructed-response questions | Content- and skills-based questions assessing the student's ability to apply, analyze, and evaluate material (primarily from Standards 1, 2, 6, and 7) | 25–35% |
| C | Constructed-response and/or extended constructed-response questions | Content-based and application questions assessing the student's ability to apply knowledge of science concepts and skills (primarily from Standards 1, 2, 4, 6, and 7) | 20–30% |

Each examination will be scaled, and all examinations will be equated, based on a standard setting process. A chart for converting the student's total examination raw score to a scaled score will be provided in the rating guide for each administration. Teachers will score the examinations in their districts, following the guidelines provided by the New York State Education Department.

Appendix I "Examination Blueprint," indicates the approximate percentage of examination questions for each content standard in the Physical Setting/Physics core curriculum. Appendices II, III and IV, "Mapping the Core Curriculum to the Sampler," "Mapping the Sampler to the Core Curriculum," and "Mapping the Sampler to the Core Curriculum Process Skills", link each question in the Sampler Draft to the Physical Setting/Physics Core Curriculum. Individual questions may be linked to several key ideas and skills.

**Laboratiory Requirements:** Critical to understanding science concepts is the use of scientific inquiry to develop explanations of natural phenomena. Therefore, as a prerequisite for admission to the Regents examination in Physicl Setting/Physics, students must have successfully completed 1,200 minutes of hands-on laboratory experience with satisfactory reports on file. Because of the strong emphasis on student development of laboratory skills, a minimum of 280 minutes of class and laboratory time per week is recommended.

Test modifications will be consistently provided to students with disabilities when it is determined that such accommodations are necessary. Such modifications must be documented either in an Individualized Education Plan (IEP) or in a Section504 Accommodation Plan. Modifications are being redrawn to reflect the requirements of the new assessments. The revised State assessments are being developed by both special and general educators to ensure that they are appropriate for students with disabilities.

The Physical Setting/Physics Regents Examination Test Sampler Draft may be used in the classroom to help teachers plan for instruction. Teachers are encouraged to use the sampler to introduce students to the test format, and to use the scoring rubrics for practice in scoring student papers.

# Sample Test Questions for the Physical Setting/Physics Regents Examination Part A

**Answer all questions in this part.** [35]

*Directions (1–35):* For *each* statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet. Some questions may require the use of the *Physical Setting/Physics Reference Tables.*

1 Which is a vector quantity?

(1) gravitational field strength of Earth
(2) mass of a jogger
(3) charge of an electron
(4) kinetic energy of a freely falling body

2 A ball starting from rest accelerates uniformly at 5.0 meters per second$^2$ as it rolls 40. meters down an incline. How much time is required for the ball to roll the 40. meters?

(1) 2.8 s
(2) 8.0 s
(3) 16 s
(4) 4.0 s

3 The speed of a car is decreased uniformly from 30. meters per second to 10. meters per second in 4.0 seconds. The magnitude of the car's acceleration is

(1) 5.0 m/s$^2$
(2) 10. m/s$^2$
(3) 20. m/s$^2$
(4) 40. m/s$^2$

4 Objects *A* and *B* are dropped from rest near Earth's surface. Object *A* has mass *m* and object *B* has mass 2*m*. After 2 seconds of free fall, object *A* has a speed *v* and has fallen a distance *d*. What are the speed and distance of fall of object *B* after 2 seconds of free fall?

(1) speed = $\frac{v}{2}$; distance = $\frac{d}{2}$
(2) speed = $v$; distance = $d$
(3) speed = $\frac{v}{2}$; distance = $2d$
(4) speed = $2v$; distance = $2d$

5 A ball is thrown horizontally from the top of a building with an initial velocity of 15 meters per second. At the same instant, a second ball is dropped from the top of the building. The two balls have the same

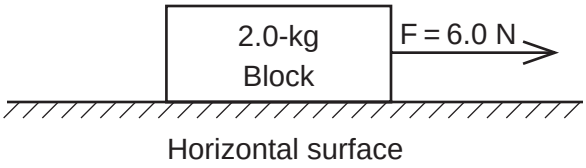
(1) path as they fall
(2) final velocity as they reach the ground
(3) initial horizontal velocity
(4) initial vertical velocity

6 In the diagram below, the upward drag force acting on a parachute is equal in magnitude but opposite in direction to the weight of the parachutist and equipment.


As a result of the forces shown, the parachutist may be moving

(1) downward with decreasing speed
(2) downward at constant speed
(3) upward with decreasing speed
(4) upward with constant acceleration

7 The diagram below shows a 2.0-kilogram block being moved across a frictionless horizontal surface by a 6.0-newton horizontal force.




What is the magnitude of the acceleration of the block?

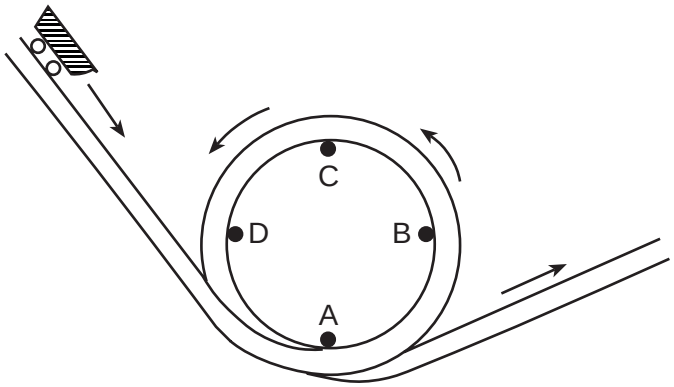
(1) 0.33 $m/s^2$
(2) 6.0 $m/s^2$
(3) 3.0 $m/s^2$
(4) 12 $m/s^2$

8 The magnitude of the acceleration due to gravity on the surface of planet *A* is twice as great as on the surface of planet *B*. What is the ratio of the weight of mass *X* on the surface of planet *A* to its weight on the surface of planet *B*?

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

Base your answers to questions 9 and 10 on the information and diagram below.

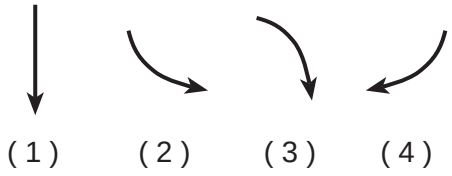
A roller coaster cart starts from rest and accelerates, due to gravity, down a track. The cart starts at a height that enables it to complete a loop in the track. [Neglect friction.]



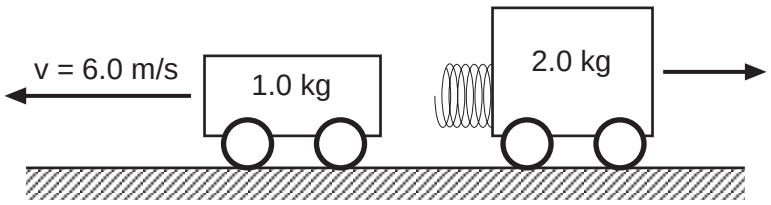

9 The magnitude of the centripetal force keeping the cart in circular motion would be greatest at point

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

10 Which diagram best represents the path followed by an object that falls off the cart when the cart is at point *D*?



11 The diagram below shows two carts initially at rest on a horizontal frictionless surface being pushed apart when a compressed spring attached to one of the carts is released.




If the 1.0-kilogram cart moves to the left with a speed of 6.0 meters per second, then the 2.0-kilogram cart moves to the right with a speed of

(1) 6.0 m/s
(2) 2.0 m/s
(3) 3.0 m/s
(4) 12 m/s

12 A mother pushes her 120-newton child, who is sitting on a swing. If the mother exerts a 10.-newton force on the child for 0.50 second, what is the magnitude of the impulse imparted to the child by the mother?

(1) 5.0 N•s
(2) 20. N/s
(3) 60. N•s
(4) 240 N/s

**Note that question 13 has only three choices.**

13 A ball having mass *m* is struck by a bat having mass 9 m. Compared to the magnitude of the force exerted by the bat on the ball, the magnitude of the force exerted by the ball on the bat is

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

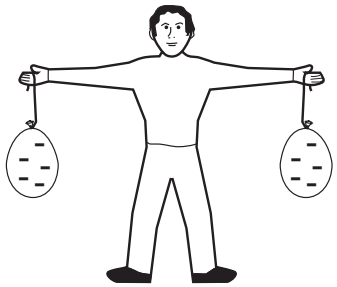
14 Gravitational force *F* exists between point objects *A* and *B* separated by distance *R*. If the mass of *A* is doubled and distance *R* is tripled, what is the new gravitational force between *A* and *B*?

(1) $\frac{2}{9}$ F
(2) $\frac{2}{3}$ F
(3) $\frac{3}{2}$ F
(4) $\frac{9}{2}$ F

15 At point *P* in an electric field, the magnitude of the electrostatic force on a proton is $4.0 \times 10^{-10}$ newton. What is the magnitude of the electric field intensity at point *P*?

(1) $6.4 \times 10^{-29}$ N/C
(2) $1.6 \times 10^{-19}$ N/C
(3) $4.0 \times 10^{-10}$ N/C
(4) $2.5 \times 10^{9}$ N/C

16 The diagram below shows two negatively charged balloons suspended from nonconducting strings being held by a student.



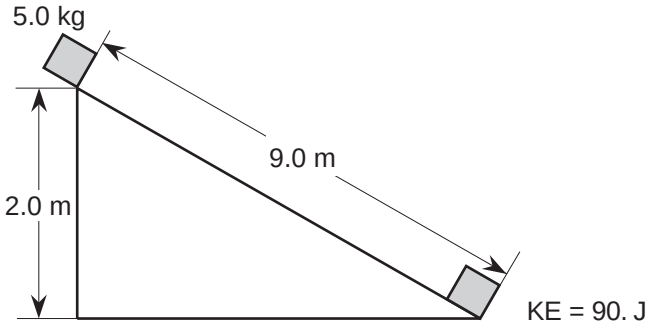
What occurs as the student brings the balloons closer to each other without allowing them to touch?

(1) The magnitude of the electrostatic force between the balloons decreases, and they attract each other.
(2) The magnitude of the electrostatic force between the balloons decreases, and they repel each other.
(3) The magnitude of the electrostatic force between the balloons increases, and they attract each other.
(4) The magnitude of the electrostatic force between the balloons increases, and they repel each other.

17 A 500.-newton girl lifts a 10.-newton box vertically upward a distance of 0.50 meter. The work done on the box is

(1) 5.0 J
(2) 50. J
(3) 250 J
(4) 2500 J

18 The diagram below shows a 5.0-kilogram mass sliding 9.0 meters down an incline from a height of 2.0 meters in 3.0 seconds. The object gains 90. joules of kinetic energy while sliding.




How much work is done against friction as the mass slides the 9.0 meters?

(1) 0 J
(2) 8 J
(3) 45 J
(4) 90. J

19 A motor having a power rating of 500. watts is used to lift an object weighing 100. newtons. How much time does the motor take to lift the object a vertical distance of 10.0 meters?

(1) 0.500 s
(2) 2.00 s
(3) 5.00 s
(4) 50.0 s

20 If 1.0 joule of work is required to move a charge of 1.0 coulomb between two points in an electric field, the potential difference between these two points is

(1) 1.0 V
(2) $1.6 \times 10^{-19}$ V
(3) $9.0 \times 10^{9}$ V
(4) $6.3 \times 10^{18}$ V

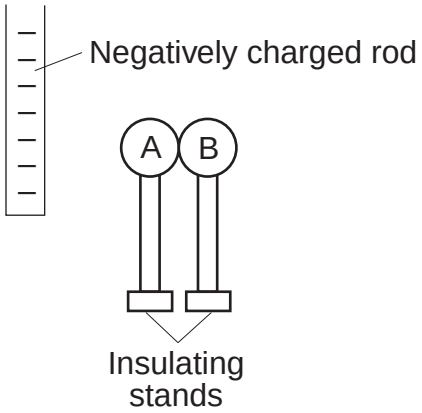
21 A microwave oven operating at 120 volts is used to heat a hot dog. If the oven draws 12.5 amperes of current for 45 seconds, what is the power dissipated by the oven?

(1) 33 W
(2) $1.5 \times 10^{3}$ W
(3) $5.4 \times 10^{3}$ W
(4) $6.8 \times 10^{4}$ W

22 For which quantities are values needed to calculate the amount of energy supplied to an operating toaster?

(1) applied voltage and resistance, only
(2) applied voltage and operation time, only
(3) applied voltage, current drawn, and resistance
(4) applied voltage, current drawn, and operation time

23 Two electrically neutral metal spheres, *A* and *B*, on insulating stands are placed in contact with each other. A negatively charged rod is brought near, but does *not* touch the spheres, as shown in the diagram below.



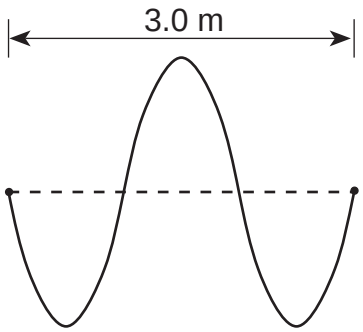

How are the spheres now charged?

(1) *A* is positive and *B* is positive.
(2) *A* is positive and *B* is negative.
(3) *A* is negative and *B* is positive.
(4) *A* is negative and *B* is negative.

24 In a television set, an electron beam with a current of $5.0 \times 10^{-6}$ ampere is directed at the screen. Approximately how many electrons are transferred to the screen in 60. seconds?

(1) $1.2 \times 10^{7}$
(2) $5.3 \times 10^{11}$
(3) $1.9 \times 10^{15}$
(4) $6.3 \times 10^{18}$

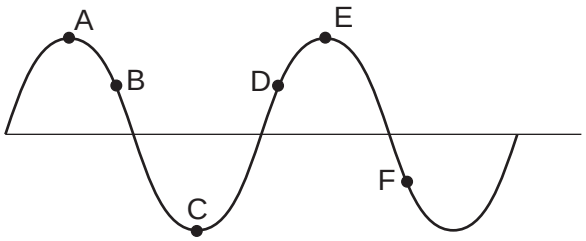
25 The diagram below represents a periodic wave generated during a 1.5-second interval.




The frequency of the wave is

(1) 1.0 Hz
(2) 2.0 Hz
(3) 0.50 Hz
(4) 4.5 Hz

26 The diagram below represents a periodic wave.



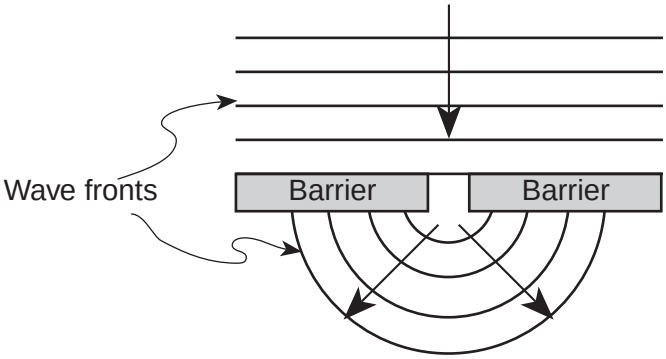

Which two points on the wave are in phase?

(1) *A* and *E*
(2) *A* and *C*
(3) *B* and *D*
(4) *D* and *F*

27 What is the frequency of a light wave with a wavelength of $6.0 \times 10^{-7}$ meter traveling through space?

(1) $2.0 \times 10^{-15}$ Hz
(2) $5.0 \times 10^{1}$ Hz
(3) $1.8 \times 10^{14}$ Hz
(4) $5.0 \times 10^{14}$ Hz

28 The diagram below shows a wave phenomenon.



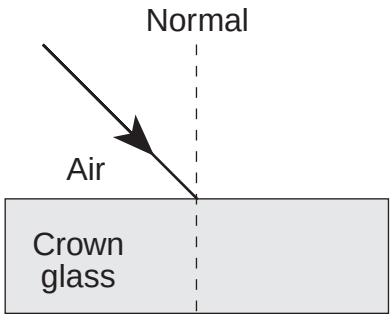

The pattern of waves shown behind the barriers is the result of

(1) reflection
(2) diffraction
(3) refraction
(4) absorption

29 An astronomical body emitting high-intensity pulses of green light is moving toward Earth at high velocity. To an observer on Earth, this light may appear

(1) red
(2) blue
(3) orange
(4) yellow

30 The diagram below shows a light ray in air incident on a crown glass block.




As the light ray enters the crown glass block, it will

(1) slow down and bend toward the normal
(2) slow down and bend away from the normal
(3) speed up and bend toward the normal
(4) speed up and bend away from the normal

31 If a small sphere possesses an excess of 5 electrons, the net charge on the sphere is

(1) $-3.2 \times 10^{-20}$ C
(2) $-8.0 \times 10^{-19}$ C
(3) $-8.0 \times 10^{19}$ C
(4) $-3.2 \times 10^{20}$ C

32 A baryon may have a charge of

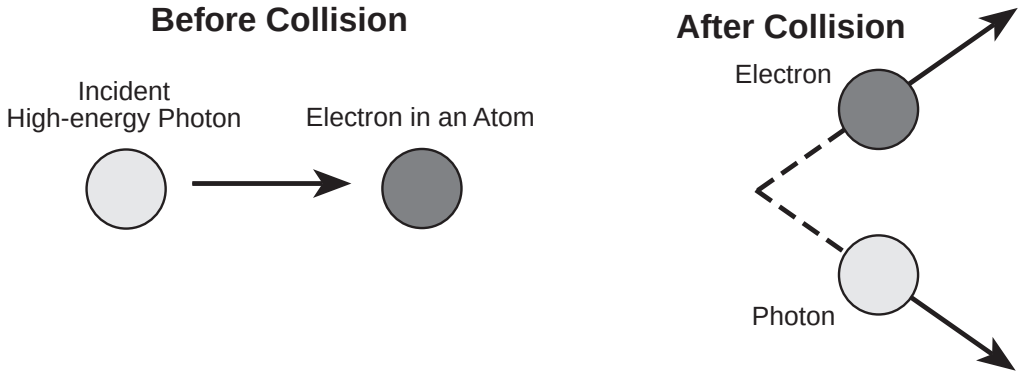
(1) $-\frac{1}{3}e$
(2) 0 e
(3) $+\frac{2}{3}e$
(4) $+\frac{4}{3}e$

33 What is the energy equivalent of a mass of 0.026 kilogram?

(1) $2.34 \times 10^{15}$ J
(2) $2.3 \times 10^{15}$ J
(3) $2.34 \times 10^{17}$ J
(4) $2.3 \times 10^{17}$ J

**Note that questions 34 and 35 have only three choices.**

Base your answers to questions 34 and 35 on the diagrams below, which show a photon and an electron before and after their collision.




34 Compared to the wavelength of the photon before its collision with the electron, the wavelength of the photon after the collision is

(1) shorter
(2) longer
(3) the same

35 Compared to the total momentum of the photon-electron system before the collision, the total momentum of the photon-electron system after the collision is

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

# Part B-1

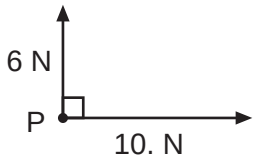
**Answer all questions in this part.**

*Directions* (36–48): 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. Some questions may require the use of the *Physical Setting/Physics Reference Tables.*

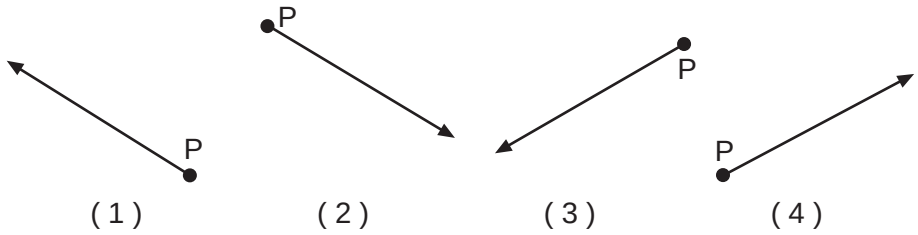
36 The thickness of one page of this test booklet is closest to

(1) $10^{-4}$ m
(2) $10^{-2}$ m
(3) $10^{0}$ m
(4) $10^{2}$ m

37 The diagram below represents two forces acting concurrently on an object at point *P*.



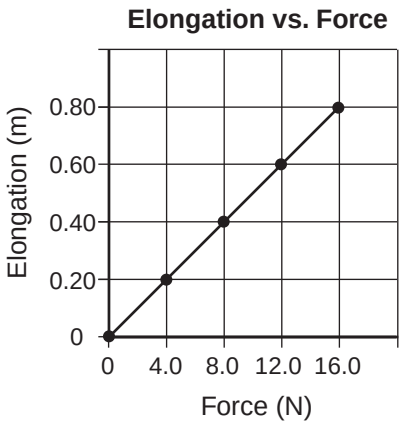

Which diagram best represents the resultant of these two forces?




38 Two students are pushing a car. What should be the angle of each student's arms with respect to the flat ground to maximize the horizontal component of the force?

(1) $0^{o}$
(2) $30^{o}$
(3) $45^{o}$
(4) $90^{o}$

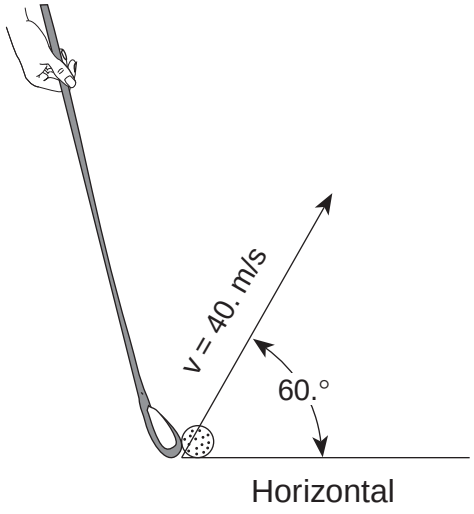
39 A student performed a laboratory investigation to determine the spring constant of a spring. The force applied to the spring was varied and the resulting elongation of the spring measured. The student graphed the data collected, as shown below.




According to the student's graph, what is the spring constant for this spring?

(1) 0.050 m/N
(2) 9.8 N/kg
(3) 13 N• m
(4) 20. N/m

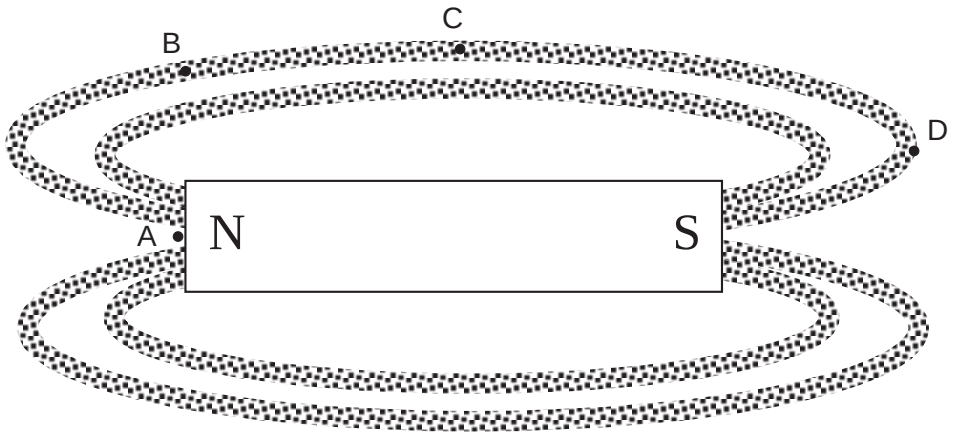
40 The diagram below shows a golf ball being struck by a club. The ball leaves the club with a speed of 40. meters per second at an angle of 60.° with the horizontal.




If the ball strikes the ground 7.1 seconds later, how far from the golfer does the ball land? [Assume level ground and neglect air resistance.]

(1) 35 m
(2) 71 m
(3) 140 m
(4) 280 m

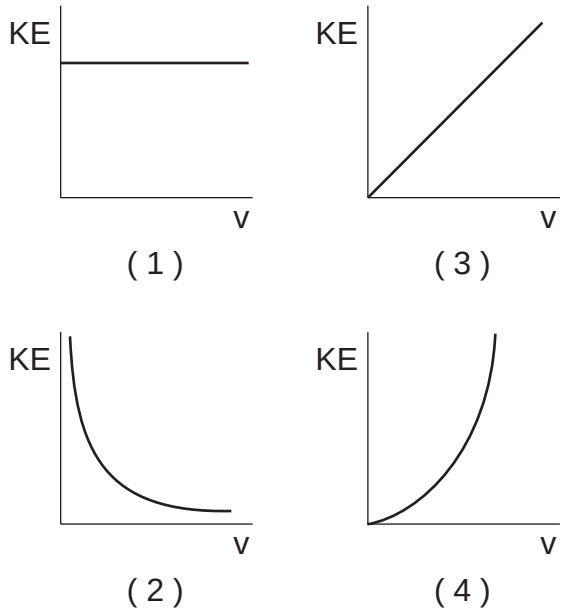
41 A student sprinkled iron filings around a bar magnet and observed that the filings formed the pattern shown below.



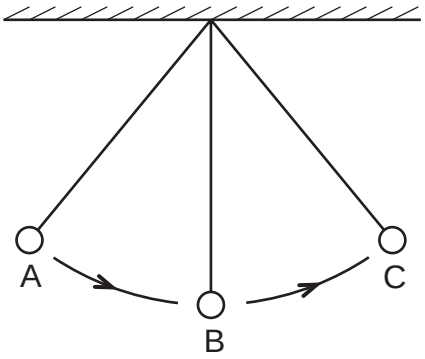

The magnetic field is strongest at point

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

42 Which graph best represents the kinetic energy KE of an object as a function of its speed *v*?



43 The diagram below shows three positions, *A*, *B*, and *C*, in the swing of a pendulum, released from rest at point *A*. [Neglect friction.]



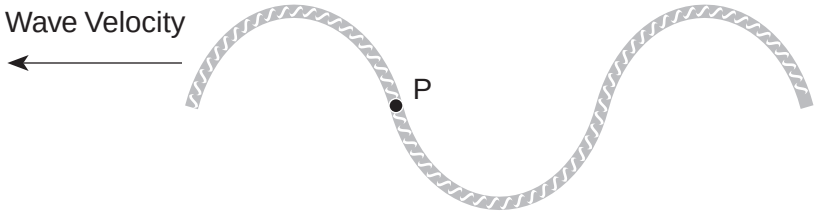

Which statement is true about this swinging pendulum?

(1) The potential energy at *A* equals the kinetic energy at *C*.
(2) The speed of the pendulum at *A* equals the speed of the pendulum at *B*.
(3) The potential energy at *B* equals the potential energy at *C*.
(4) The potential energy at *A* equals the kinetic energy at *B*.

44 A manufacturer recommends that the longer the extension cord used with an electric drill, the thicker (heavier gauge) the extension cord should be. This recommendation is made because the resistance of a wire varies

(1) directly with length and inversely with cross-sectional area
(2) inversely with length and directly with cross-sectional area
(3) directly with both length and cross-sectional area
(4) inversely with both length and cross-sectional area

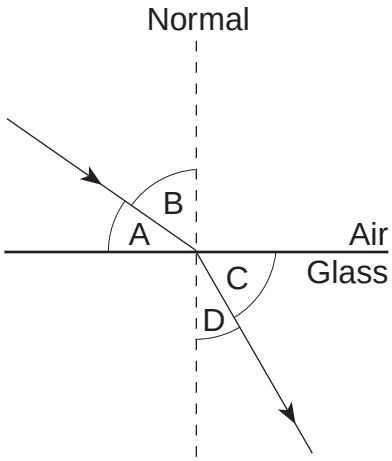
45 The diagram below shows a transverse wave moving toward the left along a rope.




At the instant shown, point *P* on the rope is moving toward the

(1) bottom of the page
(2) top of the page
(3) left of the page
(4) right of the page

46 A light ray passes from air into glass as shown in the diagram below.




Which relationship represents the index of refraction of the glass?

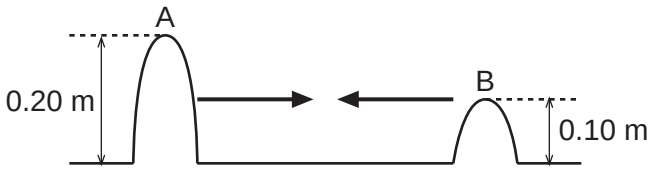
(1) $\frac{\sin A}{\sin C}$

(2) $\frac{\sin A}{\sin D}$

(3) $\frac{\sin B}{\sin C}$

(4) $\frac{\sin B}{\sin D}$

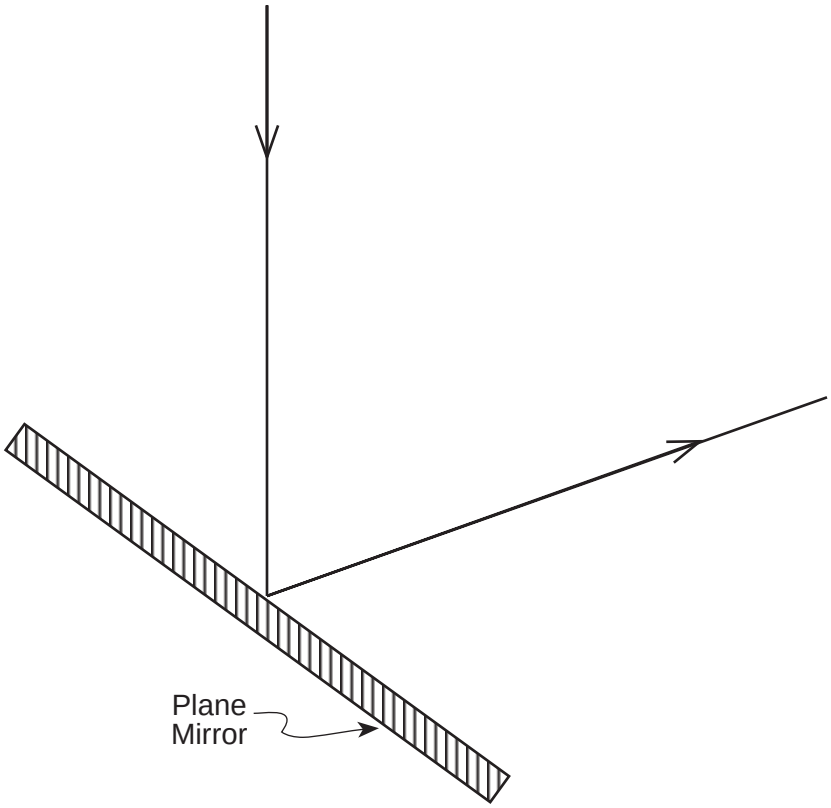
47 The diagram below shows two pulses approaching each other from opposite directions in the same medium. Pulse *A* has an amplitude of 0.20 meter and pulse *B* has an amplitude of 0.10 meter.




After the pulses have passed through each other, what will be the amplitude of each of the two pulses?

(1) $A$ = 0.10 m; $B$ = 0.20 m
(2) $A$ = 0.20 m; $B$ = 0.10 m
(3) $A$ = 0.30 m; $B$ = 0.30 m
(4) $A$ = 0.15 m; $B$ = 0.15 m

48 The diagram below shows a light ray being reflected from a plane mirror.




What is the angle of incidence?

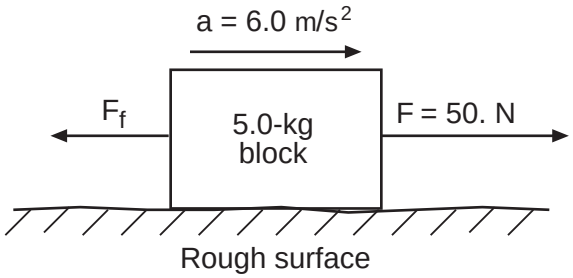
(1) 20°
(2) 35°
(3) 55°
(4) 70.°

# Part B-2

**Answer all questions in this part.**

*Directions* (49–64): Record your answers in the spaces provided in your answer booklet.

49 The diagram below shows a 5.0-kilogram block accelerating at 6.0 meters per second$^2$ along a rough horizontal surface by the application of a horizontal force, *F*, of 50. newtons.




What is the magnitude in newtons of the force of friction, $F_f$, acting on the block? [1]

Base your answers to questions 50 through 53 on the data table below, which describes the motion of an object moving in a straight line.

**Data Table**

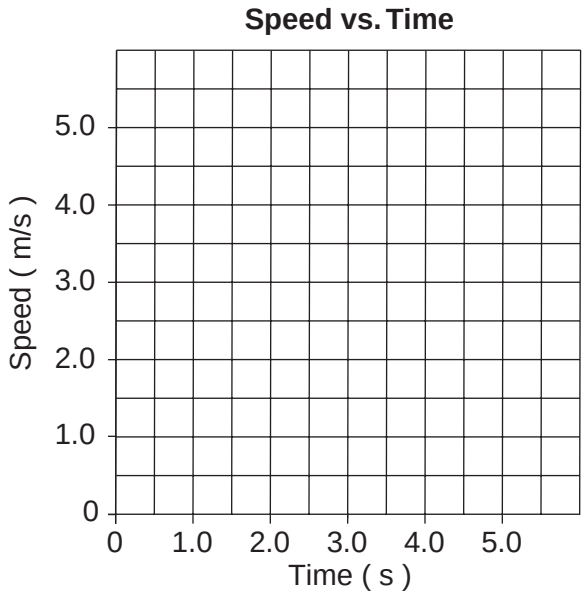
| **Time** (s) | **Speed** (m/s) |
|---|---|
| 0.0 | 0.0 |
| 1.0 | 1.2 |
| 2.0 | 2.7 |
| 3.0 | 3.3 |
| 4.0 | 5.0 |
| 5.0 | 5.6 |

*Directions* (50–53): Using the information in the data table, construct a graph on the grid provided *on your answer paper*, following the directions below. The grid below is provided for practice purposes only. Be sure your final answer appears on your answer paper.

50 Plot the data points. [1]

51 Draw the line of best-fit. [1]

52 On the same grid, sketch a line representing an object decelerating uniformly in a straight line. [1]




53 Based on your line of best-fit, what is the acceleration of the object? [1]

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

A student conducted a series of experiments to investigate the effect of mass, length, and amplitude (angle of release) on a simple pendulum. The table below shows the initial conditions for a series of trials.

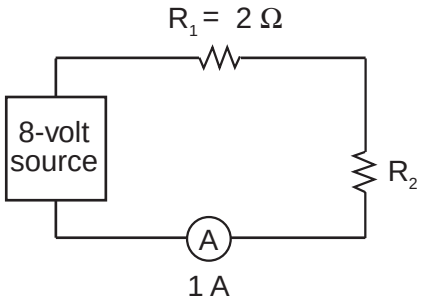
| **Trial** | **Mass** (kg) | **Length** (m) | **Angle of release** (°) |
|---|---|---|---|
| R | 2 | 3 | 10. |
| S | 3 | 2 | 15 |
| T | 3 | 2 | 10. |
| U | 1 | 3 | 10. |
| V | 3 | 2 | 5 |
| W | 2 | 2 | 15 |
| X | 2 | 1 | 15 |
| Y | 3 | 3 | 10. |
| Z | 2 | 3 | 15 |

54 Which three trials should the student use to test the effect of mass on the period of the pendulum? [1]

55 Which three trials should the student use to test the effect of length on the period of the pendulum? [1]

---

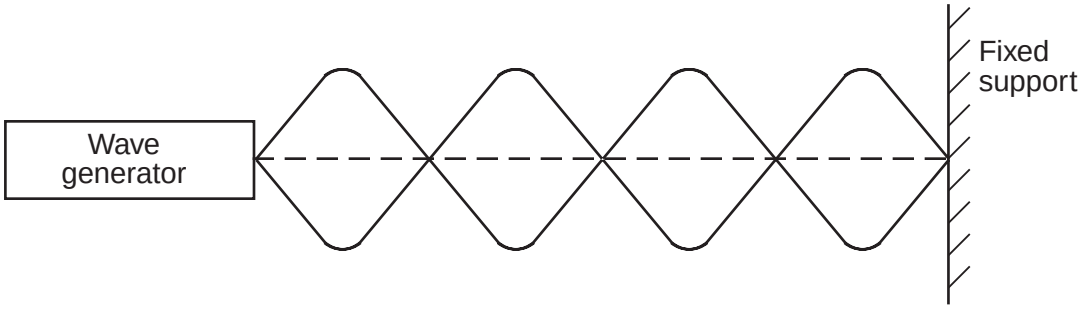
56 The circuit shown below contains two resistors, $R_1$ and $R_2$.




What is the resistance of resistor $R_2$? [1]

Base your answers to questions 57 through 60 on the information and diagram below.

A wave generator having a constant frequency of 15 hertz produces a standing wave pattern in a stretched string.




57 Using a ruler, measure the amplitude of the wave shown. Record the value to the *nearest tenth of a centimeter* on your answer paper. [1]

58 Using a ruler, measure the wavelength of the wave shown. Record the value to the *nearest tenth of a centimeter* on your answer paper. [1]

59 State what would happen to the wavelength of the wave if the frequency of the wave were increased. [1]

60 How many antinodes are shown in the diagram? [1]

---

Base your answers to questions 61 through 64 on the information below.

When an electron in an excited hydrogen atom falls from a higher to a lower energy level, a photon having a wavelength of $6.58 \times 10^{-7}$ meter is emitted.

61 Calculate the energy of a photon of this light wave in joules. [Show all calculations, including the equation and substitution with units.] [2]

62 Convert the energy of the photon to electronvolts. [1]

63 Determine which *two* energy levels the electron has fallen between to emit this photon. [1]

64 Is this photon an x-ray photon? Justify your answer. [1]

---

# Part C

**Answer all questions in this part.**

*Directions* (65–74): Record your answers in the spaces provided in your answer booklet.

65 Four small metal spheres *R*, *S*, *T*, and *U* on insulating stands act on each other by means of electrostatic forces.

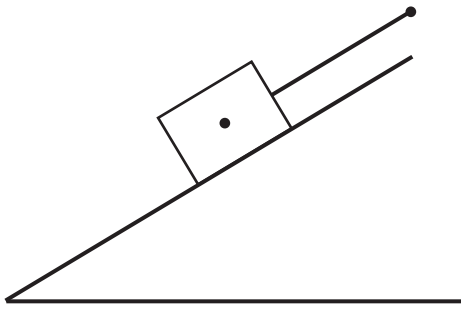
It was known that sphere *S* is negatively charged. The following observations were made:

- Sphere *S* attracts all the other spheres.
- Spheres *T* and *U* repel each other.
- Sphere *R* attracts all the other spheres.

Determine the charge on each sphere and complete the table *on your answer paper* noting for each sphere if it is positive (+), negative (–), or neutral (0). The chart below is provided for practice purposes only. Be sure your final answer appears *on your answer paper*. [3]

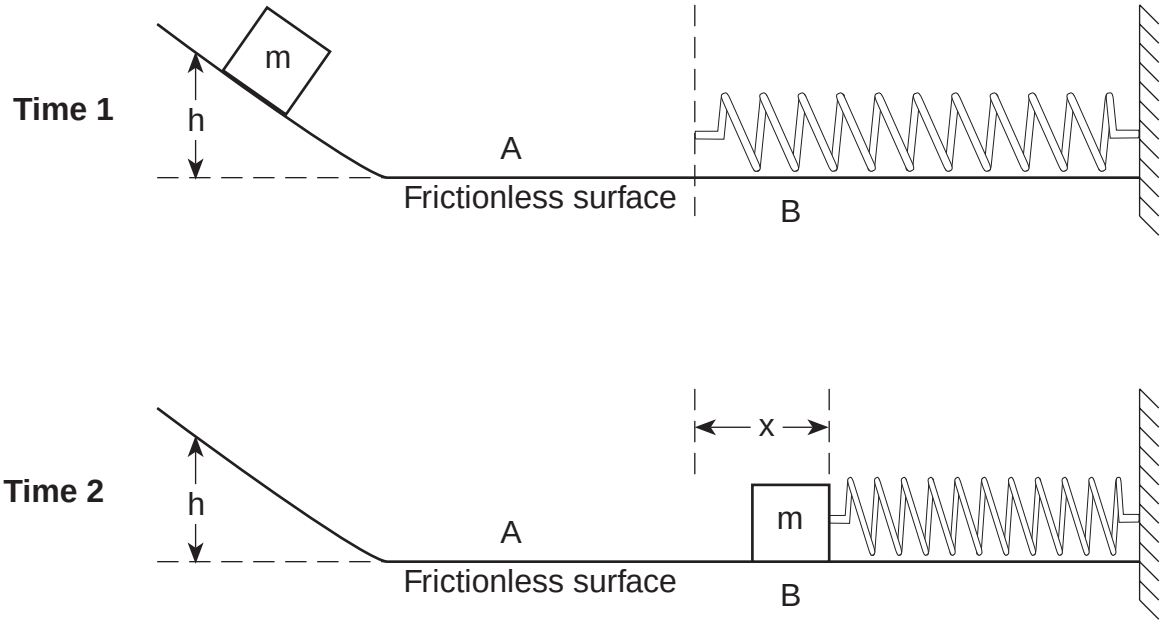
| Sphere | Charge |
|---|---|
| R | |
| T | |
| U | |

66 A box of mass *m* is held motionless on a frictionless inclined plane by a rope that is parallel to the surface of the plane. On the diagram provided *on your answer paper*, draw and label all of the force vectors acting on the box. The diagram below is provided for practice purposes only. Be sure your final answer appears *on your answer paper*. [3]



Base your answers to questions 67 and 68 on the information and diagram below.

A block of mass *m* starts from rest at height *h* on a frictionless incline. The block slides down the incline across a frictionless level surface and comes to rest by compressing a spring through distance x, as shown in the diagram below.




67 Name the forms of mechanical energy possessed by the system when the block is in position *A* and in position *B*. [2]

68 Determine the spring constant, *k*, in terms of *g*, *h*, *m*, and *x*. [Show all work including formulas and an algebraic solution for *k*.] [2]

Base your answers to questions 69 through 71 on the information below.

You are given a 12-volt battery, ammeter *A*, voltmeter *V*, resistor $R_1$, and resistor $R_2$
Resistor $R_2$ has a value of 3.0 ohms.

69 Using appropriate symbols from the *Reference Tables for Physical Setting/Physics*, draw and label a complete circuit showing:

- resistors $R_1$ and $R_2$ connected in parallel with the battery [1]
- the ammeter connected to measure the current through resistor $R_1$, only [1]
- the voltmeter connected to measure the potential drop across resistor $R_1$ [1]

70 If the total current in the circuit is 6.0 amperes, determine the equivalent resistance of the circuit. [1]

71 If the total current in the circuit is 6.0 amperes, determine the resistance of resistor $R_1$. [Show all calculations, including the equation and substitution with units.] [2]

Base your answers to questions 72 through 74 on the passage below and on your knowledge of physics.

**Forces of Nature**

Our understanding of the fundamental forces has evolved along with our growing knowledge of the particles of matter. Many everyday phenomena seemed to be governed by a long list of unique forces. Observations identified the gravitational, electric, and magnetic forces as distinct. A large step toward simplification came in the mid-19th century with Maxwell's unification of the electric and magnetic forces into a single electromagnetic force. Fifty years later came the recognition that the electromagnetic force also governed atoms. By the late 1800s, all commonly observed phenomena could be understood with only the electromagnetic and gravitational forces.

*Particle Physics–Perspectives and Opportunities (*adapted)

A hydrogen atom, consisting of an electron in orbit about a proton, has an approximate radius of $10^{-10}$ meter.

72 Determine the order of magnitude of the electrostatic force between the electron and the proton. [1]

73 Determine the order of magnitude of the gravitational force between the electron and the proton. [1]

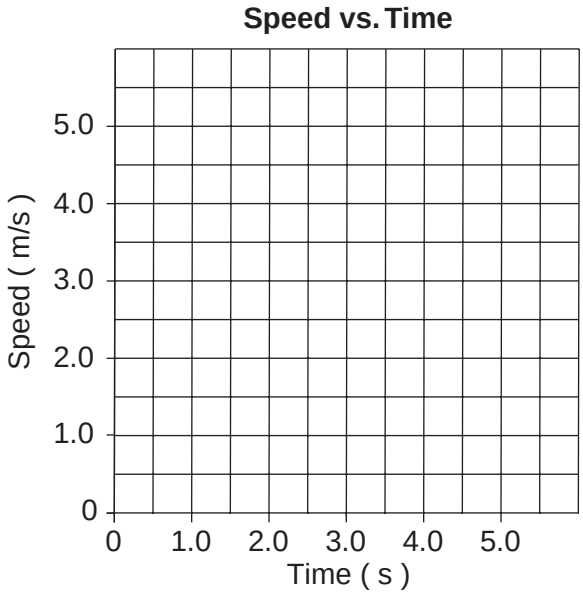
74 In the above passage there is an apparent contradiction. The author stated that "the electromagnetic force also governed atoms." He concluded with "all commonly observed phenomena could be understood with only the electromagnetic and gravitational forces."

Use your responses to questions 72 and 73 to explain why the gravitational interaction is negligible for the hydrogen atom. [2]

**Sample Answer Paper**
**Part B – 2**

49 _____ N

50 - 52




53 _____

54 _____

55 _____

56 _____ v

57 _____ cm

58 _____ cm

59 _____

_____

_____

60 _____

61

62 _____ eV

63 _____

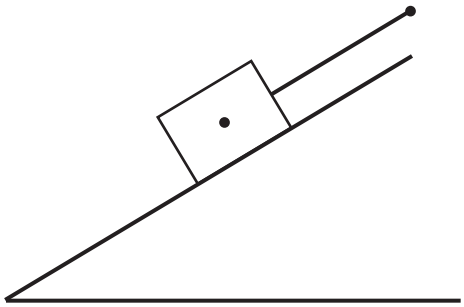
64 _____

**Sample Answer Paper**
**Part C**

65

| Sphere | Charge |
|---|---|
| R | |
| T | |
| U | |

66



67 Position A: _____

Position B: _____

68

69

70 _____ V

71

72 _____ N

73 _____ N

74 _____

_____

_____