The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Wednesday, June 17, 1998 — 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.

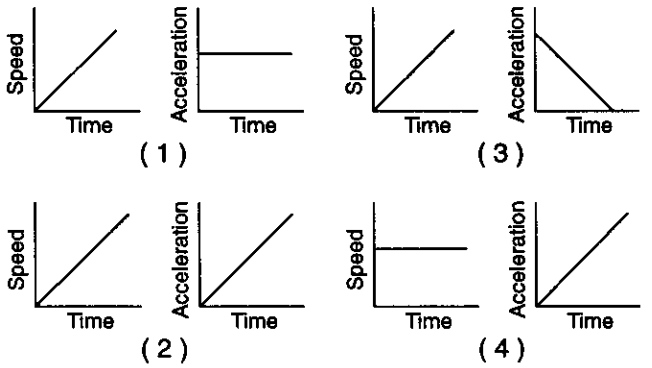
1 A car travels 12 kilometers due north and then 8 kilometers due west going from town *A* to town *B*. What is the magnitude of the displacement of a helicopter that flies in a straight line from town *A* to town *B*?

(1) 20. km
(2) 14 km
(3) 10. km
(4) 4 km

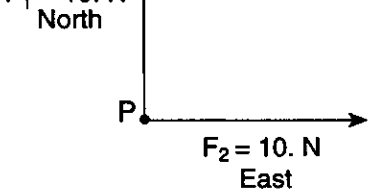
2 What is the approximate diameter of a dinner plate?

(1) 0.0025 m
(2) 0.025 m
(3) 0.25 m
(4) 2.5 m

3 Which two graphs best represent the motion of an object falling freely from rest near Earth's surface?



4 Forces F_1 and F_2 act concurrently on point *P*, as shown in the diagram below.



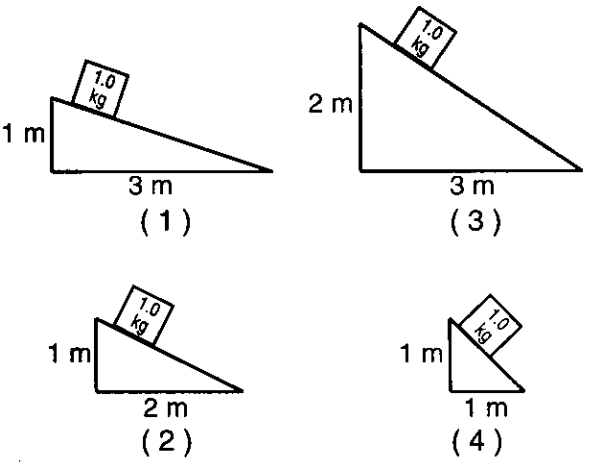
The equilibrant of F_1 and F_2 is

(1) 14 N southwest
(2) 14 N southeast
(3) 20. N southwest
(4) 20. N southeast

5 What is the average velocity of a car that travels 30. kilometers due west in 0.50 hour?

(1) 15 km/hr
(2) 60. km/hr
(3) 15 km/hr west
(4) 60. km/hr west

6 A 1.0-kilogram block is placed on each of four frictionless planes inclined at different angles. On which inclined plane will the acceleration of the block be greatest?



7 A car having an initial speed of 16 meters per second is uniformly brought to rest in 4.0 seconds. How far does the car travel during this 4.0-second interval?

(1) 32 m
(2) 82 m
(3) 96 m
(4) 4.0 m

8 A man weighs 900 newtons standing on a scale in a stationary elevator. If some time later the reading on the scale is 1200 newtons, the elevator must be moving with

1 constant acceleration downward
2 constant speed downward
3 constant acceleration upward
4 constant speed upward

9 Net force F causes mass m_1 to accelerate at rate a. A net force of $3F$ causes mass m_2 to accelerate at rate $2a$. What is the ratio of mass m_1 to mass m_2?

(1) 1:3
(2) 2:3
(3) 1:2
(4) 1:6

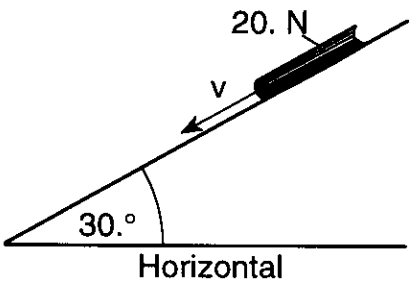
10 What is the magnitude of the gravitational force between an electron and a proton separated by a distance of 1.0×10^{-10} meter?

(1) 1.0×10^{-47} N
(2) 1.5×10^{-46} N
(3) 1.0×10^{-37} N
(4) 1.5×10^{-36} N

11 On the surface of planet X, the acceleration due to gravity is 16 meters per second^2. What is the weight of a 6.0-kilogram mass located on the surface of planet X?

(1) 2.7 N
(2) 59 N
(3) 96 N
(4) 940 N

12 A book weighing 20. newtons slides at constant velocity down a ramp inclined 30.° to the horizontal as shown in the diagram below.



What is the force of friction between the book and the ramp?

(1) 10. N up the ramp
(2) 17 N up the ramp
(3) 10. N down the ramp
(4) 17 N down the ramp

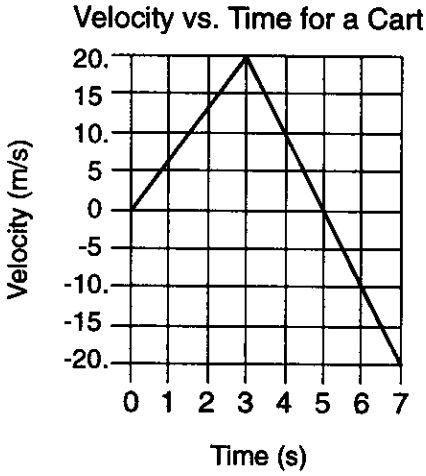
13 A 0.60-kilogram softball initially at rest is hit with a bat. The ball is in contact with the bat for 0.20 second and leaves the bat with a speed of 25 meters per second. What is the magnitude of the average force exerted by the ball on the bat?

(1) 8.3 N
(2) 15 N
(3) 3.0 N
(4) 75 N

14 If the speed of a moving object is doubled, which quantity associated with the object must also double?

1 its momentum
2 its kinetic energy
3 its acceleration
4 its gravitational potential energy

15 The velocity-time graph below represents the motion of a 3-kilogram cart along a straight line. The cart starts at $t = 0$ and initially moves north.



What is the magnitude of the change in momentum of the cart between $t = 0$ and $t = 3$ seconds?

(1) 20 kg•m/s
(2) 30 kg•m/s
(3) 60 kg•m/s
(4) 80 kg•m/s

16 A person kicks a 4.0-kilogram door with a 48-newton force causing the door to accelerate at 12 meters per second^2. What is the magnitude of the force exerted by the door on the person?

(1) 48 N
(2) 24 N
(3) 12 N
(4) 4.0 N

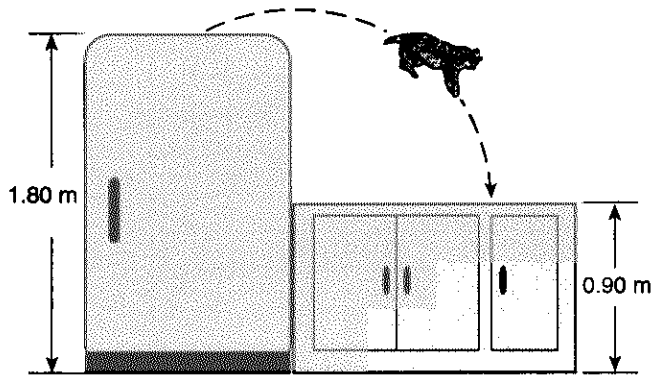
17 A 45-kilogram bicyclist climbs a hill at a constant speed of 2.5 meters per second by applying an average force of 85 newtons. Approximately how much power does the bicyclist develop?

(1) 110 W
(2) 210 W
(3) 1100 W
(4) 1400 W

18 Which action would require no work to be done on an object?

1 lifting the object from the floor to the ceiling
2 pushing the object along a horizontal floor against a frictional force
3 decreasing the speed of the object until it comes to rest
4 holding the object stationary above the ground

19 The diagram below shows a 1.5-kilogram kitten jumping from the top of a 1.80-meter-high refrigerator to a 0.90-meter-high counter.



Compared to the kitten's gravitational potential energy on top of the refrigerator, the kitten's gravitational potential energy on top of the counter is

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

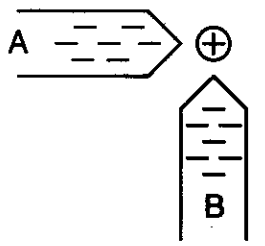
20 A 60.-kilogram student running at 3.0 meters per second has a kinetic energy of

(1) 180 J
(2) 270 J
(3) 540 J
(4) 8100 J

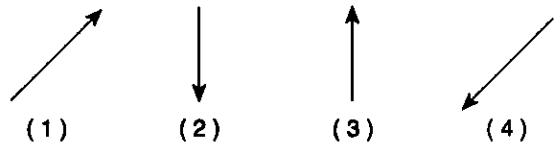
21 A student pulls a box across a horizontal floor at a constant speed of 4.0 meters per second by exerting a constant horizontal force of 45 newtons. Approximately how much work does the student do against friction in moving the box 5.5 meters across the floor?

(1) 45 J
(2) 180 J
(3) 250 J
(4) 740 J

22 Two plastic rods, *A* and *B*, each possess a net negative charge of 1.0×10^{-3} coulomb. The rods and a positively charged sphere are positioned as shown below.



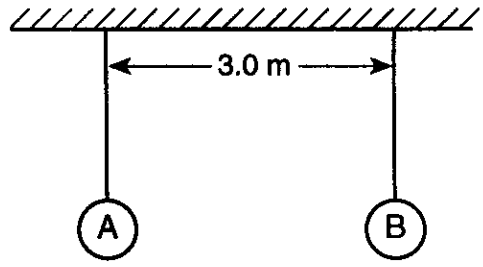
Which vector best represents the resultant electrostatic force on the sphere?



23 A sphere has a net excess charge of -4.8×10^{-19} coulomb. The sphere must have an excess of

(1) 1 electron
(2) 1 proton
(3) 3 electrons
(4) 3 protons

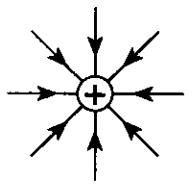
24 The diagram below shows two metal spheres suspended by strings and separated by a distance of 3.0 meters. The charge on sphere *A* is $+5.0 \times 10^{-4}$ coulomb and the charge on sphere *B* is $+3.0 \times 10^{-5}$ coulomb.



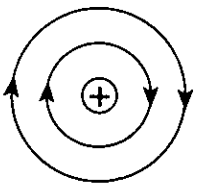
Which statement best describes the electrical force between the spheres?

1 It has a magnitude of 15 N and is repulsive.
2 It has a magnitude of 45 N and is repulsive.
3 It has a magnitude of 15 N and is attractive.
4 It has a magnitude of 45 N and is attractive.

25 Which diagram best represents the electric field near a positively charged conducting sphere?



(1)



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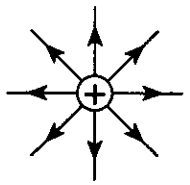

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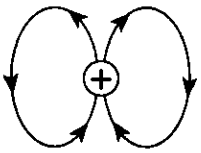
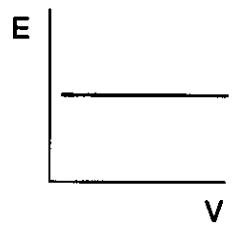
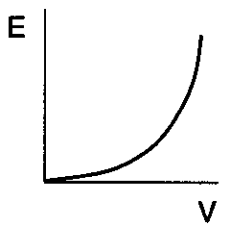


(4)

26 Two oppositely charged parallel plates are a fixed distance apart. Which graph best represents the relationship between the electric field intensity (E) between the plates and the potential difference (V) across the plates?



(1)



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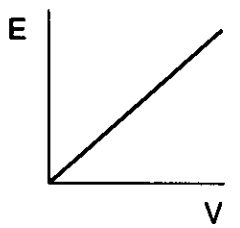

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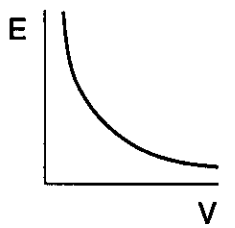
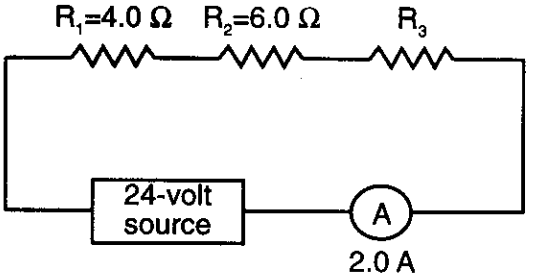


(4)

27 What is the potential difference across a 2.0-ohm resistor that draws 2.0 coulombs of charge per second?

(1) 1.0 V
(2) 2.0 V
(3) 3.0 V
(4) 4.0 V

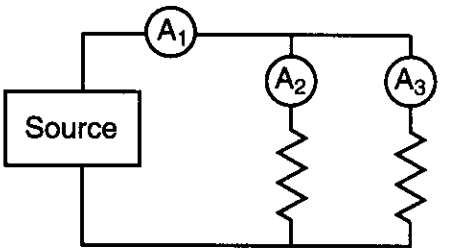
28 The diagram below shows a circuit with three resistors.



What is the resistance of resistor R_3?

(1) 6.0 Ω
(2) 2.0 Ω
(3) 12 Ω
(4) 4.0 Ω

29 Three ammeters are placed in a circuit as shown below.



If A_1 reads 5.0 amperes and A_2 reads 2.0 amperes, what does A_3 read?

(1) 1.0 A
(2) 2.0 A
(3) 3.0 A
(4) 7.0 A

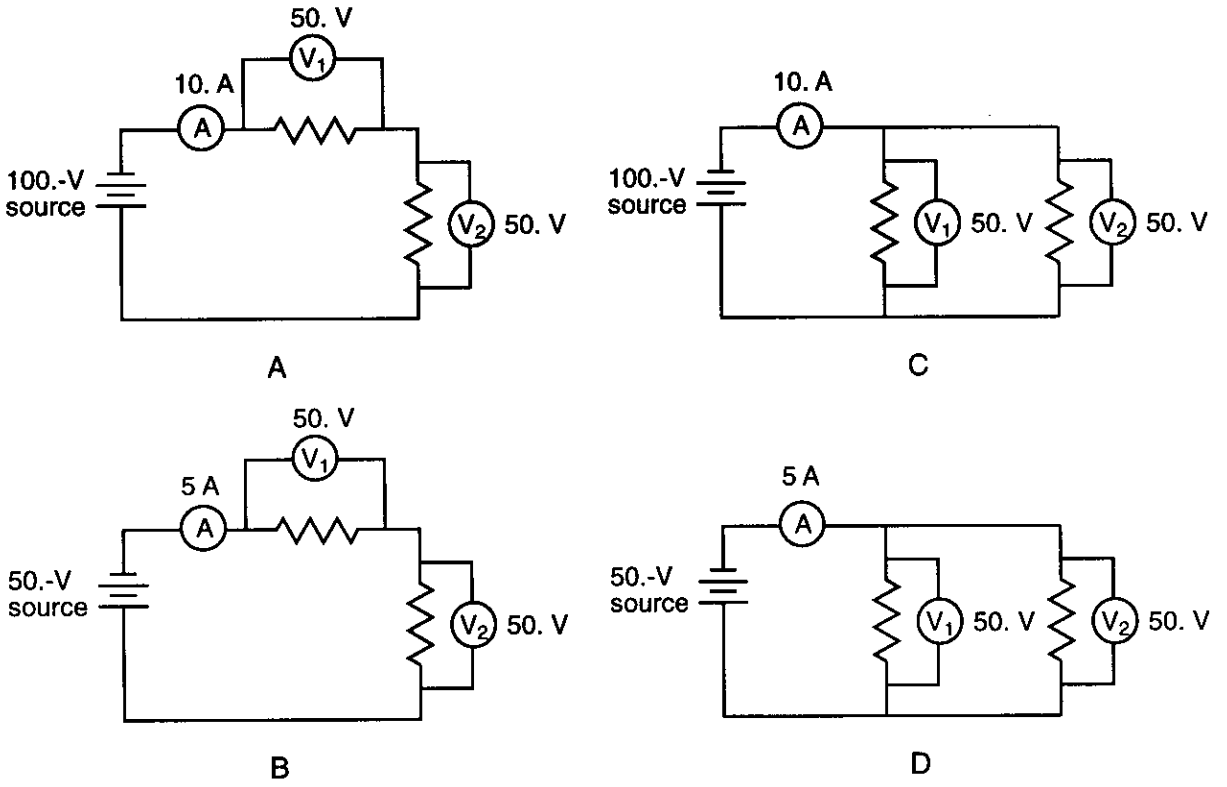
30 An electric motor draws 150 amperes of current while operating at 240 volts. What is the power rating of this motor?

(1) 1.6 W
(2) 3.8×10^2 W
(3) 3.6×10^4 W
(4) 5.4×10^6 W

31 An operating 75-watt lamp is connected to a 120-volt outlet. How much electrical energy is used by the lamp in 60. minutes (3600 seconds)?

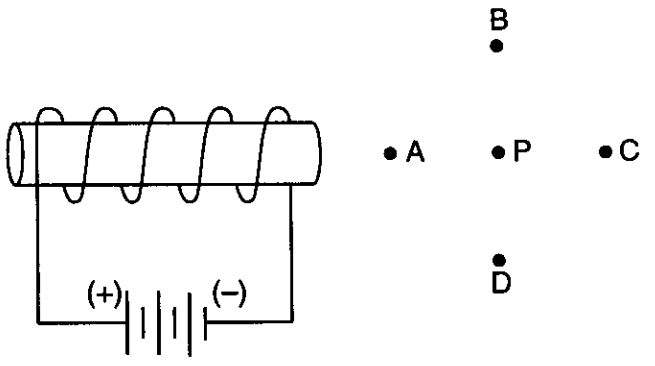
(1) 4.5×10^3 J
(2) 2.7×10^5 J
(3) 5.4×10^5 J
(4) 3.2×10^7 J

32 In which pair of circuits shown below could the readings of voltmeters V_1 and V_2 and ammeter A be correct?



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

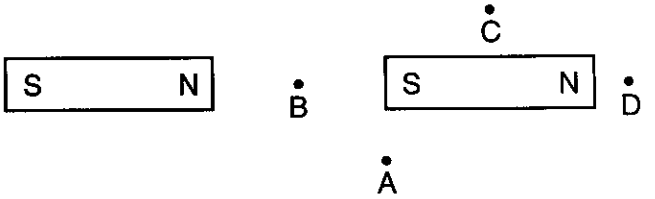
33 The diagram below shows a coil of wire (solenoid) connected to a battery.



The north pole of a compass placed at point P would be directed toward point

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

34 Two bar magnets of equal strength are positioned as shown.



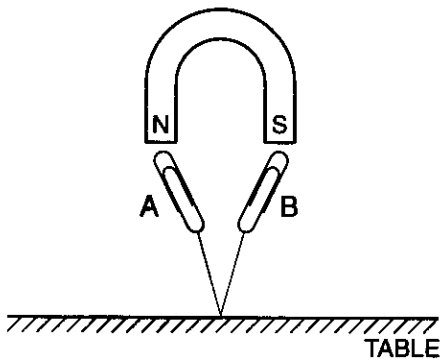
At which point is the magnetic flux density due to the two magnets greatest?

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

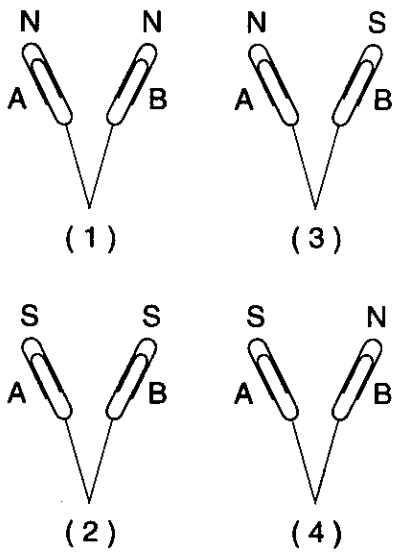
35 As a sound wave travels through air, there is a net transfer of

1 energy, only
2 mass, only
3 both mass and energy
4 neither mass nor energy

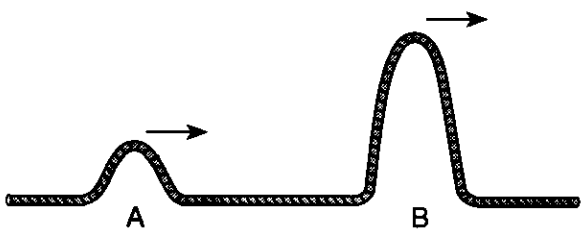
36 In the diagram below, steel paper clips *A* and *B* are attached to a string, which is attached to a table. The clips remain suspended beneath a magnet.



Which diagram best represents the induced polarity of the paper clips?



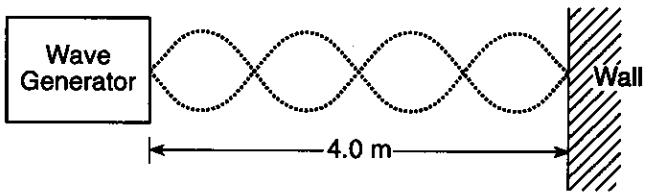
37 The diagram below shows two pulses, *A* and *B*, moving to the right along a uniform rope.



Compared to pulse *A*, pulse *B* has

1 a slower speed and more energy
2 a faster speed and less energy
3 a faster speed and the same energy
4 the same speed and more energy

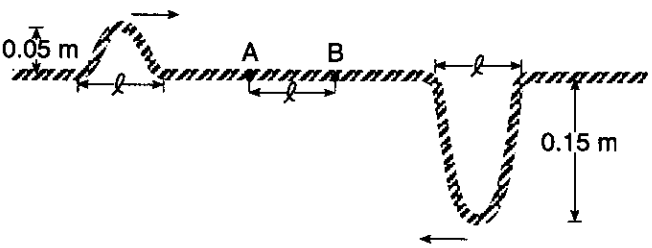
38 A wave generator located 4.0 meters from a reflecting wall produces a standing wave in a string, as shown in the diagram below.



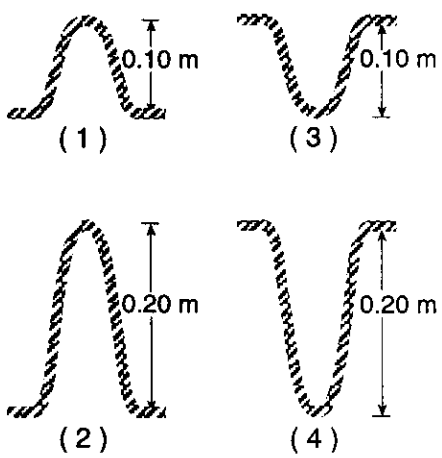
If the speed of the wave is 10. meters per second, what is its frequency?

(1) 0.40 Hz
(2) 5.0 Hz
(3) 10. Hz
(4) 40. Hz

39 The diagram below shows two pulses, each of length ℓ, traveling toward each other at equal speed in a rope.



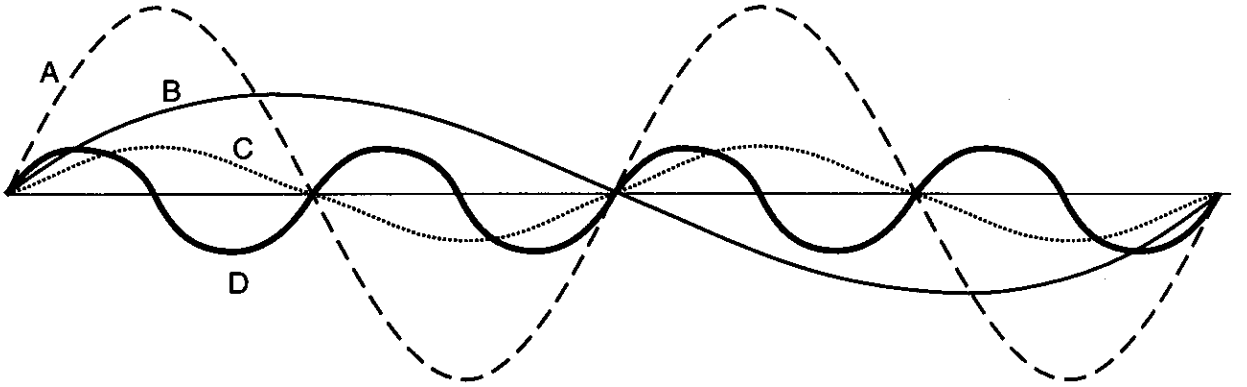
Which diagram best represents the shape of the rope when both pulses are in region *AB*?



40 A nearby object may vibrate strongly when a specific frequency of sound is emitted from a loudspeaker. This phenomenon is called

1 resonance
2 the Doppler effect
3 reflection
4 interference

Base your answers to questions 41 and 42 on the diagram below, which represents waves *A*, *B*, *C*, and *D* traveling in the same medium.



41 Which two waves have the same wavelength?

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

42 Which wave has the longest period?

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

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43 A ray of light strikes a plane mirror at an angle of incidence equal to 35°. The angle between the incident ray and the reflected ray is

(1) 0°
(2) 35°
(3) 55°
(4) 70.°

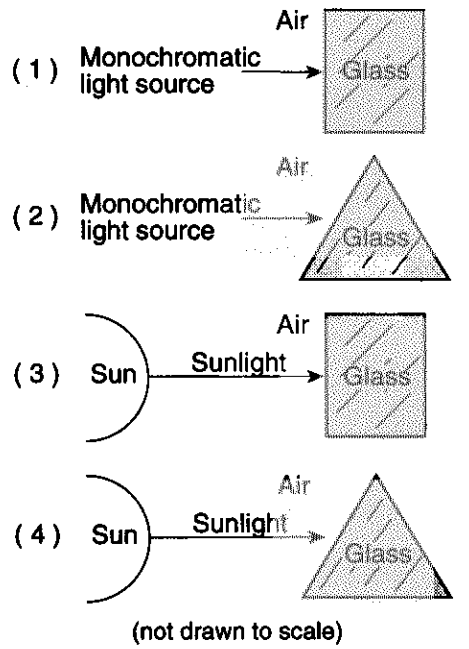
44 A ray of light ($\lambda = 5.9 \times 10^{-7}$ meter) traveling in air is incident on an interface with medium *X* at an angle of 30.°. The angle of refraction for the light ray in medium *X* is 12.°. Medium *X* could be

1 alcohol
2 corn oil
3 diamond
4 flint glass

45 An excited hydrogen atom returns to its ground state. A possible energy change for the atom is a

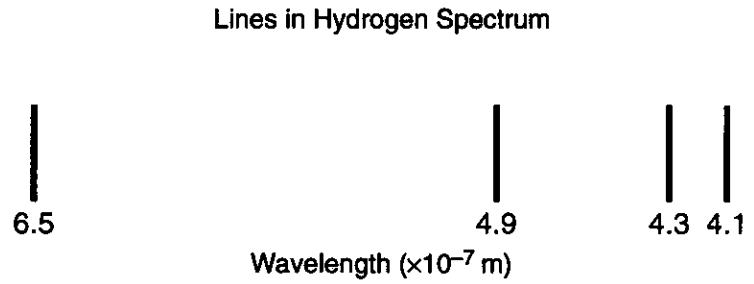
1 loss of 10.20 eV
2 gain of 10.20 eV
3 loss of 3.40 eV
4 gain of 3.40 eV

46 In which diagram below could the light source and optical device be used to demonstrate the phenomenon of dispersion?



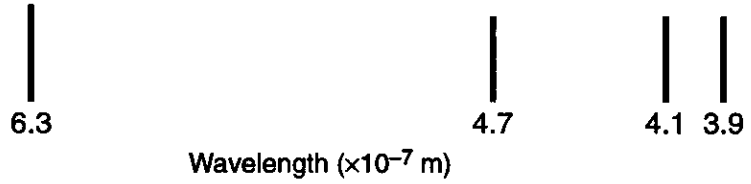
(not drawn to scale)

47 The four-line Balmer series spectrum shown below is emitted by a hydrogen gas sample in a laboratory. A star moving away from Earth also emits a hydrogen spectrum.



Which spectrum might be observed on Earth for this star?

(1)



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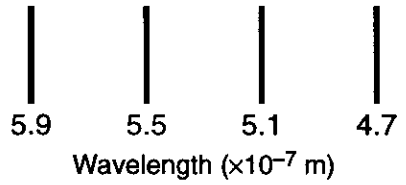

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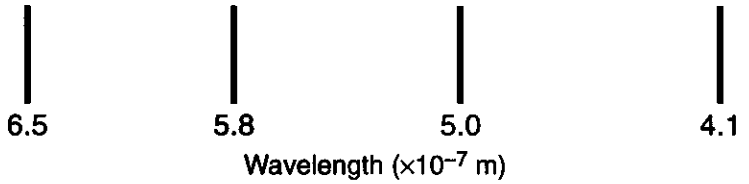
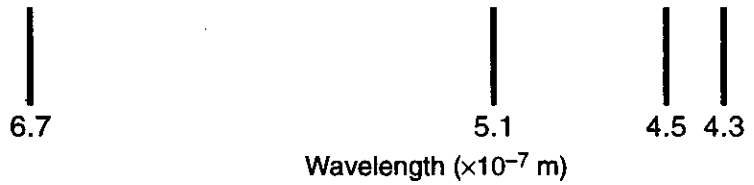
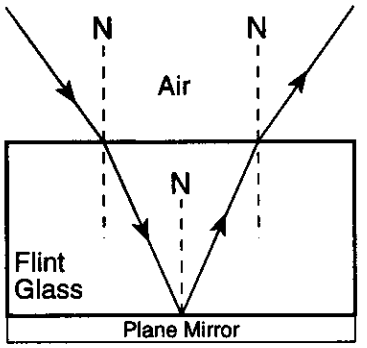


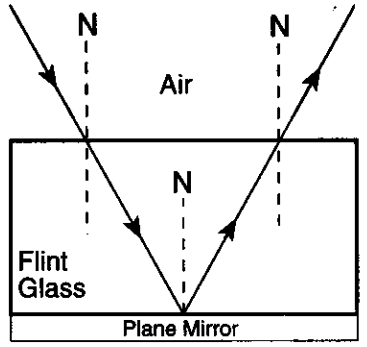
(4)



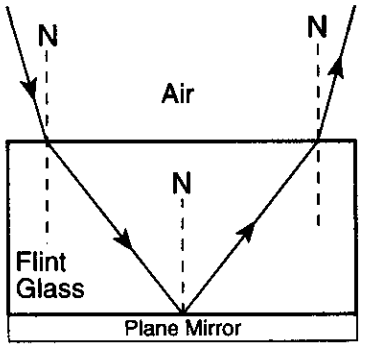
48 A ray of monochromatic light traveling in air enters a rectangular glass block obliquely and strikes a plane mirror at the bottom. Then the ray travels back through the glass and strikes the air-glass interface. Which diagram below best represents the path of this light ray? [*N* represents the normal to the surface.]



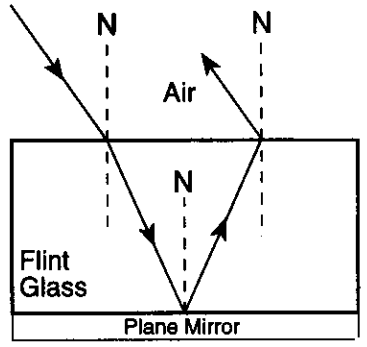
(1)



(3)



(2)



(4)

49 In an experiment, Ernest Rutherford observed that some of the alpha particles directed at a thin gold foil were scattered at large angles. This scattering occurred because the

1 negatively charged alpha particles were attracted to the gold's positive atomic nuclei
2 negatively charged alpha particles were repelled by the gold's negative atomic nuclei
3 positively charged alpha particles were attracted to the gold's negative atomic nuclei
4 positively charged alpha particles were repelled by the gold's positive atomic nuclei

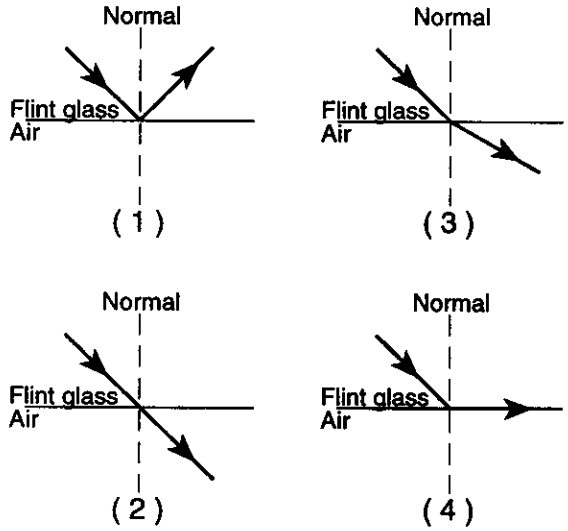
50 The maximum kinetic energy of an electron ejected from a metal by a photon depends on

1 the photon's frequency, only
2 the metal's work function, only
3 both the photon's frequency and the metal's work function
4 neither the photon's frequency nor the metal's work function

51 During a collision between a photon and an electron, there is conservation of

1 energy, only
2 momentum, only
3 both energy and momentum
4 neither energy nor momentum

52 A ray of monochromatic light is traveling in flint glass. The ray strikes the flint glass–air interface at an angle of incidence greater than the critical angle for flint glass. Which diagram best represents the path of this light ray?

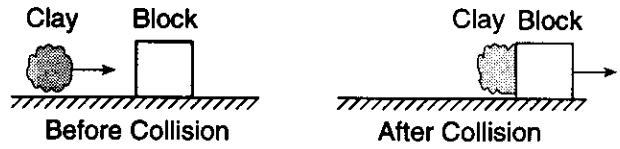


Note that questions 53 through 55 have only three choices.

53 When an incandescent light bulb is turned on, its thin wire filament heats up quickly. As the temperature of this wire filament increases, its electrical resistance

1 decreases
2 increases
3 remains the same

54 As shown in the diagrams below, a lump of clay travels horizontally to the right toward a block at rest on a frictionless surface. Upon collision, the clay and the block stick together and move to the right.



Compared to the total momentum of the clay and the block before the collision, the momentum of the clay-block system after the collision is

1 less
2 greater
3 the same

55 When yellow light shines on a photosensitive metal, photoelectrons are emitted. As the intensity of the light is decreased, the number of photoelectrons emitted per second

1 decreases
2 increases
3 remains the same

Part II

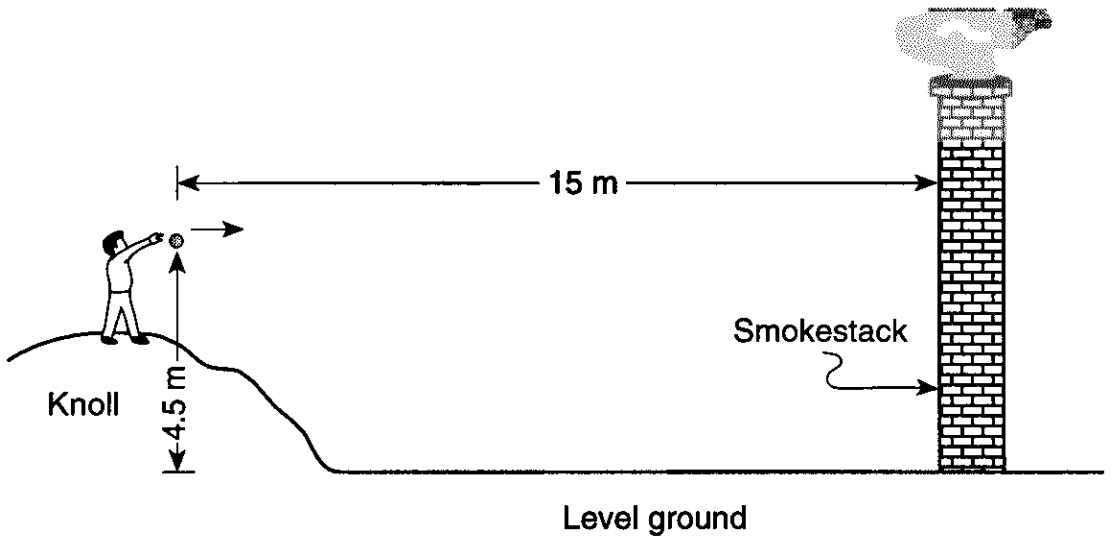
This part consists of six groups, each containing ten questions. Each group tests an optional area of the course. Choose two of these six groups. Be sure that you answer all ten questions in each group chosen. Record the answers to the questions in accordance with the directions on the front page of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

Group 1 — Motion in a Plane

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

Base your answers to questions 56 and 57 on the information and diagram below.

A student standing on a knoll throws a snowball horizontally 4.5 meters above the level ground toward a smokestack 15 meters away. The snowball hits the smokestack 0.65 second after being released. [Neglect air resistance.]



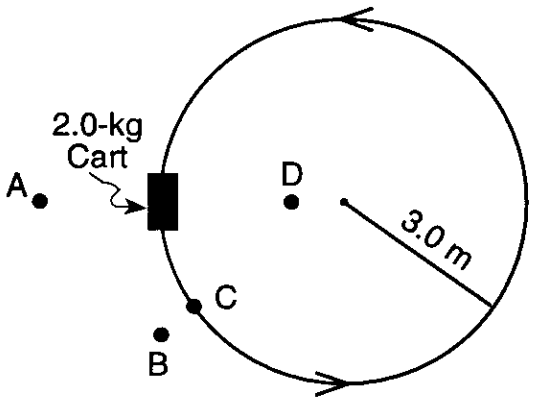
56 Approximately how far above the level ground does the snowball hit the smokestack?

(1) 0.0 m
(2) 0.4 m
(3) 2.4 m
(4) 4.5 m

57 At the instant the snowball is released, the horizontal component of its velocity is approximately

(1) 6.9 m/s
(2) 9.8 m/s
(3) 17 m/s
(4) 23 m/s

Base your answers to questions 58 through 60 on the diagram below which shows a 2.0-kilogram cart traveling at a constant speed in a horizontal circle of radius 3.0 meters. The magnitude of the centripetal force of the cart is 24 newtons.



58 In the position shown, the acceleration of the cart is

(1) 8.0 m/s^2 directed toward point *A*
(2) 8.0 m/s^2 directed toward point *D*
(3) 12 m/s^2 directed toward point *A*
(4) 12 m/s^2 directed toward point *D*

59 Which statement correctly describes the direction of the cart's velocity and centripetal force in the position shown?

1 Velocity is directed toward point *B*, and the centripetal force is directed toward point *A*.
2 Velocity is directed toward point *B*, and the centripetal force is directed toward point *D*.
3 Velocity is directed toward point *C*, and the centripetal force is directed toward point *A*.
4 Velocity is directed toward point *C*, and the centripetal force is directed toward point *D*.

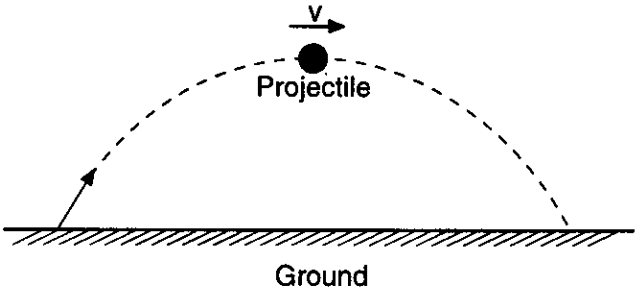
60 What is the speed of the cart?

(1) 6.0 m/s
(2) 16 m/s
(3) 36 m/s
(4) 4.0 m/s

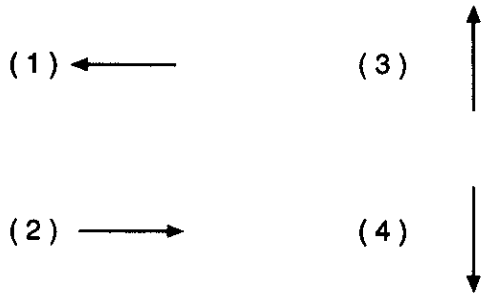
61 An artillery shell is fired at an angle to the horizontal. Its initial velocity has a vertical component of 150 meters per second and a horizontal component of 260 meters per second. What is the magnitude of the initial velocity of the shell?

(1) 9.0×10^4 m/s
(2) 4.1×10^2 m/s
(3) 3.0×10^2 m/s
(4) 1.1×10^2 m/s

62 The diagram below shows a projectile moving with speed v at the top of its trajectory.

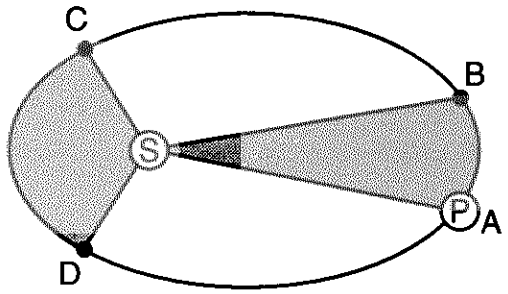


Which vector best represents the acceleration of the projectile in the position shown?



GO RIGHT ON TO THE NEXT PAGE.

Base your answers to question 63 and 64 on the diagram below. A planet, *P*, moves around the Sun, *S*, in an elliptical orbit. The amount of time required for the planet to travel from point *A* to point *B* is equal to the amount of time required to travel from point *C* to point *D*.



63 As the planet moves from point *B* to point *C*, how do its kinetic energy and potential energy change?

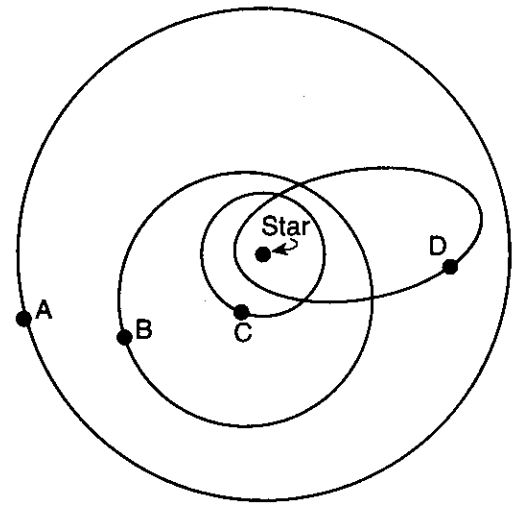
1 Its kinetic energy decreases, and its potential energy decreases.
2 Its kinetic energy decreases, and its potential energy increases.
3 Its kinetic energy increases, and its potential energy decreases.
4 Its kinetic energy increases, and its potential energy increases.

Note that question 64 has only three choices.

64 Compared to the area of region *ABS*, the area of region *CDS* is

1 smaller
2 larger
3 the same

65 The diagram below shows four planets, *A*, *B*, *C*, and *D*, orbiting a star.



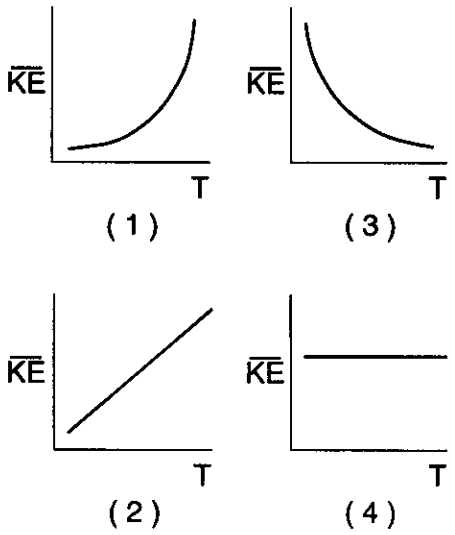
Which planet has the greatest orbital period?

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

Group 2 — Internal Energy

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

66 Which graph best represents the relationship between the average kinetic energy ($\overline{KE}$) of the random motion of the molecules of an ideal gas and its absolute temperature (T)?



67 Normal human body temperature is 37° Celsius. This temperature is equivalent to

(1) 63 K
(2) 137 K
(3) 236 K
(4) 310. K

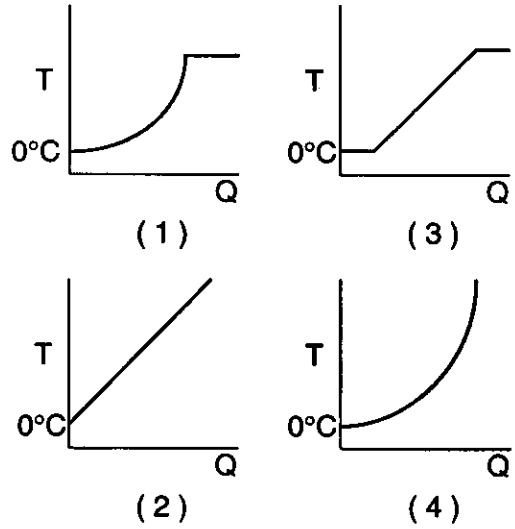
68 If only the respective temperatures of two objects are known, what additional information can be determined?

1 how much heat the objects contain
2 how much heat the warmer object can supply to the colder object
3 whether a heat exchange would take place if the objects were in contact
4 the total amount of energy the objects contain

69 Equal masses of platinum, iron, aluminum, and copper are at their respective boiling points. Which of these metals requires the greatest amount of heat to change from the liquid to the gaseous phase?

1 aluminum
2 iron
3 platinum
4 copper

70 A mixture of ice and water is heated at a constant rate. Which graph best represents the relationship between the temperature of the mixture (T) and the heat added (Q)?



71 A 0.060-kilogram ice cube at 0.0°C is placed in a glass containing 0.250 kilogram of water at 25°C. Which statement describes this system when equilibrium is reached? [Assume no external exchange of heat.]

1 The ice is completely melted and the water temperature is above 0°C.
2 The ice is completely melted and the water temperature is 0°C.
3 Part of the ice remains frozen and the water temperature is above 0°C.
4 Part of the ice remains frozen and the water temperature is 0°C.

72 As 6.00 kilograms of a liquid substance at its freezing point completely freezes, it gives off enough heat to melt 3.00 kilograms of ice at 0°C. The heat of fusion of the substance is

(1) 2.05 kJ/kg
(2) 4.19 kJ/kg
(3) 167 kJ/kg
(4) 668 kJ/kg

73 As lead melts, there is a change in its

1 temperature
2 heat of fusion
3 average molecular kinetic energy
4 average molecular potential energy

74 How do the freezing point and boiling point of ocean water compare to those of distilled water?

1 Ocean water freezes at a lower temperature and boils at a lower temperature.
2 Ocean water freezes at a lower temperature and boils at a higher temperature.
3 Ocean water freezes at a higher temperature and boils at a lower temperature.
4 Ocean water freezes at a higher temperature and boils at a higher temperature.

Note that question 75 has only three choices.

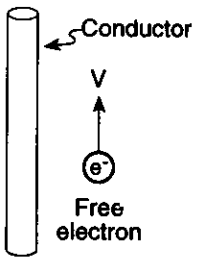
75 A cylinder fitted with a piston contains a fixed mass of an ideal gas. Heat is added to the gas, causing it to expand and raise the piston. If all the added heat is converted to work done in raising the piston, the internal energy of the gas will

1 decrease
2 increase
3 remain the same

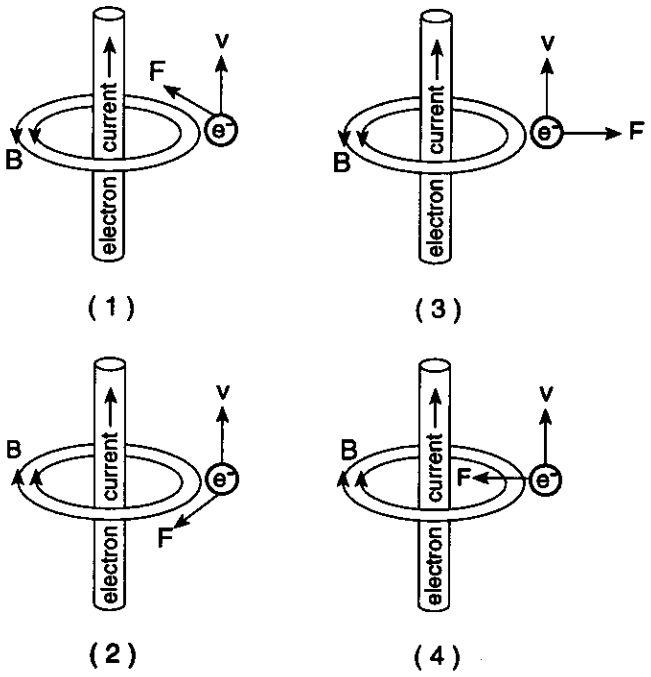
Group 3 — Electromagnetic Applications

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

76 In the diagram below, a free electron is traveling upward at speed v parallel to a conductor. An electron current begins to flow upward in the conductor.



Which diagram best represents the resulting magnetic field, B, and the direction of the magnetic force, F, on the free electron?



77 A magnetic force acts on a charged particle moving at a constant speed perpendicular to a uniform magnetic field. The magnitude of the magnetic force on the particle will increase if the

1 flux density of the magnetic field increases
2 time of travel of the charge increases
3 magnitude of the charge decreases
4 speed of the charge decreases

78 Which statement best describes the torque experienced by a current-carrying loop of wire in an external magnetic field?

1 It is due to the current in the loop of wire, only.
2 It is due to the interaction of the external magnetic field and the magnetic field produced by current in the loop.
3 It is inversely proportional to the length of the conducting loop in the magnetic field.
4 It is inversely proportional to the strength of the permanent magnetic field.

79 Which device consists of a galvanometer with a low-resistance shunt placed in parallel across its terminals?

1 mass spectrometer
2 transformer
3 voltmeter
4 ammeter

80 An operating electric motor produces a back emf, which opposes the applied potential difference. As a result, the armature current

1 decreases
2 increases
3 changes from d.c. to a.c.
4 changes from a.c. to d.c.

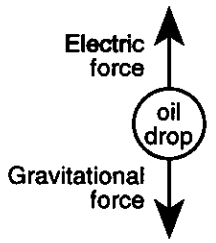
81 As the temperature of a surface increases, how does the rate of thermionic emission change?

1 Electrons are emitted at a lower rate.
2 Electrons are emitted at a higher rate.
3 Protons are emitted at a lower rate.
4 Protons are emitted at a higher rate.

82 In an operating mass spectrometer, the motion of positive ion beams is influenced by

1 electric fields, only
2 magnetic fields, only
3 both electric and magnetic fields
4 neither electric nor magnetic fields

83 The diagram below, which illustrates the Millikan oil drop experiment, shows a 3.2×10^{-14}-kilogram oil drop with a charge of -1.6×10^{-18} coulomb. The oil drop was in equilibrium when the upward electric force on the drop was equal in magnitude to the gravitational force on the drop.



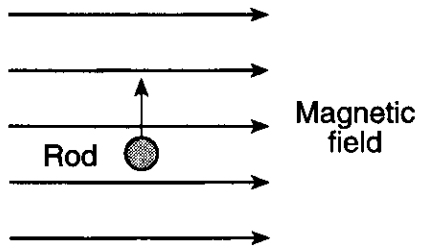
$q = -1.6 \times 10^{-18}$ C

$m = 3.2 \times 10^{-14}$ kg

What was the magnitude of the electric field intensity when this oil drop was in equilibrium?

(1) 2.0×10^{-5} N/C
(2) 2.0×10^{5} N/C
(3) 5.0×10^{-5} N/C
(4) 5.0×10^{5} N/C

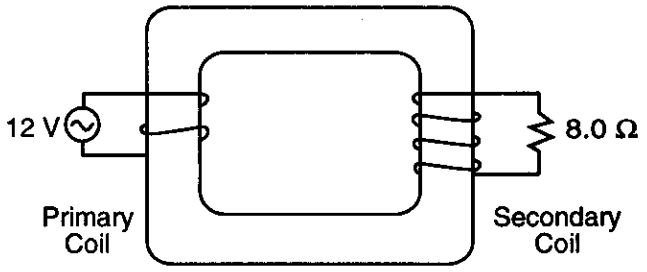
84 The diagram below shows an end view of a metal rod moving upward perpendicular to a uniform magnetic field having a flux density of 2.0×10^{-2} tesla. The 2.0-meter-long wire is moving at a constant speed of 3.0 meters per second.



What is the emf induced across the rod?

(1) 0.060 V
(2) 0.12 V
(3) 1.2 V
(4) 6.0 V

85 The diagram below shows a step-up transformer having a primary coil with two windings and a secondary coil with four windings.



When a potential difference of 12 volts is applied to the primary coil, what is the current in an 8.0-ohm resistor connected to the secondary coil as shown?

(1) 0.33 A
(2) 0.75 A
(3) 3.0 A
(4) 4.5 A

Group 4 — Geometric Optics

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

Base your answers to questions 86 through 88 on the information below.

When a 0.020-meter-tall object is placed 0.15 meter in front of a converging mirror, the object's image appears 0.30 meter in front of the mirror.

86 The focal length of the mirror is

(1) 0.45 m
(2) 0.10 m
(3) −0.10 m
(4) −0.15 m

87 The image of the object is

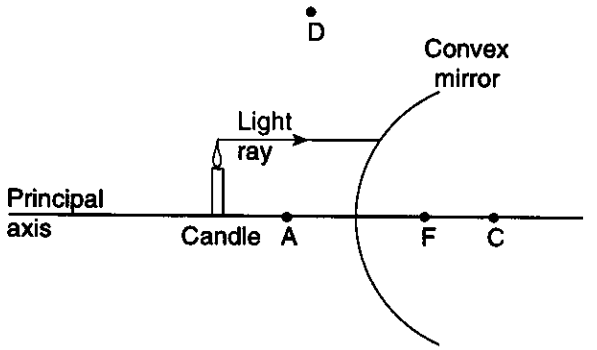
1 real and erect
2 real and inverted
3 virtual and erect
4 virtual and inverted

88 How tall is the image?

(1) 0.010 m
(2) 0.020 m
(3) 0.030 m
(4) 0.040 m

---

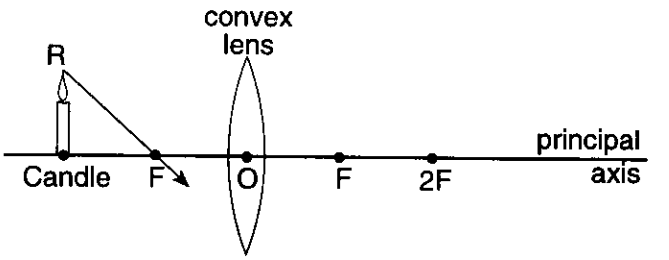
89 The diagram below shows a light ray parallel to the principal axis of a spherical convex (diverging) mirror. Point *F* is the virtual focal point of the mirror and *C* is the center of curvature.



After the light ray is reflected, it will pass through point

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

Base your answers to questions 90 through 92 on the information and diagram below. A convex lens having optical center *O* and principal focus *F* is used to produce an image of a candle. Ray *RF* is shown.



90 The lens is being used to produce an image of the candle that is

1 virtual and erect
2 virtual and inverted
3 real and erect
4 real and inverted

91 When ray *RF* reaches the lens, the ray will

1 reflect back through point *R*
2 polarize and travel perpendicular to the principal axis
3 refract and pass through point *2F*
4 refract and emerge parallel to the principal axis

Note that question 92 has only three choices.

92 As the candle is moved toward the left, the size of its image will

1 decrease
2 increase
3 remain the same

---

93 A 2.0-meter-tall student is able to view his entire body at once using a plane mirror. The minimum length of the mirror is

(1) 1.0 m
(2) 0.50 m
(3) 1.5 m
(4) 2.5 m

94 The filament in an automobile headlight radiates light that is reflected from a concave (converging) mirror. The reflected rays form a parallel beam of light because the filament is placed

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

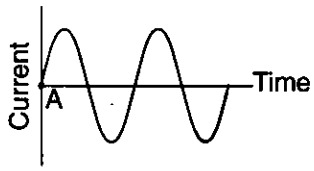
95 Which phenomenon may cause a concave mirror to form fuzzy, out-of-focus images?

1 spherical aberration
2 chromatic aberration
3 dispersion
4 refraction

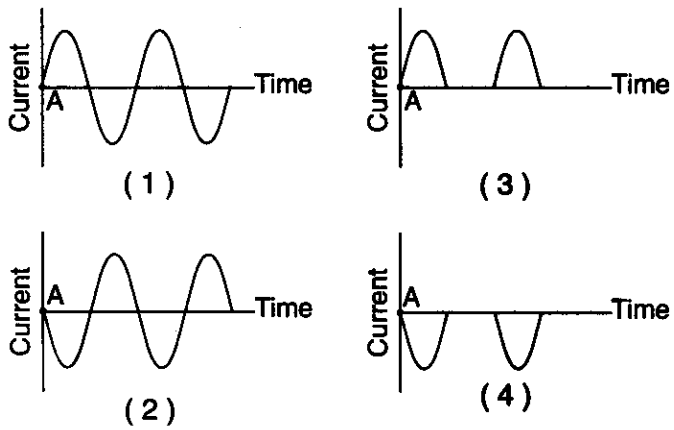
Group 5 — Solid State

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

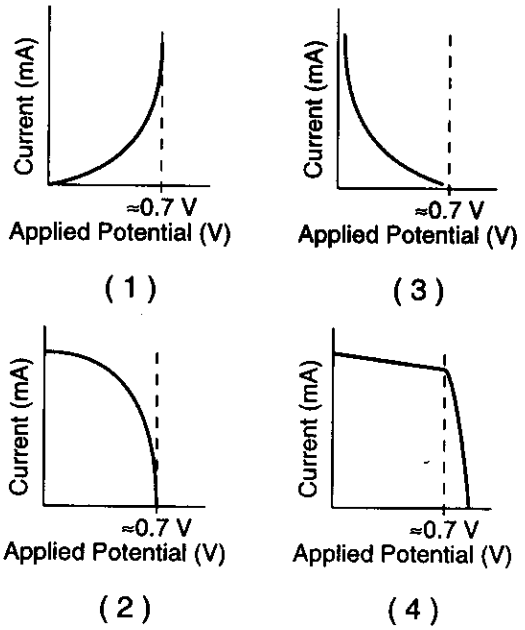
96 The diagram below represents the wave form and phase of an alternating current signal.



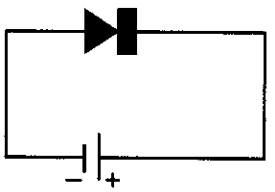
Which graph best represents the wave form and phase of this signal after it has passed through a diode rectifier?



97 Which graph best represents the relationship between current and potential difference for a forward-biased diode?



98 A circuit is shown in the diagram below.



The current in the electronic device is classified as

1 reverse biased
2 forward biased
3 unbiased
4 transistorized

Note that question 99 has only three choices.

99 Compared to the number of holes in an *N*-type semiconductor, the number of free electrons is

1 less
2 greater
3 the same

100 The primary source of holes in *P-N-P* transistors is the

1 transmitter
2 collector
3 base
4 emitter

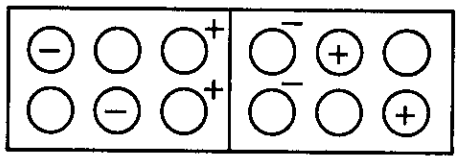
101 What occurs as the temperature of a solid conductor increases?

1 The cross-sectional area of the conductor decreases.
2 The electrons with higher kinetic energy move slower.
3 More collisions occur between conduction electrons and atom kernels.
4 More electrons move from the conduction band into the valence band.

102 Charge carriers in a semiconductor can be

1 electrons, only
2 holes, only
3 both electrons and holes
4 both electrons and protons

103 What type of semiconductor device is formed by the two semiconductors shown below?



1 triode
2 transistor
3 donor
4 diode

104 Indium is an element that has only three valence electrons. If a very small amount of indium was added to a germanium crystal, the resulting semiconductor would be

(1) *N*-type
(2) *P*-type
(3) negatively charged
(4) positively charged

105 How should the junctions of an *N-P-N* transistor be biased?

1 The emitter-base is forward biased and the base-collector is reverse biased.
2 The emitter-base and collector-base are forward biased.
3 The emitter-base is reverse biased and the base-collector is forward biased.
4 The emitter-base and collector-base are reverse biased.

Group 6 — Nuclear Energy

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

Base your answers to questions 106 and 107 on the equation below.

$$^{32}_{16}S + {}^{1}_{0}n \rightarrow {}^{32}_{15}P + X$$

106 How many neutrons are in an atom of $^{32}_{15}P$?

(1) 15
(2) 16
(3) 17
(4) 32

107 What is particle X?

1 a proton
2 a neutron
3 an alpha particle
4 a beta particle

108 Compared to the gravitational force between two nucleons in an atom of helium, the nuclear force between the nucleons is

1 weaker and has a shorter range
2 weaker and has a longer range
3 stronger and has a shorter range
4 stronger and has a longer range

109 The subatomic particles that make up protons are called

1 hyperons
2 baryons
3 positrons
4 quarks

110 Which nuclear phenomenon produces a change in the mass number of a nucleus?

1 alpha decay
2 electron capture
3 gamma ray emission
4 positron emission

111 According to the Uranium Disintegration Series, how many different isotopes of polonium (Po) are formed as $^{238}_{92}U$ decays to $^{206}_{82}Pb$?

(1) 1
(2) 2
(3) 3
(4) 0

112 Gamma radiation consists of a stream of high-energy

1 photons
2 protons
3 neutrons
4 electrons

113 A radioactive nuclide sample has a half-life of 3.0 days. If 2.0 kilograms of the sample remains unchanged after 9.0 days, what was the initial mass of the sample?

(1) 18 kg
(2) 16 kg
(3) 8.0 kg
(4) 6.0 kg

114 Uranium-235 and plutonium-239 are used as fuels in nuclear reactors because of their

1 ability to undergo fission
2 ability to undergo fusion
3 inability to absorb neutrons
4 inability to release neutrons

115 What is represented by the nuclear reaction below?

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + \text{energy}$$

1 fusion
2 fission
3 alpha decay
4 beta decay

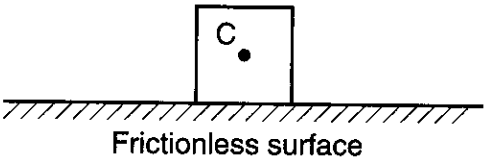
Part III

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 and 117 on the information below.

A 5.0-kilogram block weighing 49 newtons sits on a frictionless, horizontal surface. A horizontal force of 20. newtons toward the right is applied to the block. [Neglect air resistance.]

116 On the diagram *on your answer paper*, draw a vector to represent each of the *three* forces acting on the block. Use a ruler and a scale of 1.0 centimeter = 10. newtons. Begin each vector at point *C* and label its magnitude in newtons. The diagram below is to be used for practice purposes only. Be sure your final answer appears *on your answer paper*. [3]



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

Base your answers to questions 118 through 120 on the information below.

A scientist set up an experiment to collect data about lightning. In one lightning flash, a charge of 25 coulombs was transferred from the base of a cloud to the ground. The scientist measured a potential difference of 1.8×10^6 volts between the cloud and the ground and an average current of 2.0×10^4 amperes.

118 Determine the time interval over which this flash occurred. [Show all calculations, including the equation and substitution with units.] [2]

119 Determine the amount of energy, in joules, involved in the transfer of the electrons from the cloud to the ground. [Show all calculations, including the equation and substitution with units.] [2]

120 The scientist was several kilometers from the lightning flash. Using one or more complete sentences, explain why the scientist saw the lightning flash several seconds before he heard the sound of the thunderclap from that flash. [1]

Base your answers to questions 121 through 124 on the information in the data table below. The data were obtained by varying the force applied to a spring and measuring the corresponding elongation of the spring.

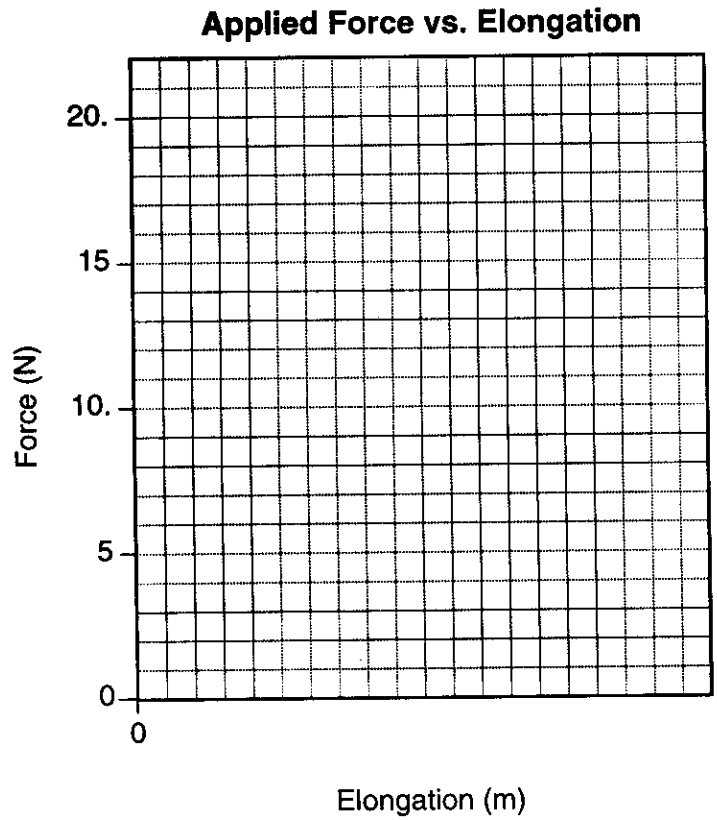
Applied Force (N)	Elongation of Spring (m)
0.0	0.00
4.0	0.16
8.0	0.27
12.0	0.42
16.0	0.54
20.0	0.71

Directions (121–123): Using the information in the 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.*

121 Mark an appropriate scale on the axis labeled "Elongation (m)." [1]

122 Plot the data points for force versus elongation. [1]

123 Draw the best-fit line. [1]



124 *Using the best-fit line*, determine the spring constant of the spring. [Show all calculations, including the equation and substitution with units.] [2]

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Wednesday, June 17, 1998 — 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	
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	
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	4

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	4
92	1	2	3	
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	
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	4

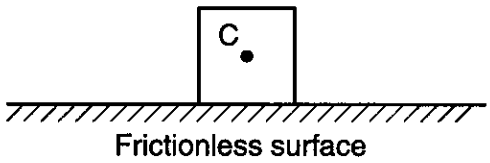
Group 6
Nuclear Energy

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 all questions in this part.

116



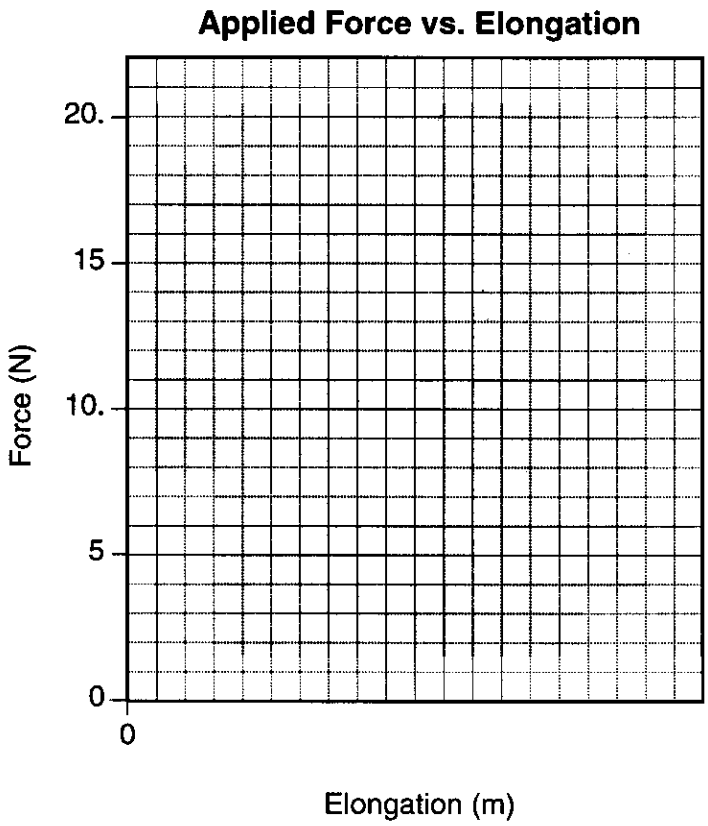
117

118

119

120

121–123



124

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

Wednesday, June 17, 1998—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	2	X	4	41	1	X	3	4
2	1	2	X	4	22	1	2	3	X	42	1	X	3	4
3	X	2	3	4	23	1	2	X	4	43	1	2	3	X
4	X	2	3	4	24	X	2	3	4	44	1	2	X	4
5	1	2	3	X	25	1	X	3	4	45	X	2	3	4
6	1	2	3	X	26	1	X	3	4	46	1	2	3	X
7	X	2	3	4	27	1	2	3	X	47	1	2	3	X
8	1	2	X	4	28	1	X	3	4	48	X	2	3	4
9	1	X	3	4	29	1	2	X	4	49	1	2	3	X
10	X	2	3	4	30	1	2	X	4	50	1	2	X	4
11	1	2	X	4	31	1	X	3	4	51	1	2	X	4
12	X	2	3	4	32	1	2	3	X	52	X	2	3	4
13	1	2	3	X	33	X	2	3	4	53	1	X	3	
14	X	2	3	4	34	1	X	3	4	54	1	2	X	
15	1	2	X	4	35	X	2	3	4	55	X	2	3	
16	X	2	3	4	36	1	2	3	X					
17	1	X	3	4	37	1	2	3	X					
18	1	2	3	X	38	1	X	3	4					
19	X	2	3	4	39	1	2	X	4					
20	1	X	3	4	40	X	2	3	4					

Directions to the teacher:

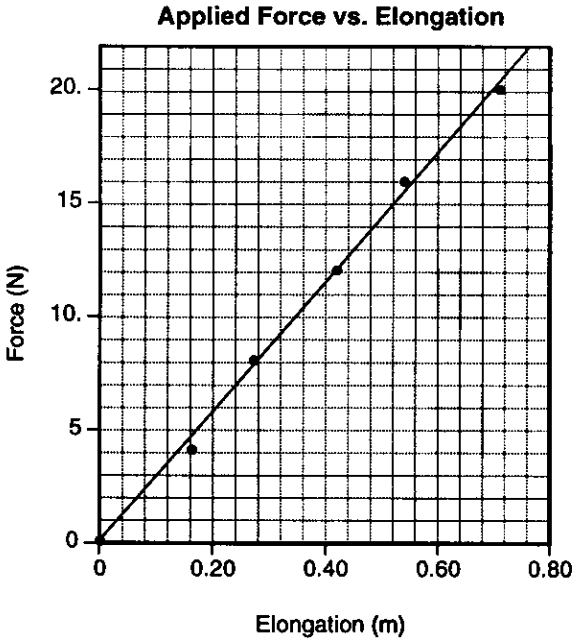
Use only *red* ink or *red* pencil in rating Regents examination papers. Do *not* correct the student's work by making insertions or changes of any kind.

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.

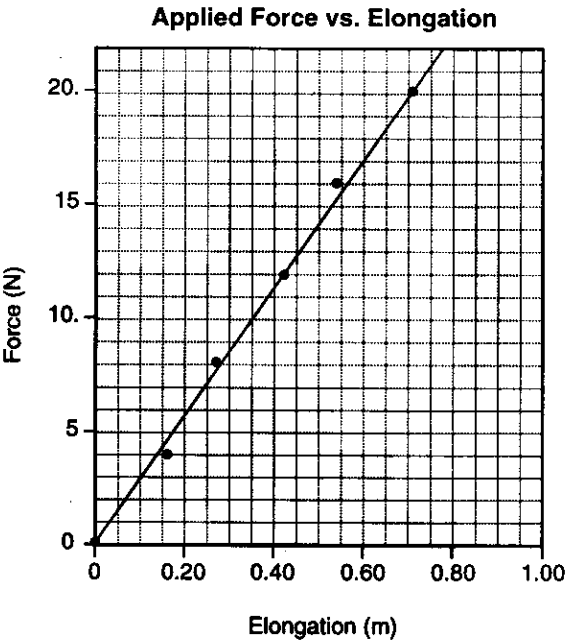
To facilitate scoring, the scoring key has been printed in the same format as the answer paper. The scoring key for **Part I and Part II** may be made into a scoring stencil by punching out the correct answers. Be sure that the stencil is aligned with the answer paper so that the holes correspond to 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]

121–123 Examples of Acceptable Responses



or



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

Group 2
Internal Energy

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

Group 3
Electromagnetic Applications

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

Group 4
Geometric Optics

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

Group 5
Solid State

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

Group 6
Nuclear Energy

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

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 117, 118, 119, and 124.

- 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 a total of three credits.

If each of the three vectors meets *all three* of the following criteria, award a total of three credits.

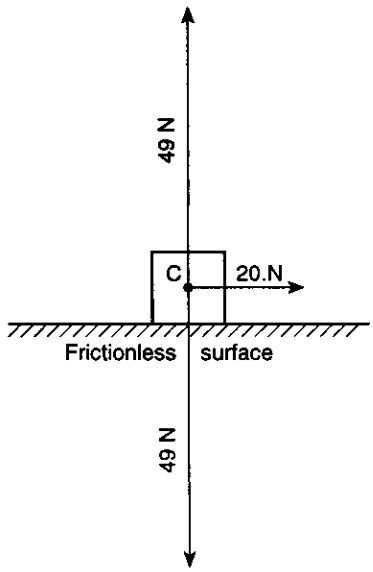
- a line originating at point *C* and having an arrowhead indicating the correct direction (A vector with either of its ends in contact with an edge of the block is acceptable.)
  - applied force: parallel to the horizontal
  - weight: perpendicular to the horizontal
  - normal force: perpendicular to the horizontal
- the vector, including its arrowhead, is drawn to the appropriate length
  - applied force: 2.0 cm ± 0.2 cm long
  - weight: 4.9 cm ± 0.2 cm long
  - normal force: 4.9 cm ± 0.2 cm long
- the vectors must be labeled
  - applied force: 20. N or 20 N
  - weight: 49 N
  - normal force: 49 N

If each of the three vectors meets *at least two* of the three criteria, award a total of two credits.

If each of the three vectors meets *at least one* of the three criteria, award a total of one credit.

[See vector diagram, top of next column.]

Example of Acceptable Response



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

Examples of Acceptable Responses

$F = ma$

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

$a = \frac{20.\ \text{N}}{5.0\ \text{kg}}$

$a = 4.0\ \text{m/s}^2$

or

$a = 4\ \text{N/kg}$

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

Examples of Acceptable Responses

$I = \frac{\Delta q}{\Delta t}$

$\Delta t = \frac{\Delta q}{I}$

$\Delta t = \frac{25\ \text{C}}{2.0 \times 10^4\ \text{A}}$

$\Delta t = 1.3 \times 10^{-3}\ \text{s}$

or

$\Delta t = 1.25 \times 10^{-3}\ \text{C/A}$

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

Examples of Acceptable Responses

$V = \frac{W}{q}$

$W = Vq$

$W = (1.8 \times 10^6\ \text{V})\ (25\ \text{C})$

$W = 4.5 \times 10^7\ \text{J}$

or

$W = 45 \times 10^6\ \text{V•C}$

120 Allow one credit. To receive this credit the response must be written in one or more complete sentences.

Examples of Acceptable Responses

Light travels much faster than sound.

The speed of light is 3.0×10^8 m/s and the speed of sound is only 3.3×10^2 m/s.

121–123 Examples of Acceptable Responses

[See the back of the Scoring Key for Part I for two acceptable graphs.]

121 Allow one credit.

The scale must be linear and the scale divisions appropriate. A scale of 0.10 meter per division is *not* acceptable.

122 Allow one credit.

All points must be plotted accurately (±0.3 grid space). Allow credit if the student correctly uses his or her response to question 121.

123 Allow one credit.

The best-fit line must be straight. If one or more points are plotted incorrectly in question 122 but a best-fit straight line is drawn, allow this credit.

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

Allow credit for an answer that is consistent with the student's graph, *unless* the student receives no credits for questions 122 and 123. In that case, credit may be awarded if the student correctly calculates the spring constant using data in the table.

Note: The slope *may* be determined by direct substitution into the equation $k = F/x$ *only* if the best-fit line passes through the *origin* and the data values used for substitution are on that line.

Example of Acceptable Response

This response is based on the assumption that the elongation of 0.42 meter due to an applied force of 12.0 newtons lies on the best-fit line and that the line passes through the *origin*.

$F = kx$

$k = \frac{F}{x}$

$k = \frac{12.0\ \text{N}}{0.42\ \text{m}}$

$k = 29\ \text{N/m}\ (\pm 2\ \text{N/m})$