The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, June 17, 1997 — 1:15 to 4:15 p.m., only

The answer paper is stapled in the center of this examination booklet. Open the examination booklet, carefully remove the answer paper, and close the examination booklet. Then fill in the heading on your answer paper.

All of your answers are to be recorded on the separate answer paper. For each question in Part I and Part II, decide which of the choices given is the best answer. Then on the answer paper, in the row of numbers for that question, circle with pencil the number of the choice that you have selected. The sample below is an example of the first step in recording your answers.

SAMPLE: (1) 2 3 4

If you wish to change an answer, erase your first penciled circle and then circle with pencil the number of the answer you want. After you have completed the examination and you have decided that all of the circled answers represent your best judgment, signal a proctor and turn in all examination material except your answer paper. Then and only then, place an X in ink in each penciled circle. Be sure to mark only one answer with an X in ink for each question. No credit will be given for any question with two or more X's marked. The sample below indicates how your final choice should be marked with an X in ink.

SAMPLE: ⊗ 2 3 4

For questions in Part III, record your answers in accordance with the directions given in the examination booklet.

The *Reference Tables for Physics*, which you may need to answer some questions in this examination, are supplied separately. Be certain you have a copy of these reference tables before you begin the examination.

When you have completed the examination, you must sign the statement printed at the end of the answer paper, 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 paper cannot be accepted if you fail to sign this declaration.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Part I

Answer all 55 questions in this part. [65]

Directions (1–55): 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 paper in accordance with the directions on the front page of this booklet.

1 What is the total displacement of a student who walks 3 blocks east, 2 blocks north, 1 block west, and then 2 blocks south?

(1) 0
(2) 2 blocks east
(3) 2 blocks west
(4) 8 blocks

2 A baseball pitcher throws a fastball at 42 meters per second. If the batter is 18 meters from the pitcher, approximately how much time does it take for the ball to reach the batter?

(1) 1.9 s
(2) 2.3 s
(3) 0.86 s
(4) 0.43 s

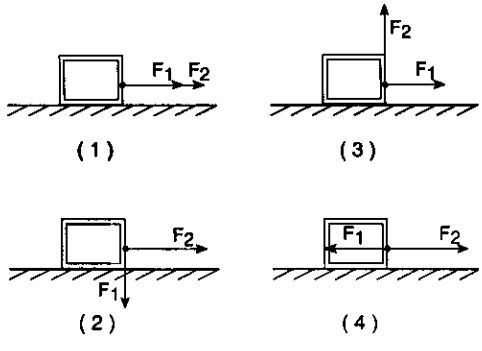
3 The length of a high school physics classroom is probably closest to

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

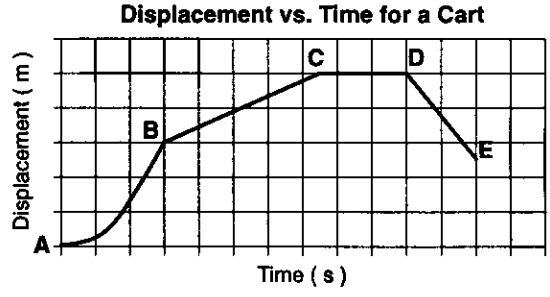
4 A stone is dropped from a bridge 45 meters above the surface of a river. Approximately how many seconds does the stone take to reach the water's surface?

(1) 1.0 s
(2) 10. s
(3) 3.0 s
(4) 22 s

5 A 150.-newton force, F_1, and a 200.-newton force, F_2, are applied simultaneously to the same point on a large crate resting on a frictionless, horizontal surface. Which diagram shows the forces positioned to give the crate the greatest acceleration?



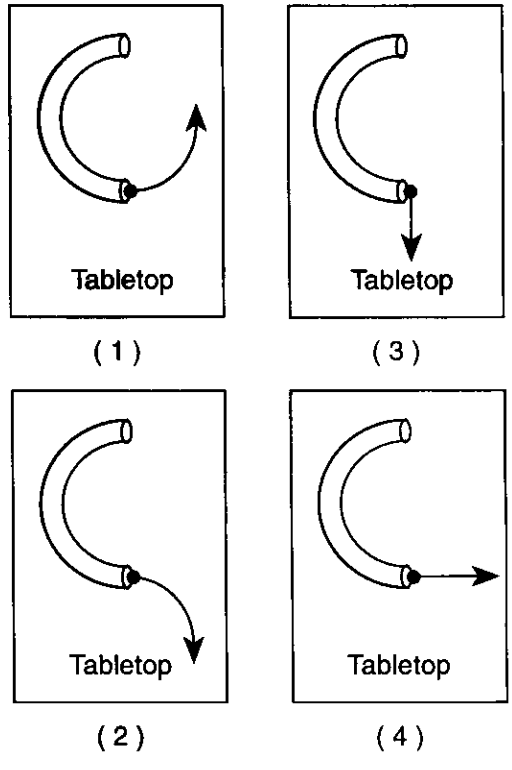
6 The displacement-time graph below represents the motion of a cart along a straight line.



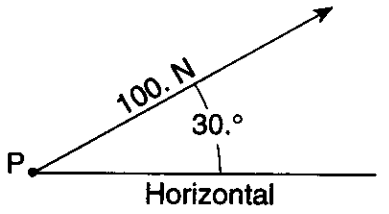
During which interval was the cart accelerating?

(1) *AB*
(2) *BC*
(3) *CD*
(4) *DE*

7 A ball rolls through a hollow semicircular tube lying flat on a horizontal tabletop. Which diagram best shows the path of the ball after emerging from the tube, as viewed from above?



8 A 100.-newton force acts on point P, as shown in the diagram below.



The magnitude of the vertical component of this force is approximately

(1) 30. N
(2) 50. N
(3) 71 N
(4) 87 N

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

A 1,000-kilogram car traveling with a velocity of +20. meters per second decelerates uniformly at –5.0 meters per second^2 until it comes to rest.

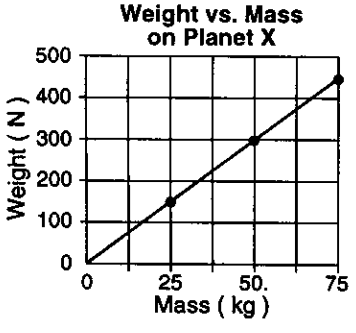
9 What is the total distance the car travels as it decelerates to rest?

(1) 10. m
(2) 20. m
(3) 40. m
(4) 80. m

10 What is the magnitude of the impulse applied to the car to bring it to rest?

(1) 1.0×10^4 N•s
(2) 2.0×10^4 N•s
(3) 3.9×10^4 N•s
(4) 4.3×10^4 N•s

11 The graph below shows the weight of three objects on planet X as a function of their mass.



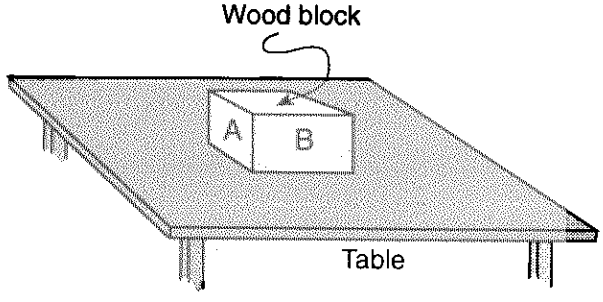
The acceleration due to gravity on planet X is approximately

(1) 0.17 m/s^2
(2) 6.0 m/s^2
(3) 9.8 m/s^2
(4) 50. m/s^2

12 What is the magnitude of the net force acting on a 2.0×10^3-kilogram car as it accelerates from rest to a speed of 15 meters per second in 5.0 seconds?

(1) 6.0×10^3 N
(2) 2.0×10^4 N
(3) 3.0×10^4 N
(4) 6.0×10^4 N

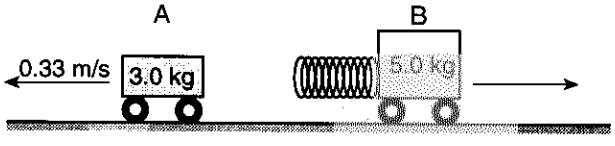
13 In the diagram below, surface B of the wooden block has the same texture as surface A, but twice the area of surface A.



If force F is required to slide the block at constant speed across the table on surface A, approximately what force is required to slide the block at constant speed across the table on surface B?

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

14 The diagram below shows two carts on a horizontal, frictionless surface being pushed apart when a compressed spring attached to one of the carts is released. Cart A has a mass of 3.0 kilograms and cart B has a mass of 5.0 kilograms. The speed of cart A is 0.33 meter per second after the spring is released.



If the carts are initially at rest, what is the approximate speed of cart B after the spring is released?

(1) 0.12 m/s
(2) 0.20 m/s
(3) 0.33 m/s
(4) 0.55 m/s

15 The magnitude of the gravitational force of attraction between Earth and the Moon is approximately

(1) 2.1×10^{20} N
(2) 6.0×10^{24} N
(3) 6.7×10^{-11} N
(4) 7.8×10^{28} N

16 How much work is done on a downhill skier by an average braking force of 9.8×10^2 newtons to stop her in a distance of 10. meters?

(1) 1.0×10^1 J
(2) 9.8×10^1 J
(3) 1.0×10^3 J
(4) 9.8×10^3 J

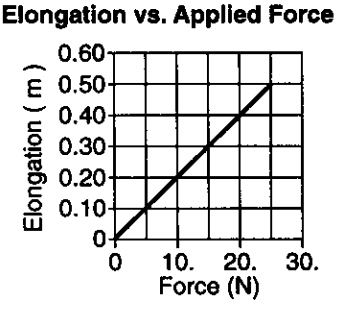
17 Which variable expression is paired with a corresponding unit?

(1) $\frac{\text{mass} \cdot \text{distance}}{\text{time}}$ and watt
(2) $\frac{\text{mass} \cdot \text{distance}^2}{\text{time}}$ and watt
(3) $\frac{\text{mass} \cdot \text{distance}^2}{\text{time}^2}$ and joule
(4) $\frac{\text{mass} \cdot \text{distance}}{\text{time}^3}$ and joule

18 A spring has a spring constant of 120 newtons per meter. How much potential energy is stored in the spring as it is stretched 0.20 meter?

(1) 2.4 J
(2) 4.8 J
(3) 12 J
(4) 24 J

19 The graph below shows the relationship between the elongation of a spring and the force applied to the spring causing it to stretch.



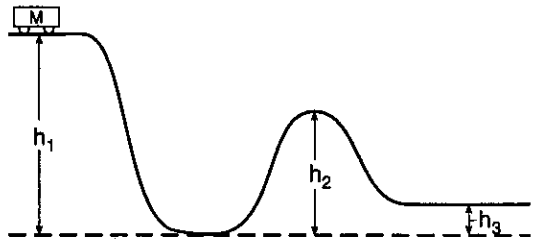
What is the spring constant for this spring?

(1) 0.020 N/m
(2) 2.0 N/m
(3) 25 N/m
(4) 50. N/m

20 A motor having a maximum power rating of 8.1×10^4 watts is used to operate an elevator with a weight of 1.8×10^4 newtons. What is the maximum weight this motor can lift at an average speed of 3.0 meters per second?

(1) 6.0×10^3 N
(2) 1.8×10^4 N
(3) 2.4×10^4 N
(4) 2.7×10^4 N

21 A cart of mass M on a frictionless track starts from rest at the top of a hill having height h_1, as shown in the diagram below.



What is the kinetic energy of the cart when it reaches the top of the next hill, having height h_2?

(1) Mgh_1
(2) $Mg(h_1 - h_2)$
(3) $Mg(h_2 - h_3)$
(4) 0

22 When a plastic rod is rubbed with wool, the wool acquires a positive charge because

1 electrons are transferred from the wool to the rod
2 protons are transferred from the wool to the rod
3 electrons are transferred from the rod to the wool
4 protons are transferred from the rod to the wool

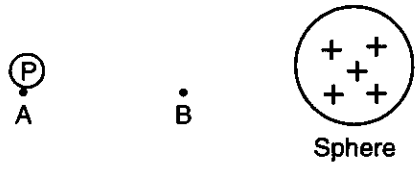
23 Three identical metal spheres are mounted on insulating stands. Initially, sphere A has a net charge of q and spheres B and C are uncharged. Sphere A is touched to sphere B and removed. Then sphere A is touched to sphere C and removed. What is the final charge on sphere A?

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

24 A distance of 1.0×10^3 meters separates the charge at the bottom of a cloud and the ground. The electric field intensity between the bottom of the cloud and the ground is 2.0×10^4 newtons per coulomb. What is the potential difference between the bottom of the cloud and the ground?

(1) 1.3×10^{23} V
(2) 2.0×10^{1} V
(3) 2.0×10^{7} V
(4) 5.0×10^{-2} V

25 The diagram below shows proton *P* located at point *A* near a positively charged sphere.



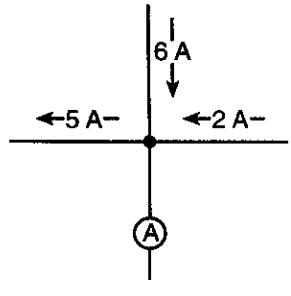
If 6.4×10^{-19} joule of work is required to move the proton from point *A* to point *B*, the potential difference between *A* and *B* is

(1) 6.4×10^{-19} V
(2) 4.0×10^{-19} V
(3) 6.4 V
(4) 4.0 V

26 What is the net static electric charge on a metal sphere having an excess of +3 elementary charges?

(1) 1.6×10^{-19} C
(2) 4.8×10^{-19} C
(3) 3.0×10^{0} C
(4) 4.8×10^{19} C

27 The diagram below shows currents in a segment of an electric circuit.



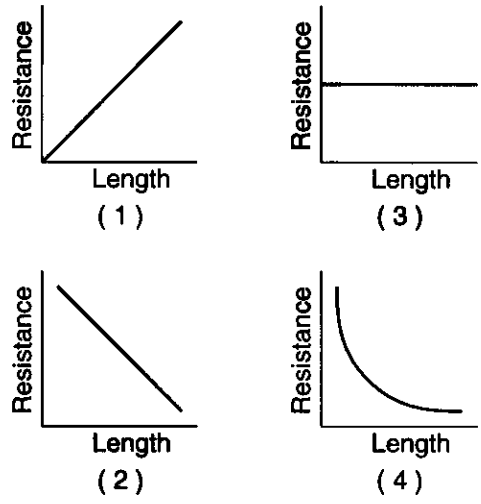
What is the reading of ammeter *A*?

(1) 8 A
(2) 2 A
(3) 3 A
(4) 13 A

28 An operating lamp draws a current of 0.50 ampere. The amount of charge passing through the lamp in 10. seconds is

(1) 0.050 C
(2) 2.0 C
(3) 5.0 C
(4) 20. C

29 Which graph best represents the relationship between the resistance of a copper wire of uniform cross-sectional area and the wire's length at constant temperature?



30 Which is a vector quantity?

1 electric charge
2 electrical resistance
3 electrical potential difference
4 electric field intensity

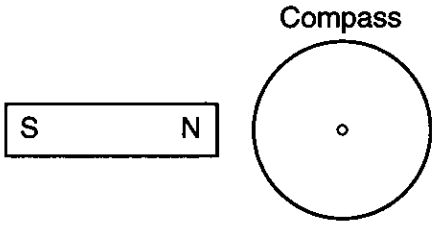
31 To increase the brightness of a desk lamp, a student replaces a 60-watt light bulb with a 100-watt bulb. Compared to the 60-watt bulb, the 100-watt bulb has

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

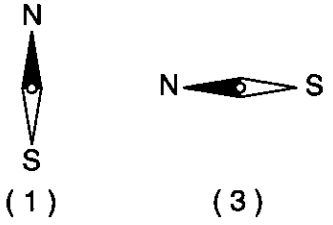
32 An electric dryer consumes 6.0×10^6 joules of energy when operating at 220 volts for 30. minutes (1800 seconds). During operation, the dryer draws a current of approximately

(1) 10. A
(2) 15 A
(3) 20. A
(4) 25 A

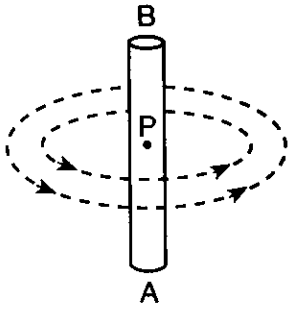
33 The diagram below shows a compass placed near the north pole, *N*, of a bar magnet.



Which diagram best represents the position of the needle of the compass as it responds to the magnetic field of the bar magnet?



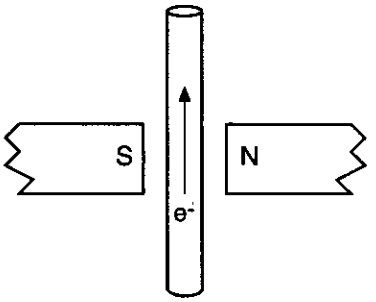
34 The diagram below represents the magnetic field around point *P*, at the center of a current-carrying wire.



What is the direction of electron flow in the wire?

1 from *A* to *B*
2 from *B* to *A*
3 from *P* into the page
4 from *P* out of the page

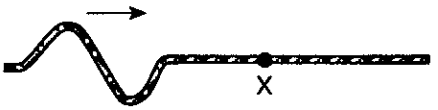
35 The diagram below represents a straight conductor between the poles of a permanent magnet.



If electrons flow within the conductor in the direction shown, then the magnetic force on the conductor is directed

1 toward *N*
2 toward *S*
3 into the page
4 out of the page

36 The diagram below shows a transverse wave moving to the right along a rope.



As the wave passes point *X*, the motion of *X* will be

1 up, then down
2 down, then up
3 left, then right
4 in a circle

37 The frequency of a light wave is 5.0×10^{14} hertz. What is the period of the wave?

(1) 1.7×10^{6} s
(2) 2.0×10^{-15} s
(3) 6.0×10^{-7} s
(4) 5.0×10^{-14} s

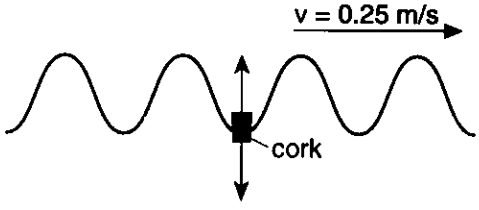
38 The amplitude of a sound wave is to its loudness as the amplitude of a light wave is to its

1 brightness
2 frequency
3 color
4 speed

39 The speed of light in glycerol is approximately

(1) 1.0×10^{7} m/s
(2) 2.0×10^{8} m/s
(3) 3.0×10^{8} m/s
(4) 4.4×10^{8} m/s

40 In the diagram below, a water wave having a speed of 0.25 meter per second causes a cork to move up and down 4.0 times in 8.0 seconds.



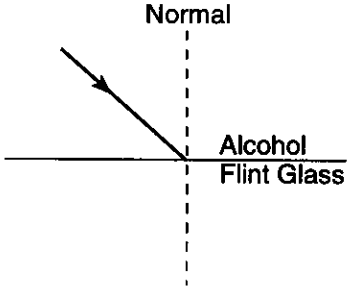
What is the wavelength of the water wave?

(1) 1.0 m
(2) 2.0 m
(3) 8.0 m
(4) 0.50 m

41 The driver of a car sounds the horn while traveling toward a stationary person. Compared to the sound of the horn heard by the driver, the sound heard by the stationary person has

1 lower pitch and shorter wavelength
2 lower pitch and longer wavelength
3 higher pitch and shorter wavelength
4 higher pitch and longer wavelength

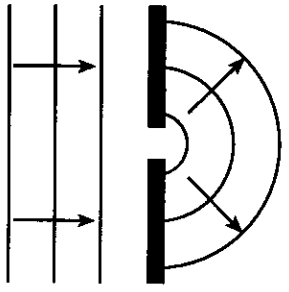
42 The diagram below shows a ray of monochromatic light incident on an alcohol-flint glass interface.



What occurs as the light travels from alcohol into flint glass?

1 The speed of the light decreases and the ray bends toward the normal.
2 The speed of the light decreases and the ray bends away from the normal.
3 The speed of the light increases and the ray bends toward the normal.
4 The speed of the light increases and the ray bends away from the normal.

43 The diagram below shows straight wave fronts passing through an opening in a barrier



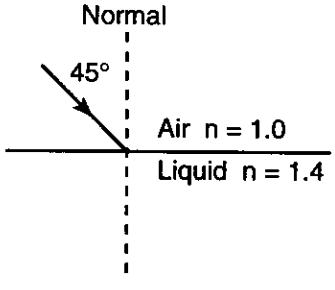
This wave phenomenon is called

1 reflection
2 refraction
3 polarization
4 diffraction

44 The absolute index of refraction for a substance is 2.0 for light having a wavelength of 5.9×10^{-7} meter. In this substance, what is the critical angle for light incident on a boundary with air?

(1) 30.°
(2) 45°
(3) 60.°
(4) 90.°

45 A ray of monochromatic light ($\lambda = 5.9 \times 10^{-7}$ meter) traveling in air is incident on an interface with a liquid at an angle of 45°, as shown in the diagram below.



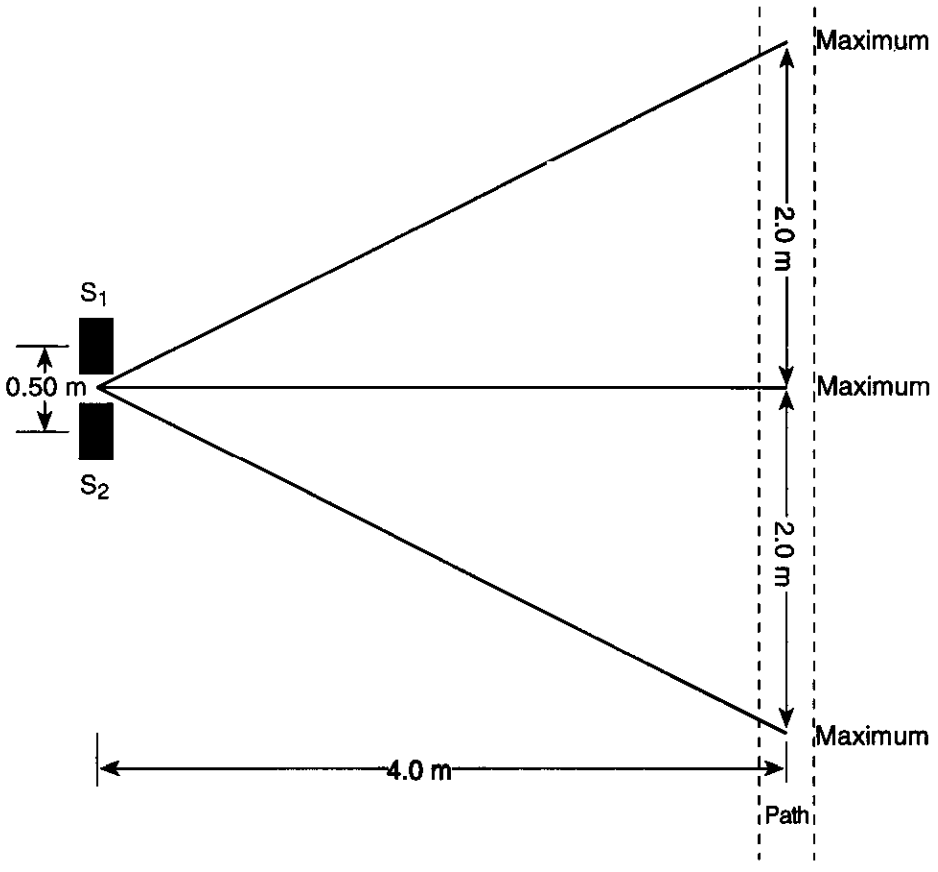
If the absolute index of refraction of the liquid is 1.4, the angle of refraction for the light ray is closest to

(1) 10.°
(2) 20.°
(3) 30.°
(4) 40.°

46 Which phenomenon can occur with light, but *not* with sound?

1 interference
2 polarization
3 refraction
4 the Doppler effect

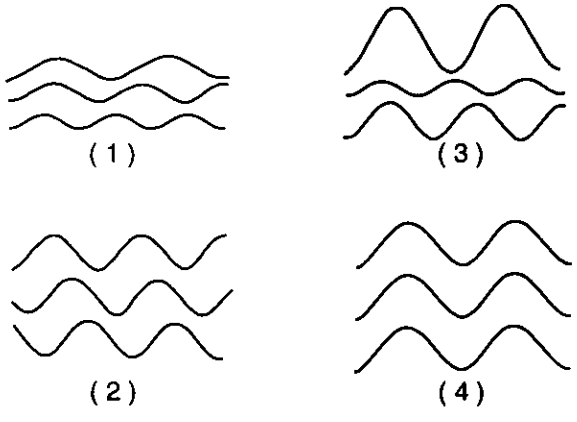
47 As shown in the diagram below, speakers S_1 and S_2, separated by a distance of 0.50 meter, are producing sound of the same constant frequency. A person walking along a path 4.0 meters in front of the speakers hears the sound reach a maximum intensity every 2.0 meters.



What is the wavelength of the sound produced by the speakers?

(1) 1.0 m
(2) 0.063 m
(3) 0.25 m
(4) 4.0 m

48 Which diagram best represents light emitted from a coherent light source?



49 When 8.0-electronvolt photons strike a photoemissive surface, the maximum kinetic energy of ejected photoelectrons is 6.0 electronvolts. The work function of the photoemissive surface is

(1) 0.0 eV
(2) 2.0 eV
(3) 7.0 eV
(4) 14.0 eV

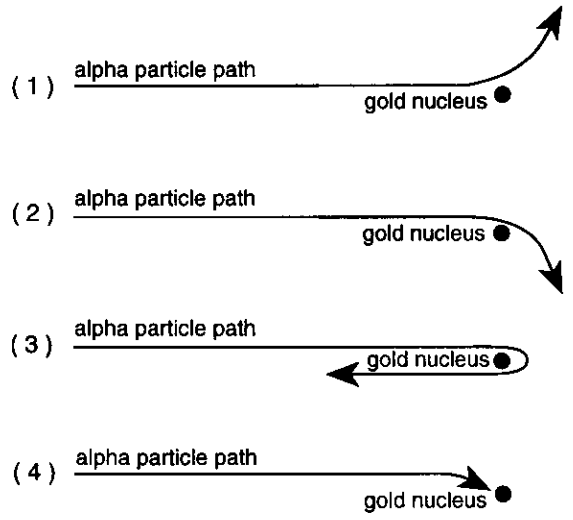
50 If the momentum of a particle is 1.8×10^{-22} kilogram-meter per second, its matter wavelength is approximately

(1) 1.2×10^{-55} m
(2) 2.7×10^{11} m
(3) 3.7×10^{-12} m
(4) 5.0×10^{-7} m

51 The threshold frequency of a photoemissive surface is 7.1×10^{14} hertz. Which electromagnetic radiation, incident upon the surface, will produce the greatest amount of current?

1 low-intensity infrared radiation
2 high-intensity infrared radiation
3 low-intensity ultraviolet radiation
4 high-intensity ultraviolet radiation

52 Which diagram shows a possible path of an alpha particle as it passes very near the nucleus of a gold atom?



53 A hydrogen atom could have an electron energy-level transition from $n = 2$ to $n = 3$ by absorbing a photon having an energy of

(1) 1.51 eV
(2) 1.89 eV
(3) 4.91 eV
(4) 10.20 eV

Note that questions 54 and 55 have only three choices.

54 A bicyclist accelerates from rest to a speed of 5.0 meters per second in 10. seconds. During the same 10. seconds, a car accelerates from a speed of 22 meters per second to a speed of 27 meters per second. Compared to the acceleration of the bicycle, the acceleration of the car is

1 less
2 greater
3 the same

55 A student drops two eggs of equal mass simultaneously from the same height. Egg *A* lands on the tile floor and breaks. Egg *B* lands intact, without bouncing, on a foam pad lying on the floor. Compared to the magnitude of the impulse on egg *A* as it lands, the magnitude of the impulse on egg *B* as it lands is

1 less
2 greater
3 the same

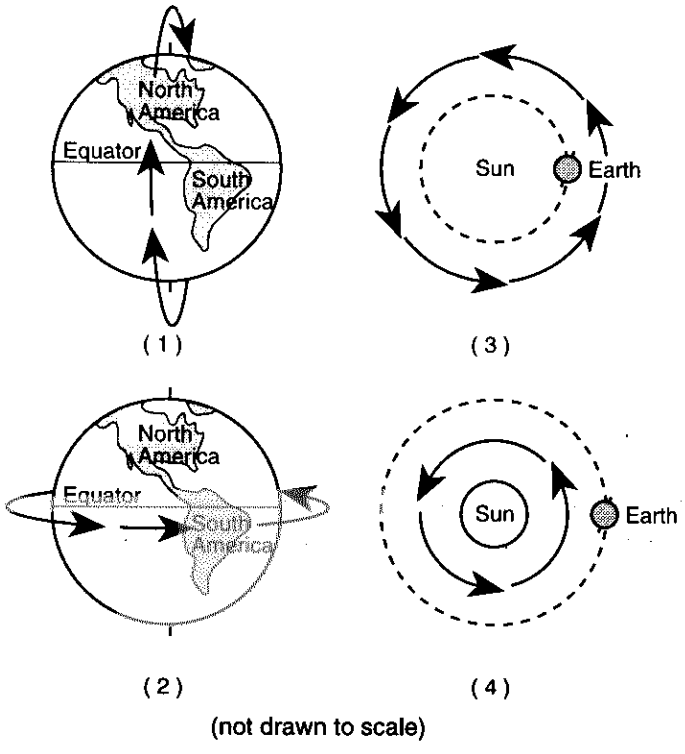
Part II

This part consists of six groups, each containing ten questions. Each group tests an optional area of the course. Choose two of these six groups. Be sure that you answer all ten questions in each group chosen. Record the answers to the questions in accordance with the directions on the front page of this booklet. [20]

Group 1 — Motion in a Plane

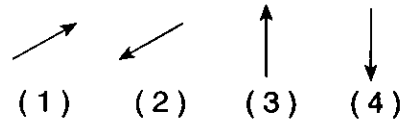
If you choose this group, be sure to answer questions 56–65.

56 In which diagram do the arrows best represent the path of a satellite in a geosynchronous orbit?



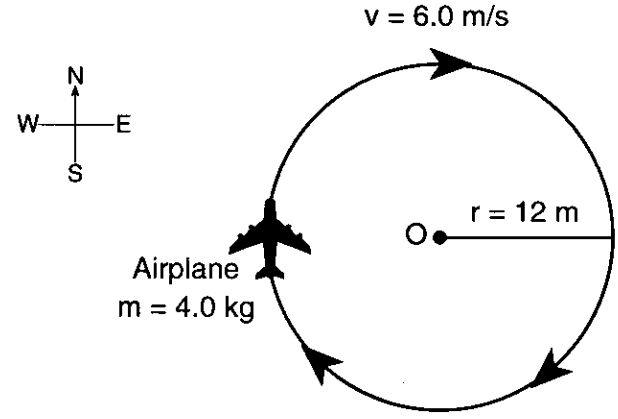
(not drawn to scale)

57 A soccer ball travels the path shown in the diagram at the right. Which vector best represents the direction of the force of air friction on the ball at point *P*?



Base your answers to questions 58 through 60 on the information and diagram below.

A 4.0-kilogram model airplane travels in a horizontal circular path of radius 12 meters at a constant speed of 6.0 meters per second.



58 At the position shown, what is the direction of the net force acting on the airplane?

1 north
2 south
3 east
4 west

59 What is the magnitude of the centripetal acceleration of the airplane?

(1) 0.50 m/s^2
(2) 2.0 m/s^2
(3) 3.0 m/s^2
(4) 12 m/s^2

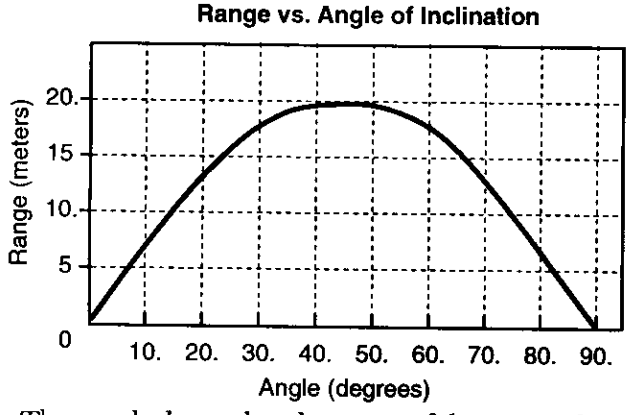
60 If the speed of the airplane is doubled and the radius of the path remains unchanged, the magnitude of the centripetal force acting on the airplane will be

1 half as much
2 twice as much
3 one-fourth as much
4 four times as much

61 A baseball player throws a baseball at a speed of 40. meters per second at an angle of 30.° to the ground. The horizontal component of the baseball's speed is approximately

(1) 15 m/s
(2) 20. m/s
(3) 30. m/s
(4) 35 m/s

62 Projectiles are fired from different angles with the same initial speed of 14 meters per second. The graph below shows the range of the projectiles as a function of the original angle of inclination to the ground, neglecting air resistance.



The graph shows that the range of the projectiles is

1 the same for all angles
2 the same for angles of 20.° and 80.°
3 greatest for an angle of 45°
4 greatest for an angle of 90.°

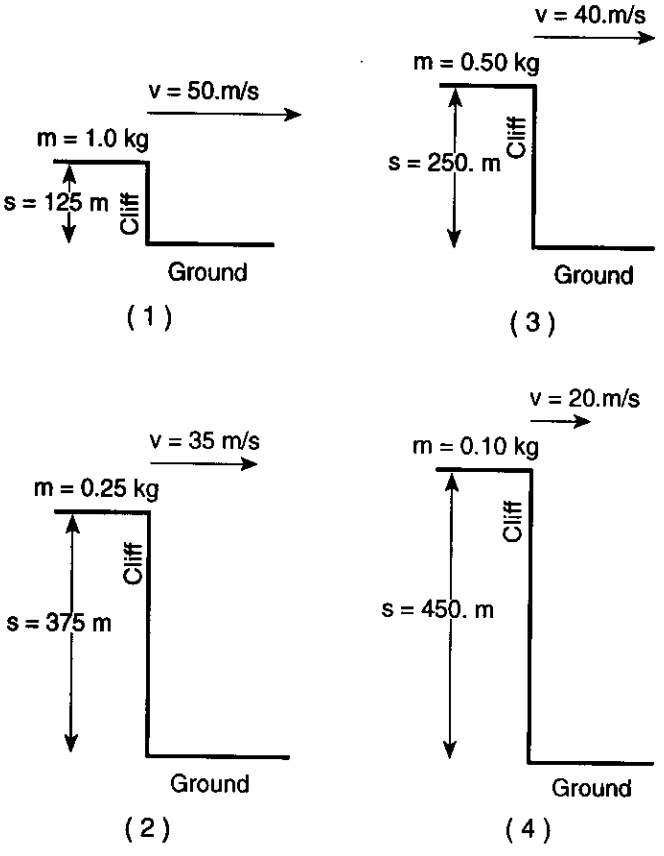
63 The data table below gives the mean radius of orbit (R) and the period (T) of some planets orbiting the Sun

Planet	Mean Radius of Orbit (R) ($\times 10^6$ kilometers)	Orbital Period (T) (days)
Mercury	58	88
Venus	108	225
Earth	150.	365
Mars	228	687

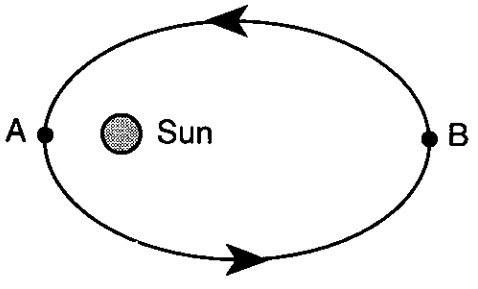
Which ratio is constant for these planets?

(1) $\frac{R}{T}$
(2) $\frac{R^2}{T}$
(3) $\frac{R^2}{T^2}$
(4) $\frac{R^3}{T^2}$

64 Four different balls are thrown horizontally off the top of four cliffs. In which diagram does the ball have the shortest time of flight?



65 The diagram below represents the path of a planet in an elliptical orbit around the Sun.



As the planet moves from point A to point B, what changes occur in its speed and kinetic energy?

1 Both speed and kinetic energy decrease.
2 Both speed and kinetic energy increase.
3 Speed decreases and kinetic energy increases.
4 Speed increases and kinetic energy decreases.

Group 2 — Internal Energy

If you choose this group, be sure to answer questions 66–75.

66 What is the boiling point of water at standard pressure on the Kelvin scale?

(1) 100. K
(2) 212 K
(3) 273 K
(4) 373 K

67 Two solid metal blocks are placed in an insulated container. If there is a net flow of heat between the blocks, they must have different

1 initial temperatures
2 melting points
3 specific heats
4 heats of fusion

68 Samples of lead, platinum, silver, and tungsten each have a mass of 1.0 kilogram and an initial temperature of 20.°C. If 10. kilojoules of heat is added to each sample, which sample will experience the smallest increase in temperature?

1 lead, because it has the lowest heat of fusion
2 platinum, because it has the lowest heat of vaporization
3 silver, because it has the highest specific heat
4 tungsten, because it has the highest melting point

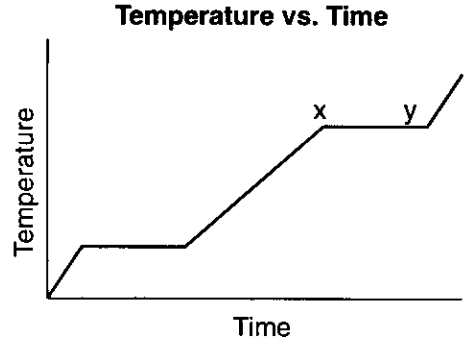
69 When Juliann drinks cold water, her body warms the water until thermal equilibrium is reached. If she drinks 6 glasses (2.5 kilograms) of water at 0°C in a day, approximately how much energy must her body expend to raise the temperature of this water to her body's temperature of 37°C?

(1) 190 kJ
(2) 390 kJ
(3) 840 kJ
(4) 2300 kJ

70 Which statement is consistent with the kinetic theory of ideal gases?

1 Molecules are always stationary.
2 The force of attraction between molecules is large.
3 Molecules transfer energy through collisions.
4 The size of molecules is large compared to the distance that separates them.

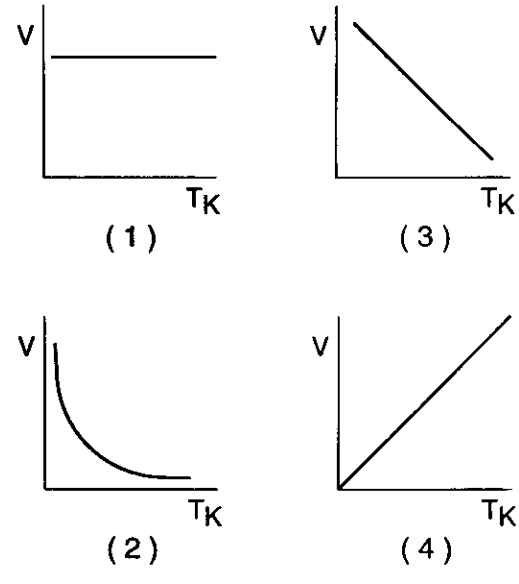
71 The graph below shows temperature versus time for 1.0 kilogram of unknown material as heat is added at a constant rate.



During interval *xy*, the material experiences

1 a decrease in internal energy and a phase change
2 an increase in internal energy and a phase change
3 no change in internal energy and a phase change
4 no change in internal energy and no phase change

72 Which graph best represents the relationship between volume (V) and absolute temperature (T_K) for a fixed mass of an ideal gas at constant pressure?



73 How much heat must be removed from 0.50 kilogram of mercury at –39°C to change it from a liquid to a solid?

(1) 1.1 kJ
(2) 5.5 kJ
(3) 150 kJ
(4) 180 kJ

74 Which phase change represents a decrease in entropy?

1 solid to gas
2 solid to liquid
3 gas to liquid
4 liquid to gas

Note that question 75 has only three choices.

75 In an operating automobile, the pressure on the coolant in the radiator is greater than 1.0 atmosphere and its temperature is above 100.°C. If the radiator's pressure cap is removed, the pressure of the coolant is lowered to 1.0 atmosphere. causing the boiling point of the coolant to

1 decrease
2 increase
3 remain the same

Group 3 — Electromagnetic Applications

If you choose this group, be sure to answer questions 76–85.

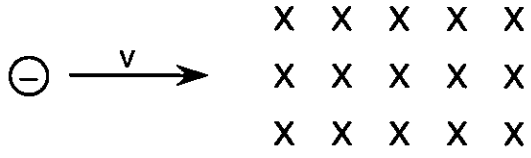
76 A high resistance is connected in series with the internal coil of a galvanometer to make

1 a motor
2 an ammeter
3 a voltmeter
4 a generator

77 A student uses a voltmeter to measure the potential difference across a circuit resistor. To obtain a correct reading, the student must connect the voltmeter

1 in parallel with the circuit resistor
2 in series with the circuit resistor
3 before connecting the other circuit components
4 after connecting the other circuit components

Base your answers to questions 78 and 79 on the diagram below which represents an electron moving with speed v to the right and about to enter a uniform magnetic field acting into the page.



78 Upon entering the magnetic field, the electron will be deflected

1 into the page
2 out of the page
3 toward the top of the page
4 toward the bottom of the page

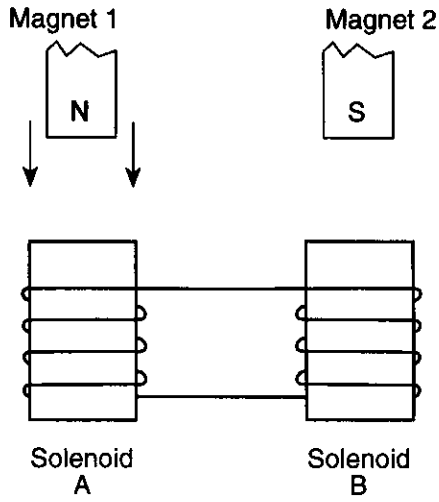
79 If the speed of the electron is 3.0×10^3 meters per second and the magnitude of the magnetic field is 3.0×10^{-5} tesla, the magnitude of the magnetic force on the electron is approximately

(1) 4.8×10^{-24} N
(2) 1.4×10^{-20} N
(3) 4.8×10^{-16} N
(4) 9.0×10^{-2} N

80 In a transformer, two coils of wire are wound around a common iron core. To operate properly, the transformer requires

1 an alternating-current source connected to the primary coil
2 a direct-current source connected to the secondary coil
3 more turns in the primary coil than in the secondary coil
4 more turns in the secondary coil than in the primary coil

81 Two hollow-core solenoids, *A* and *B*, are connected by a wire, as shown in the diagram below. Two bar magnets, 1 and 2, are suspended just above the solenoids.



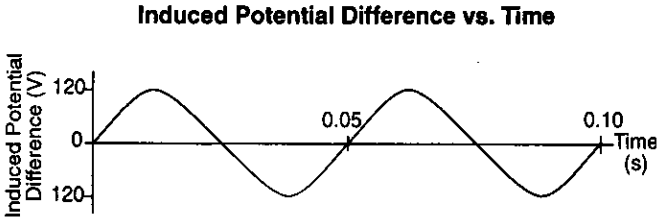
If the north pole of magnet 1 is dropped through solenoid *A*, the south pole of magnet 2 will simultaneously be

1 attracted by a magnetic force toward solenoid *B*
2 repelled by a magnetic force away from solenoid *B*
3 repelled by an electric force away from solenoid *B*
4 unaffected by solenoid *B*

82 Which device can be used to increase the voltage from a source of direct current?

1 electroscope
2 mass spectrometer
3 induction coil
4 generator

83 The graph below shows induced potential difference versus time for the rotating armature of a generator.



What is the frequency of armature rotation?

(1) 10 Hz
(2) 20 Hz
(3) 40 Hz
(4) 60 Hz

84 The transformer on a power pole steps down the voltage from 10,800 volts to 120. volts. If the secondary coil contains 360 turns, how many turns are on the primary coil?

(1) 30
(2) 90
(3) 3600
(4) 32,400

Note that question 85 has only three choices.

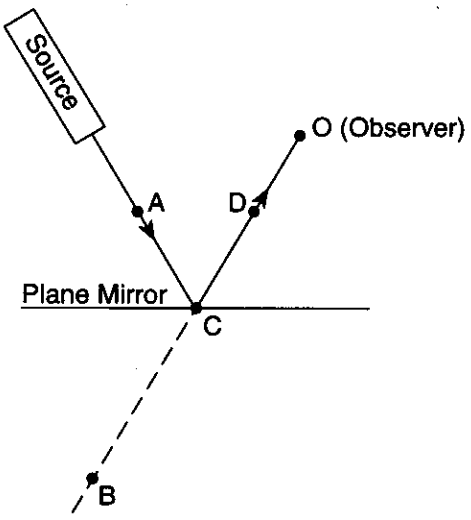
85 An electron is located between a pair of oppositely charged parallel plates. As the electron approaches the positive plate, the kinetic energy of the electron

1 decreases
2 increases
3 remains the same

Group 4 — Geometric Optics

If you choose this group, be sure to answer questions 86–95.

86 In the diagram below, a source produces a light ray that is reflected from a plane mirror.



To an observer at point *O*, the light appears to originate from point

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

87 A spherical mirror that forms only virtual images has a radius of curvature of 0.50 meter. The focal length of this mirror is

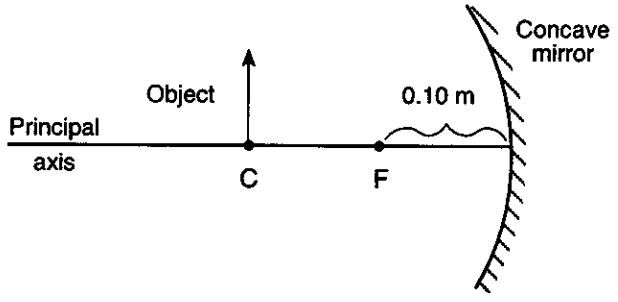
(1) –0.25 m
(2) +0.25 m
(3) –0.50 m
(4) +0.50 m

88 A spherical concave mirror is used in the back of a car headlight. Where must the bulb of the headlight be located to produce a parallel beam of reflected light?

1 between the principal focus and the mirror
2 beyond the center of curvature of the mirror
3 at the principal focus of the mirror
4 at the center of curvature of the mirror

Base your answers to questions 89 through 91 on the information and diagram below.

An object is located at the center of curvature *C* of a concave spherical mirror with principal focus *F*. The focal length of the mirror is 0.10 meter.



89 At what distance from the mirror is the image located?

(1) 0.10 m
(2) 0.20 m
(3) 0.30 m
(4) 0.40 m

90 At what distance from the mirror could the object be placed to produce a virtual image of the object?

(1) 0.05 m
(2) 0.10 m
(3) 0.30 m
(4) 0.50 m

Note that question 91 has only three choices.

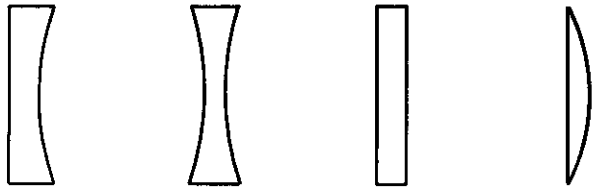
91 As the object is moved from point *C* toward point *F*, the size of its image

1 decreases
2 increases
3 remains the same

Base your answers to questions 92 and 93 on the information below.

A crown glass converging lens has a focal length of 0.10 meter.

92 Which cross-sectional diagram best represents this lens?



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

93 An object is placed 0.30 meter from the lens. How far from the lens will an image of the object be formed?

(1) 0.30 m
(2) 0.20 m
(3) 0.15 m
(4) 0.10 m

94 An object 0.080 meter high is placed 0.20 meter from a converging (convex) lens. If the distance of the image from the lens is 0.40 meter, the height of the image is

(1) 0.010 m
(2) 0.040 m
(3) 0.080 m
(4) 0.16 m

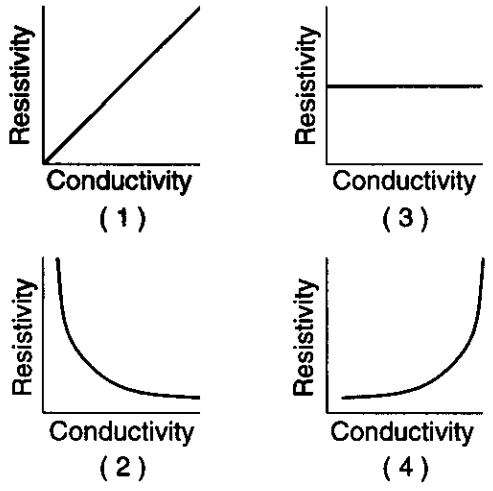
95 A diverging (concave) lens can form images that are

1 virtual, only
2 inverted, only
3 either virtual or real
4 either inverted or erect

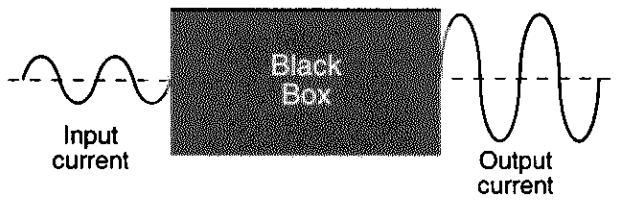
Group 5 — Solid State

If you choose this group, be sure to answer questions 96–105.

96 Which graph best represents the relationship between conductivity and resistivity for a solid?



97 The diagram below shows an input of alternating current to a "black box" and the resulting output current.



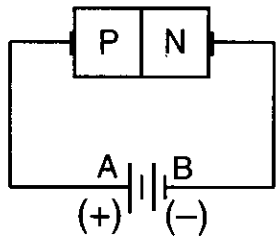
The "black box" most likely is

1 an LED
2 a transistor
3 a diode
4 an *N*-type semiconductor

98 A *P*-type semiconductor is formed by adding impurities, which provide extra

1 electrons
2 protons
3 neutrons
4 holes

Base your answers to questions 99 through 101 on the diagram below, which represents a semiconductor device connected to a battery.



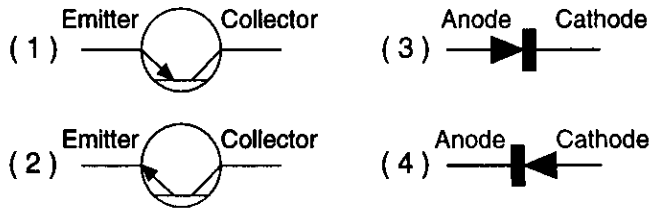
99 In the circuit, holes migrate from

(1) *A* to *B*
(2) *B* to *A*
(3) *N* to *P*
(4) *P* to *N*

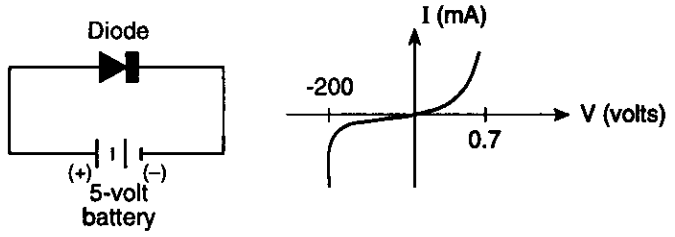
100 If an alternating potential difference is substituted for the battery, the result will be

1 an alternating current
2 a pulsating direct current
3 a steady direct current
4 no current flow

101 Which symbol best represents the orientation of the device shown in the circuit diagram?



Base your answers to questions 102 and 103 on the diagram and graph below.



(not drawn to scale)

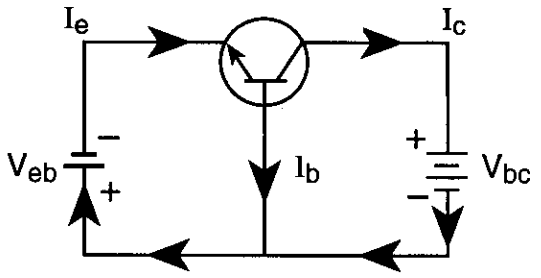
102 When connected as shown, the diode is

1 forward biased
2 reverse biased
3 open biased
4 closed biased

103 Compared to the voltage at which this diode avalanches, a more heavily doped diode would

1 avalanche at a lower voltage, only
2 avalanche at a higher voltage, only
3 not avalanche at any voltage
4 avalanche at any voltage

104 The diagram below represents an operating transistor circuit.



Which currents are approximately equal?

(1) I_b and I_e, only
(2) I_b and I_c, only
(3) I_c and I_e, only
(4) I_b, I_c, and I_e

Note that question 105 has only three choices.

105 A student measures a current of 0.05 ampere through a *P*-type semiconductor. If the battery connections are reversed, the current through the semiconductor will be

1 less than 0.05 A
2 greater than 0.05 A
3 equal to 0.05 A

Group 6 — Nuclear Energy

If you choose this group, be sure to answer questions 106–115.

106 In the transmutation reaction ${}^{30}_{15}\mathrm{P} \rightarrow X + {}^{0}_{+1}\mathrm{e}$, the X represents

(1) ${}^{30}_{16}\mathrm{S}$ (3) ${}^{31}_{14}\mathrm{Si}$

(2) ${}^{30}_{14}\mathrm{Si}$ (4) ${}^{31}_{16}\mathrm{S}$

107 What is the approximate binding energy of a helium nucleus that has a mass defect of 5.2×10^{-29} kilogram?

(1) 1.6×10^{-21} J (3) 4.7×10^{-13} J

(2) 1.6×10^{-20} J (4) 4.7×10^{-12} J

108 Which pair correctly represents isotopes of the same element?

(1) ${}^{210}_{82}\mathrm{Pb}$ and ${}^{210}_{84}\mathrm{Po}$ (3) ${}^{210}_{82}\mathrm{Pb}$ and ${}^{214}_{82}\mathrm{Pb}$

(2) ${}^{210}_{82}\mathrm{Pb}$ and ${}^{210}_{84}\mathrm{Pb}$ (4) ${}^{210}_{84}\mathrm{Pb}$ and ${}^{210}_{84}\mathrm{Po}$

109 Which particle can *not* be accelerated by a cyclotron?

1 a proton 3 an alpha particle

2 a neutron 4 an electron

110 According to the Uranium Disintegration Series, ${}^{222}_{86}\mathrm{Rn}$ undergoes

1 an alpha decay, forming ${}^{218}_{84}\mathrm{Po}$

2 a beta decay, forming ${}^{218}_{84}\mathrm{Po}$

3 an alpha decay, forming ${}^{226}_{88}\mathrm{Ra}$

4 a beta decay, forming ${}^{226}_{88}\mathrm{Ra}$

111 In the nuclear reaction represented below, what is particle X?

$${}^{238}_{93}\mathrm{Np} \rightarrow {}^{238}_{94}\mathrm{Pu} + X$$

1 a proton 3 an electron

2 a neutron 4 a positron

112 A 96-gram sample of a radioactive nuclide is placed in a container. After 12 minutes, only 6 grams of the sample has not yet decayed. What is the half-life of the nuclide?

(1) 6 min (3) 3 min

(2) 2 min (4) 8 min

113 Which process is demonstrated by the reaction ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{141}_{56}\mathrm{Ba} + {}^{92}_{36}\mathrm{Kr} + 3{}^{1}_{0}\mathrm{n} + Q$?

1 nuclear fission 3 alpha decay

2 nuclear fusion 4 beta decay

114 The principal reason for using neutrons to bombard a nucleus is that neutrons

1 have a relatively low atomic mass

2 have a very high kinetic energy

3 can be easily accelerated

4 are not repelled by the nucleus

115 Which process is the source of the Sun's energy?

1 natural radioactive decay

2 electron capture

3 fission

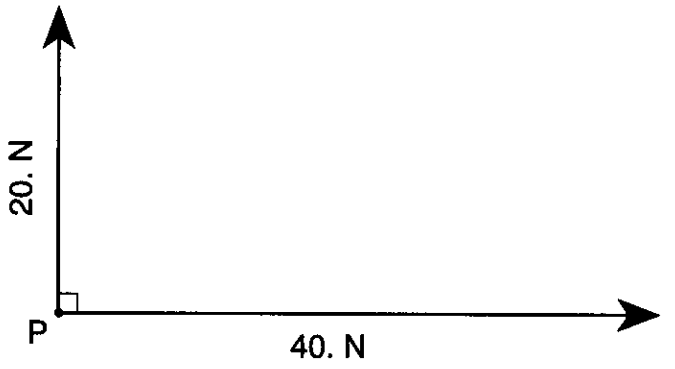
4 fusion

Part III

You must answer *all* questions in this part. Record your answers in the spaces provided on the separate answer paper. Pen or pencil may be used. [15]

Base your answers to questions 116 through 120 on the information and vector diagram below. The diagram is provided for practice purposes only. Be sure your final answer appears on your answer paper.

A 20.-newton force due north and a 40.-newton force due east act concurrently on a 10.-kilogram object, located at point *P*.



116 Using a ruler, determine the scale used in the vector diagram by finding the number of newtons represented by each centimeter. [1]

117 On the vector diagram *on your answer paper,* use a ruler and protractor to construct the vector that represents the resultant force. [1]

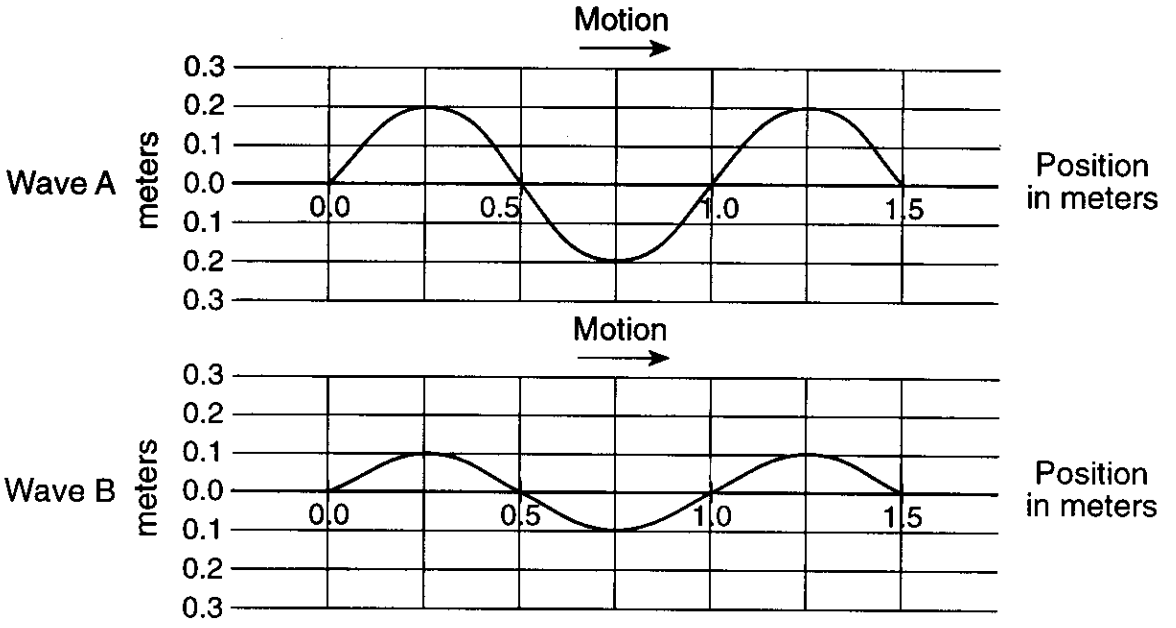
118 What is the magnitude of the resultant force? [1]

119 What is the measure of the angle (in degrees) between east and the resultant force? [1]

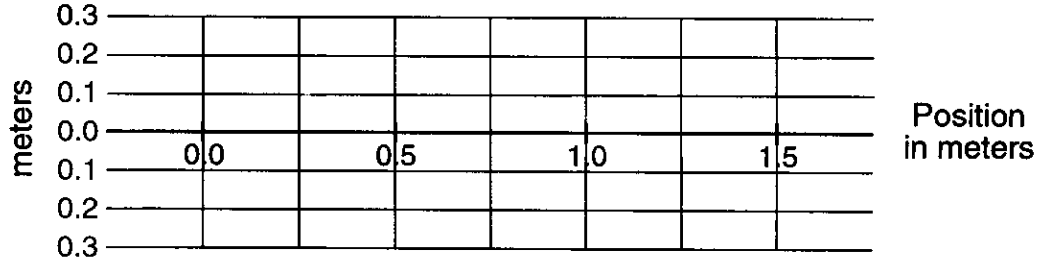
120 Calculate the magnitude of the acceleration of the object. [Show all calculations, including the equation and substitution with units.] [2]

Base your answers to questions 121 through 123 on the information and diagram below.

Two waves, *A* and *B*, travel in the same direction in the same medium at the same time.



121 On the grid *on your answer paper,* draw the resultant wave produced by the superposition of waves *A* and *B*. The grid below is to be used for practice purposes only. Be sure your final answer appears on your answer paper. [1]



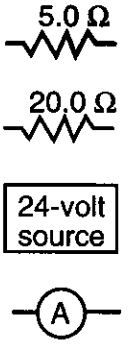
122 What is the amplitude of the resultant wave? [1]

123 What is the wavelength of the resultant wave? [1]

Base your answers to questions 124 through 126 on the information below.

A 5.0-ohm resistor, a 20.0-ohm resistor, and a 24-volt source of potential difference are connected in parallel. A single ammeter is placed in the circuit to read the total current.

124 In the space provided *on your answer paper,* draw a diagram of this circuit, using the symbols with labels given below. [Assume availability of any number of wires of negligible resistance.] [2]



125 Determine the total circuit resistance. [Show all calculations, including the equation and substitution with units.] [2]

126 Determine the total circuit current. [Show all calculations, including the equation and substitution with units.] [2]

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, June 17, 1997 — 1:15 to 4:15 p.m., only

ANSWER PAPER

Student ..... Sex: ☐ Male ☐ Female

Teacher .....

School .....

Record all of your answers on this answer paper in accordance with the instructions on the front cover of the test booklet.

Part I (65 credits)

1	1	2	3	4	**21**	1	2	3	4	**41**	1	2	3	4
2	1	2	3	4	**22**	1	2	3	4	**42**	1	2	3	4
3	1	2	3	4	**23**	1	2	3	4	**43**	1	2	3	4
4	1	2	3	4	**24**	1	2	3	4	**44**	1	2	3	4
5	1	2	3	4	**25**	1	2	3	4	**45**	1	2	3	4
6	1	2	3	4	**26**	1	2	3	4	**46**	1	2	3	4
7	1	2	3	4	**27**	1	2	3	4	**47**	1	2	3	4
8	1	2	3	4	**28**	1	2	3	4	**48**	1	2	3	4
9	1	2	3	4	**29**	1	2	3	4	**49**	1	2	3	4
10	1	2	3	4	**30**	1	2	3	4	**50**	1	2	3	4
11	1	2	3	4	**31**	1	2	3	4	**51**	1	2	3	4
12	1	2	3	4	**32**	1	2	3	4	**52**	1	2	3	4
13	1	2	3	4	**33**	1	2	3	4	**53**	1	2	3	4
14	1	2	3	4	**34**	1	2	3	4	**54**	1	2	3	
15	1	2	3	4	**35**	1	2	3	4	**55**	1	2	3	
16	1	2	3	4	**36**	1	2	3	4					
17	1	2	3	4	**37**	1	2	3	4					
18	1	2	3	4	**38**	1	2	3	4					
19	1	2	3	4	**39**	1	2	3	4					
20	1	2	3	4	**40**	1	2	3	4					

FOR TEACHER USE ONLY

Part I Score (Use table below) .....

Part II Score .....

Part III Score .....

Total Score .....

Rater's Initials: .....

PART I CREDITS

Directions to Teacher:

In the table below, draw a circle around the number of right answers and the adjacent number of credits. Then write the number of credits (not the number right) in the space provided above.

No. Right	Credits	No. Right	Credits
55	**65**	27	**42**
54	**64**	26	**41**
53	**63**	25	**40**
52	**63**	24	**40**
51	**62**	23	**39**
50	**61**	22	**38**
49	**60**	21	**37**
48	**59**	20	**36**
47	**58**	19	**35**
46	**58**	18	**35**
45	**57**	17	**34**
44	**56**	16	**33**
43	**55**	15	**32**
42	**54**	14	**31**
41	**54**	13	**31**
40	**53**	12	**29**
39	**52**	11	**26**
38	**51**	10	**24**
37	**50**	9	**21**
36	**49**	8	**19**
35	**49**	7	**17**
34	**48**	6	**14**
33	**47**	5	**12**
32	**46**	4	**10**
31	**45**	3	**7**
30	**44**	2	**5**
29	**44**	1	**2**
28	**43**	0	**0**

No. right .....

Part II (20 credits)

Answer the questions in only two of the six groups in this part. Be sure to mark the answers to the groups of questions you choose in accordance with the instructions on the front page of the test booklet. Leave blank the four groups of questions you do not choose to answer.

Group 1
Motion in a Plane

56	1	2	3	4
57	1	2	3	4
58	1	2	3	4
59	1	2	3	4
60	1	2	3	4
61	1	2	3	4
62	1	2	3	4
63	1	2	3	4
64	1	2	3	4
65	1	2	3	4

Group 2
Internal Energy

66	1	2	3	4
67	1	2	3	4
68	1	2	3	4
69	1	2	3	4
70	1	2	3	4
71	1	2	3	4
72	1	2	3	4
73	1	2	3	4
74	1	2	3	4
75	1	2	3	

Group 3
Electromagnetic Applications

76	1	2	3	4
77	1	2	3	4
78	1	2	3	4
79	1	2	3	4
80	1	2	3	4
81	1	2	3	4
82	1	2	3	4
83	1	2	3	4
84	1	2	3	4
85	1	2	3	

Group 4
Geometric Optics

86	1	2	3	4
87	1	2	3	4
88	1	2	3	4
89	1	2	3	4
90	1	2	3	4
91	1	2	3	
92	1	2	3	4
93	1	2	3	4
94	1	2	3	4
95	1	2	3	4

Group 5
Solid State

96	1	2	3	4
97	1	2	3	4
98	1	2	3	4
99	1	2	3	4
100	1	2	3	4
101	1	2	3	4
102	1	2	3	4
103	1	2	3	4
104	1	2	3	4
105	1	2	3	

Group 6
Nuclear Energy

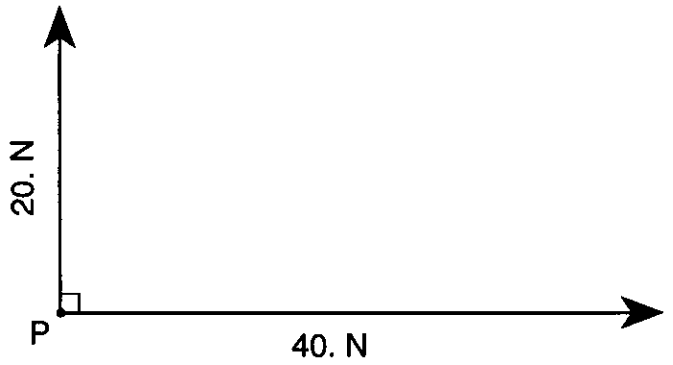
106	1	2	3	4
107	1	2	3	4
108	1	2	3	4
109	1	2	3	4
110	1	2	3	4
111	1	2	3	4
112	1	2	3	4
113	1	2	3	4
114	1	2	3	4
115	1	2	3	4

Part III (15 credits)

Answer <u>all</u> questions in this part.

116 1.0 cm = _____

117

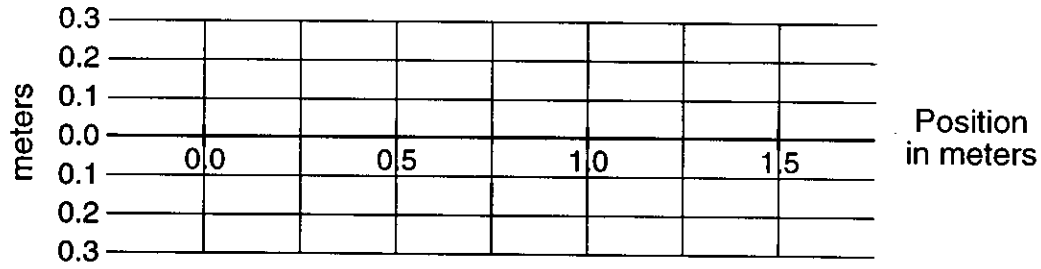


118_____

119 _____°

120

121



122 _____

123 _____

124

125

126

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

FOR TEACHERS ONLY

P

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, June 17, 1997—1:15 to 4:15 p.m., only

SCORING KEY

Part I

Refer to the table on the answer paper for the number of credits to be given on Part I.

Part I (65 credits)

1	1	**X**	3	4	**21**	1	**X**	3	4	**41**	1	2	**X**	4
2	1	2	3	**X**	**22**	**X**	2	3	4	**42**	**X**	2	3	4
3	1	2	**X**	4	**23**	1	2	3	**X**	**43**	1	2	3	**X**
4	1	2	**X**	4	**24**	1	2	**X**	4	**44**	**X**	2	3	4
5	**X**	2	3	4	**25**	1	2	3	**X**	**45**	1	2	**X**	4
6	**X**	2	3	4	**26**	1	**X**	3	4	**46**	1	**X**	3	4
7	1	2	3	**X**	**27**	1	2	**X**	4	**47**	1	2	**X**	4
8	1	**X**	3	4	**28**	1	2	**X**	4	**48**	1	2	3	**X**
9	1	2	**X**	4	**29**	**X**	2	3	4	**49**	1	**X**	3	4
10	1	**X**	3	4	**30**	1	2	3	**X**	**50**	1	2	**X**	4
11	1	**X**	3	4	**31**	**X**	2	3	4	**51**	1	2	3	**X**
12	**X**	2	3	4	**32**	1	**X**	3	4	**52**	**X**	2	3	4
13	**X**	2	3	4	**33**	1	2	3	**X**	**53**	1	**X**	3	4
14	1	**X**	3	4	**34**	1	**X**	3	4	**54**	1	2	**X**	
15	**X**	2	3	4	**35**	1	2	**X**	4	**55**	1	2	**X**	
16	1	2	3	**X**	**36**	1	**X**	3	4					
17	1	2	**X**	4	**37**	1	**X**	3	4					
18	**X**	2	3	4	**38**	**X**	2	3	4					
19	1	2	3	**X**	**39**	1	**X**	3	4					
20	1	2	3	**X**	**40**	1	2	3	**X**					

Directions to the teacher:

Use only *red* ink or *red* pencil in rating Regents examination papers. Do *not* correct the student's work by making insertions or changes of any kind.

Scan each answer paper to make certain that the student has marked only one answer for each question. If a student has marked two or more answers with an X in ink, draw a red line through the row of numbers for that question to indicate that no credit is to be allowed for that question when the answer paper is scored.

To facilitate scoring, the scoring key has been printed in the same format as the answer paper. The scoring key for **Part I and Part II** may be made into a scoring stencil by punching out the correct answers. Be sure that the stencil is aligned with the answer paper so that the holes correspond to the correct answers. To aid in proper alignment, punch out the first and last item numbers in each part and place the stencil on the answer paper so that these item numbers appear through the appropriate holes.

[OVER]

Part II

Allow a total of 20 credits, one credit for each question, for only two of the six groups in this part. If more than two groups are answered, only the first two should be considered.

Group 1
Motion in a Plane

56	1	**X**	3	4
57	1	**X**	3	4
58	1	2	**X**	4
59	1	2	**X**	4
60	1	2	3	**X**
61	1	2	3	**X**
62	1	2	**X**	4
63	1	2	3	**X**
64	**X**	2	3	4
65	**X**	2	3	4

Group 2
Internal Energy

66	1	2	3	**X**
67	**X**	2	3	4
68	1	2	**X**	4
69	1	**X**	3	4
70	1	2	**X**	4
71	1	**X**	3	4
72	1	2	3	**X**
73	1	**X**	3	4
74	1	2	**X**	4
75	**X**	2	3	

Group 3
Electromagnetic Applications

76	1	2	**X**	4
77	**X**	2	3	4
78	1	2	3	**X**
79	1	**X**	3	4
80	**X**	2	3	4
81	**X**	2	3	4
82	1	2	**X**	4
83	1	**X**	3	4
84	1	2	3	**X**
85	1	**X**	3	

Group 4
Geometric Optics

86	1	**X**	3	4
87	**X**	2	3	4
88	1	2	**X**	4
89	1	**X**	3	4
90	**X**	2	3	4
91	1	**X**	3	
92	1	2	3	**X**
93	1	2	**X**	4
94	1	2	3	**X**
95	**X**	2	3	4

Group 5
Solid State

96	1	**X**	3	4
97	1	**X**	3	4
98	1	2	3	**X**
99	1	2	3	**X**
100	1	**X**	3	4
101	1	2	**X**	4
102	**X**	2	3	4
103	**X**	2	3	4
104	1	2	**X**	4
105	1	2	**X**	

Group 6
Nuclear Energy

106	1	**X**	3	4
107	1	2	3	**X**
108	1	2	**X**	4
109	1	**X**	3	4
110	**X**	2	3	4
111	1	2	**X**	4
112	1	2	**X**	4
113	**X**	2	3	4
114	1	2	3	**X**
115	1	2	3	**X**

Part III (15 credits)

Please refer to the Department publication *Regents Examination in Physics: Rating Guide for Part III*. Teachers should become familiar with this guide before rating students' papers.

Scoring Criteria for Calculations

For each question requiring the student to show *all calculations, including the equation and substitution with units*, apply the following scoring criteria:

Allow a total of two credits for questions 120, 125, and 126.

- Allow one credit for the equation and substitution of values with units. If the equation and/or substitution with units is not shown, do not allow this credit.
- Allow one credit for the correct answer (number and unit). If the number is given without the unit, do not allow this credit.
- Penalize a student only once per equation for omitting units.
- Allow full credit even if the answer is not expressed with the correct number of significant figures.

116 Allow one credit for the correct answer. Unit must be included for this credit.

Examples of Acceptable Responses

5.0 N (±0.2 N)

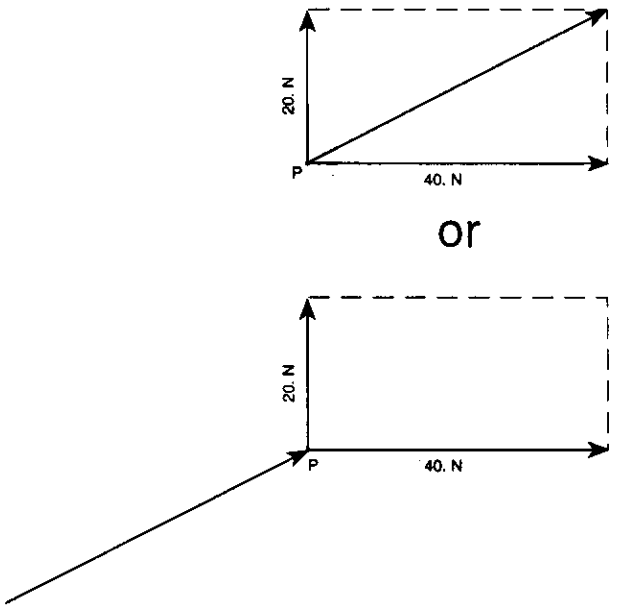
or

5 newtons (±0.2 N)

117 Allow one credit for the correct answer.

To receive this credit, the 8.9-cm ±0.2-cm vector must include an arrowhead at the end. (Note: The resultant vector need not be labeled to receive this credit.)

Accept Either of These Responses



118 Allow one credit for the correct answer. The correct unit (**newton**), must be included to receive this credit.

Example of Acceptable Response

45 N (±2 N)

Allow credit if the student correctly uses his or her responses to questions 116 and 117, or calculates magnitude using the Pythagorean theorem or trigonometry.

119 Allow one credit for the correct answer, 27° ± 2°. Allow credit if the student correctly uses his or her response to question 117, or calculates the angle using the tangent function $\tan \theta = \frac{20\ \text{N}}{40\ \text{N}}$.

120 Allow a total of two credits. Refer to *Scoring Criteria for Calculations* in this scoring key.

Examples of Acceptable Responses

$F = ma$

$a = \frac{F}{m}$

$a = \frac{45\ \text{N}}{10.\ \text{kg}}$

$a = 4.5\ \text{m/s}^2$

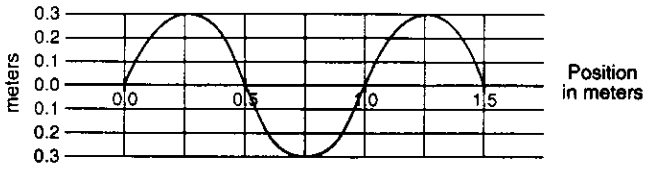
or

$a = 4.5\ \text{N/kg}$

Allow credit if the student correctly uses his or her response to question 118.

121 Allow one credit for the correct answer.

Example of an Acceptable Response



122 Allow one credit for the correct answer. Unit must be included for this credit.

Examples of Acceptable Responses

0.3 m (±0.02 m)

or

30 cm (±2 cm)

Allow credit if the student correctly uses his or her response to question 121.

123 Allow one credit for the correct answer. Unit must be included for this credit.

Examples of Acceptable Responses

1.0 m

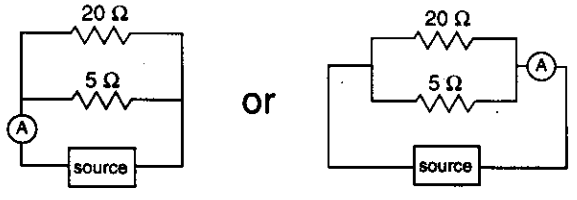
100 cm

Allow credit if the student correctly uses his or her response to question 121.

124 Allow a total of two credits.

- Allow one credit for a circuit containing two resistors labeled "5 ohms" and "20 ohms" connected in parallel with a source that may be labeled "source," "24 V," or "24-V source."
- Allow one credit for a single ammeter properly placed to measure the total current. Do not allow this credit if more than one ammeter is used. If the student has drawn a series circuit, and the ammeter is properly placed to measure the total current, allow this credit.

Examples of Acceptable Responses



125 Allow a total of two credits. Refer to *Scoring Criteria for Calculations* in this scoring key.

Examples of Acceptable Responses

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_t = \frac{1}{5.0\ \Omega} + \frac{1}{20.0\ \Omega}$$

$$\frac{1}{R_t} = \frac{4}{20.0\ \Omega} + \frac{1}{20.0\ \Omega}$$

$$\frac{1}{R_t} = \frac{5}{20.0\ \Omega}$$

$$R_t = \frac{20.0\ \Omega}{5}$$

$$R_t = 4.0\ \Omega$$

or

$$R_t = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_t = \frac{(20\ \Omega)(5\ \Omega)}{20\ \Omega + 5\ \Omega}$$

$$R_t = 4\ \Omega$$

Allow credit if the student correctly uses his or her response to question 124. That is, *if* the student connected the resistors in series in question 124, then the following answer is acceptable:

$$R_t = R_1 + R_2$$

$$R_t = 5.0\ \Omega + 20.0\ \Omega$$

$$R_t = 25.0\ \Omega$$

126 Allow a total of two credits. Refer to *Scoring Criteria for Calculations* in this scoring key.

Examples of Acceptable Responses

$$I = \frac{V}{R}$$

$$I = \frac{24\ V}{4.0\ \Omega}$$

$$I = 6.0\ A$$

or

$$I = \frac{V}{R}$$

$$I = \frac{24\ V}{4\ \Omega}$$

$$I = 6\ V/\Omega$$

Allow credit if the student correctly uses his or her response to question 125.