The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, January 23, 2001 — 9:15 a.m. to 12:15 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. You must also have access to a centimeter ruler and a protractor during this 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

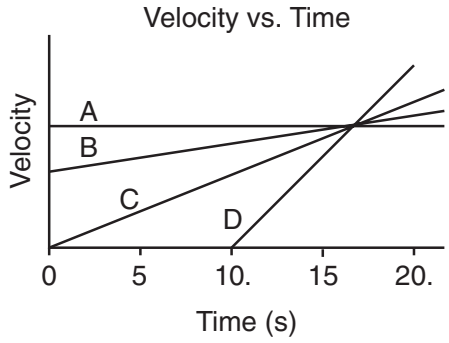
Answer all 55 questions in this part. [65]

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 The maximum time allowed for the completion of this examination is approximately

(1) 10^2 s (3) 10^4 s
(2) 10^3 s (4) 10^5 s

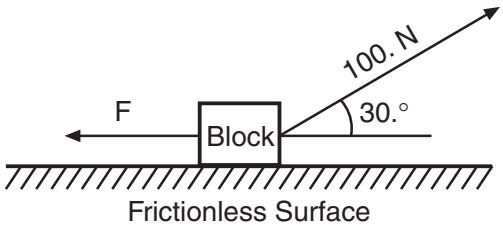
2 The diagram below represents the relationship between velocity and time of travel for four cars, *A*, *B*, *C*, and *D*, in straight-line motion.



Which car has the greatest acceleration during the time interval 10. seconds to 15 seconds?

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

3 The diagram below shows a block on a horizontal frictionless surface. A 100.-newton force acts on the block at an angle of 30.° above the horizontal.



What is the magnitude of force *F* if it establishes equilibrium?

(1) 50.0 N (3) 100. N
(2) 86.6 N (4) 187 N

4 Approximately how far will an object near Earth's surface fall in 3.0 seconds?

(1) 88 m (3) 29 m
(2) 44 m (4) 9.8 m

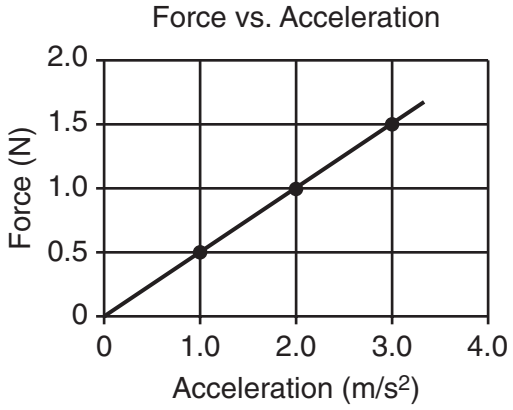
5 A 5-newton force directed east and a 5-newton force directed north act concurrently on a point. The resultant of the two forces is

(1) 5 N northeast (3) 7 N northeast
(2) 10. N southwest (4) 7 N southwest

6 Into how many possible components can a single force be resolved?

1 an unlimited number
2 two components
3 three components
4 four components at right angles to each other

7 The graph below represents the relationship between the forces applied to an object and the corresponding accelerations produced.



What is the inertial mass of the object?

(1) 1.0 kg (3) 0.50 kg
(2) 2.0 kg (4) 1.5 kg

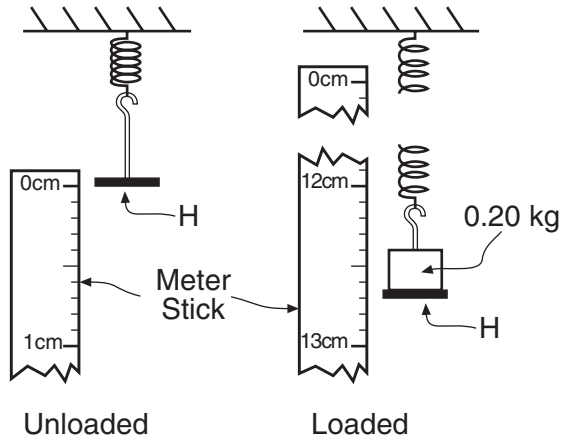
8 Which is a derived unit?

1 meter
2 second
3 kilogram
4 newton

9 What is the magnitude of the gravitational force between two 5.0-kilogram masses separated by a distance of 5.0 meters?

(1) 5.0×10^{0} N
(2) 3.3×10^{-10} N
(3) 6.7×10^{-11} N
(4) 1.3×10^{-11} N

10 What is the displacement of the mass hanger (H) shown in the diagram after a 0.20-kilogram mass is loaded on it? [Assume the hanger is at rest in both positions.]



(1) 12.30 cm
(2) 12.50 cm
(3) 12.70 cm
(4) 13.30 cm

11 Two cars having different weights are traveling on a level surface at different constant velocities. Within the same time interval, greater force will always be required to stop the car that has the greater

1 weight
2 kinetic energy
3 velocity
4 momentum

12 A 0.050-kilogram bullet is fired from a 4.0-kilogram rifle that is initially at rest. If the bullet leaves the rifle with momentum having a magnitude of 20. kilogram•meters per second, the rifle will recoil with a momentum having a magnitude of

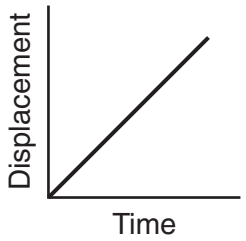
(1) 1,600 kg•m/s
(2) 80. kg•m/s
(3) 20. kg•m/s
(4) 0.25 kg•m/s

13 A 2.0-kilogram mass weighs 10. newtons on planet X. The acceleration due to gravity on planet X is approximately

(1) 0.20 m/s^2
(2) 5.0 m/s^2
(3) 9.8 m/s^2
(4) 20. m/s^2

Note that questions 14 and 15 have only three choices.

14 The graph below represents the motion of an object.



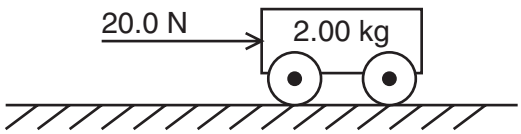
According to the graph, as time increases, the velocity of the object

1 decreases
2 increases
3 remains the same

15 A wooden block is at rest on a horizontal steel surface. If a 10.-newton force applied parallel to the surface is required to set the block in motion, how much force is required to keep the block moving at constant velocity?

(1) less than 10. N
(2) greater than 10. N
(3) 10. N

16 In the diagram below, a 20.0-newton force is used to push a 2.00-kilogram cart a distance of 5.00 meters.

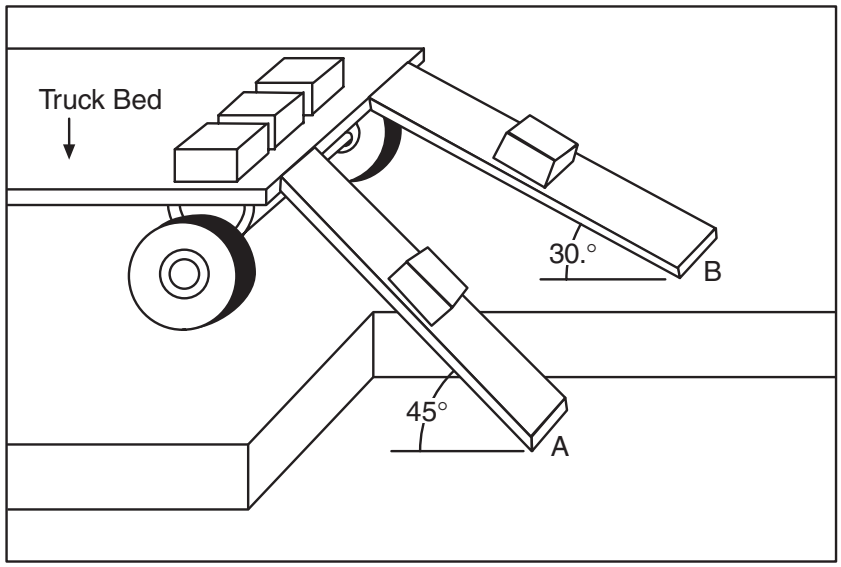


The work done on the cart is

(1) 100. J
(2) 200. J
(3) 150. J
(4) 40.0 J

Note that questions 17 and 18 have only three choices.

17 The diagram below shows two identical wooden planks, *A* and *B*, at different incline angles, used to slide concrete blocks from a truck.



Compared to the amount of work done against friction by a block sliding down plank *A*, the work done against friction by a block sliding down plank *B* is

1 less
2 more
3 the same

18 Two vacationers walk out on a horizontal pier as shown in the diagram below.

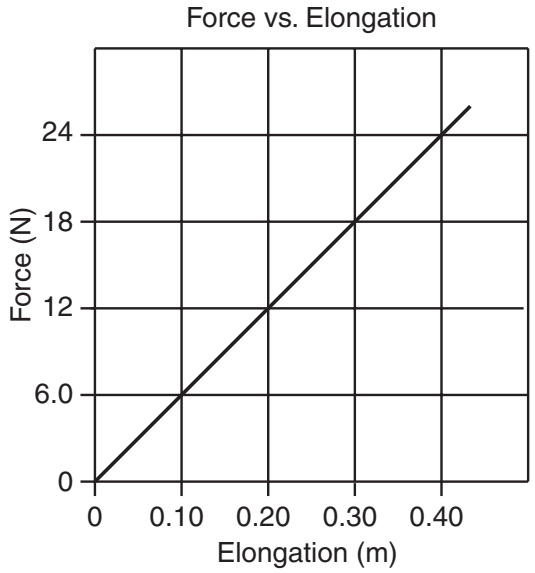
As they approach the end of the pier, their gravitational potential energy will

1 decrease
2 increase
3 remain the same

19 A girl weighing 500. newtons takes 50. seconds to climb a flight of stairs 18 meters high. Her power output vertically is

(1) 9,000 W
(2) 4,000 W
(3) 1,400 W
(4) 180 W

20 The graph below represents the elongation of a spring as a function of the applied force.



How much work must be done to stretch the spring 0.40 meter?

(1) 4.8 J
(2) 6.0 J
(3) 9.8 J
(4) 24 J

21 Metal sphere *A* has a charge of +12 elementary charges and identical sphere *B* has a charge of +16 elementary charges. After the two spheres are brought into contact, the charge on sphere *A* is

(1) –2 elementary charges
(2) +2 elementary charges
(3) +14 elementary charges
(4) +28 elementary charges

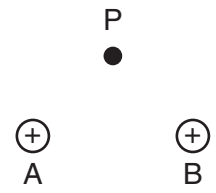
22 Electrostatic force *F* exists between two point charges. If the distance between the charges is tripled, the force between the charges will be

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

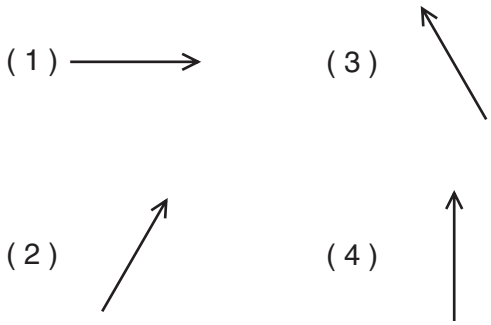
23 Which net charge could be found on an object?

(1) $+3.2 \times 10^{-18}$ C
(2) $+2.4 \times 10^{-19}$ C
(3) -1.8×10^{-18} C
(4) -0.80×10^{-19} C

24 In the diagram below, two identical spheres, *A* and *B*, have equal net positive charges.



Which arrow best represents the direction of their resultant electric field at point *P*?



25 How much work is done in moving 5.0 coulombs of charge against a potential difference of 12 volts?

(1) 2.4 J
(2) 12 J
(3) 30. J
(4) 60. J

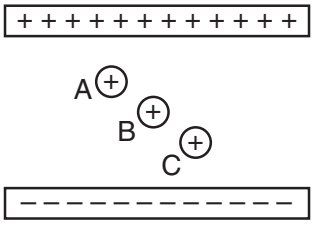
26 Compared to insulators, metals are better conductors of electricity because metals contain more free

1 protons
2 electrons
3 positive ions
4 negative ions

27 If a 15-ohm resistor is connected in parallel with a 30.-ohm resistor, the equivalent resistance is

(1) 15 Ω
(2) 2.0 Ω
(3) 10. Ω
(4) 45 Ω

28 Identical charges *A*, *B*, and *C* are located between two oppositely charged parallel plates, as shown in the diagram below.



The magnitude of the force exerted on the charges by the electric field between the plates is

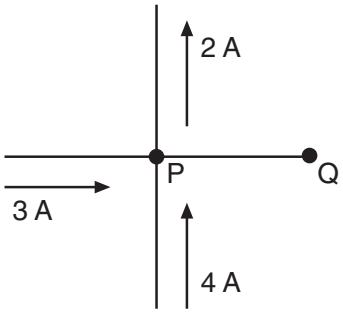
1 least on *A* and greatest on *C*
2 greatest on *A* and least on *C*
3 the same on *A* and *C*, but less on *B*
4 the same for *A*, *B*, and *C*

29 A metal wire has length *L* and cross-sectional area *A*. The resistance of the wire is directly proportional to

(1) $\frac{L}{A}$ (3) $\frac{A}{L}$

(2) $L \times A$ (4) $L + A$

30 The diagram below shows electric currents in conductors that meet at junction *P*.



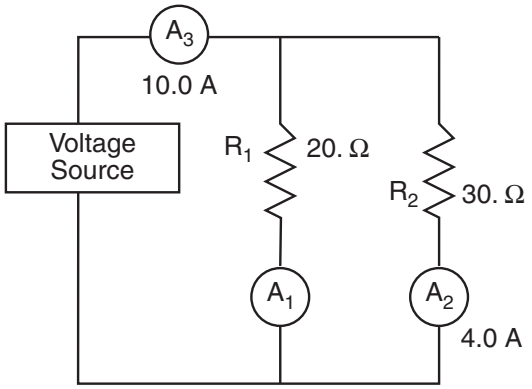
What are the magnitude and direction of the current in conductor *PQ*?

(1) 9 A toward *P* (3) 5 A toward *P*
(2) 9 A toward *Q* (4) 5 A toward *Q*

31 A glass rod becomes positively charged when it is rubbed with silk. This net positive charge accumulates because the glass rod

1 gains electrons 3 loses electrons
2 gains protons 4 loses protons

Base your answers to questions 32 and 33 on the diagram below, which shows two resistors and three ammeters connected to a voltage source.



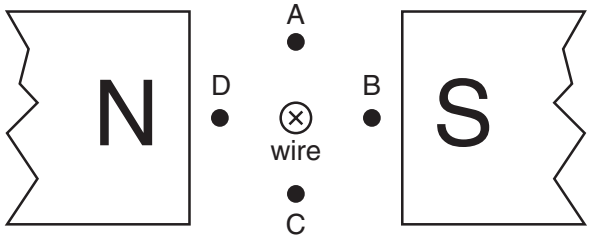
32 What is the potential difference across the source?

(1) 440 V (3) 120 V
(2) 220 V (4) 60. V

33 What is the current reading of ammeter A_1?

(1) 10.0 A (3) 3.0 A
(2) 6.0 A (4) 4.0 A

34 In the diagram below, a wire carrying an electron current into the page, as denoted by *X*, is placed in a magnetic field.



The magnetic field exerts a force on the wire toward point

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

35 A wire carries a current of 2.0 amperes. How many electrons pass a given point in this wire in 1.0 second?

(1) 1.3×10^{18} (3) 1.3×10^{19}
(2) 2.0×10^{18} (4) 2.0×10^{19}

36 How much time is required for an operating 100-watt light bulb to dissipate 10 joules of electrical energy?

(1) 1 s
(2) 0.1 s
(3) 10 s
(4) 1000 s

Note that question 37 has only three choices.

37 A wire conductor is moved at constant speed perpendicularly to a uniform magnetic field. If the strength of the magnetic field is increased, the induced potential across the ends of the conductor

1 decreases
2 increases
3 remains the same

38 A light spring is attached to a heavier spring at one end. A pulse traveling along the light spring is incident on the boundary with the heavier spring. At this boundary, the pulse will be

1 totally reflected
2 totally absorbed
3 totally transmitted into the heavier spring
4 partially reflected and partially transmitted into the heavier spring

39 As a wave travels through a medium, the particles of the medium vibrate in the direction of the wave's travel. What type of wave is traveling through the medium?

1 longitudinal
2 torsional
3 transverse
4 hyperbolic

40 A wave completes one vibration as it moves a distance of 2 meters at a speed of 20 meters per second. What is the frequency of the wave?

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

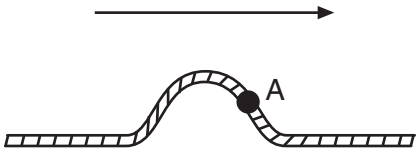
41 What is the period of a wave if 20 crests pass an observer in 4 seconds?

(1) 80 s
(2) 0.2 s
(3) 5 s
(4) 4 s

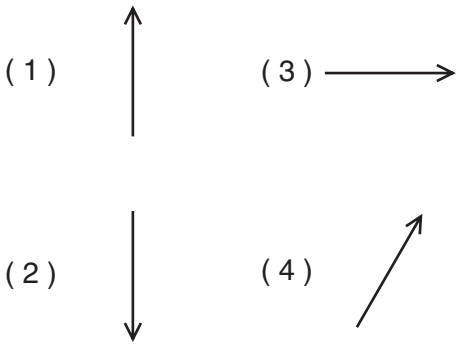
42 A beam of green light may have a frequency of

(1) 5.0×10^{-7} Hz
(2) 1.5×10^{2} Hz
(3) 3.0×10^{8} Hz
(4) 6.0×10^{14} Hz

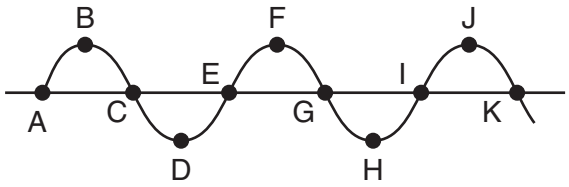
43 The diagram below shows a pulse moving to the right in a rope. *A* is a point on the rope.



Which arrow best shows the direction of movement of point *A* at this instant?



44 The diagram below represents a periodic wave.



Which two points on the wave are in phase?

(1) *A* and *D*
(2) *A* and *G*
(3) *C* and *K*
(4) *D* and *I*

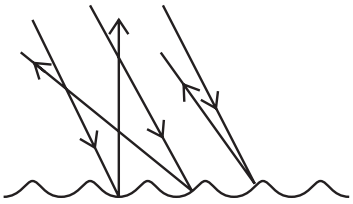
45 Two waves traveling in the same medium interfere to produce a standing wave. What is the phase difference between the two waves at a node?

(1) 0°
(2) 90°
(3) 180°
(4) 360°

46 When yellow light having a wavelength of 5.8×10^{-7} meter shines through two slits 2.0×10^{-4} meter apart, an interference pattern is formed on a screen 2.0 meters from the slits. What distance separates the first-order maximum and the central maximum?

(1) 5.8×10^{-11} m
(2) 1.5×10^{-3} m
(3) 5.8×10^{-3} m
(4) 6.9×10^{2} m

47 The diagram below shows parallel rays of light incident on an irregular surface.



Which phenomenon of light is illustrated by the diagram?

1 diffraction
2 refraction
3 regular reflection
4 diffuse reflection

48 What is the speed of light in a medium having an absolute index of refraction of 2.3?

(1) 0.77×10^8 m/s
(2) 1.3×10^8 m/s
(3) 1.5×10^8 m/s
(4) 2.3×10^8 m/s

Note that questions 49 through 52 have only three choices.

49 The driver of a car blows the horn as the car approaches a crosswalk. Compared to the actual pitch of the horn, the pitch observed by a pedestrian in the crosswalk is

1 lower
2 higher
3 the same

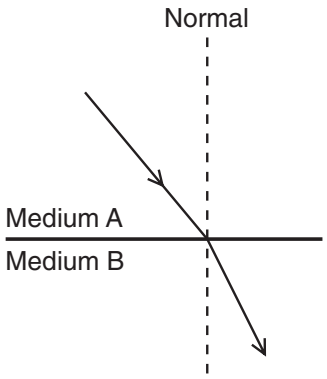
50 Compared to wavelengths of visible light, the wavelengths of ultraviolet light are

1 shorter
2 longer
3 the same

51 As a pulse travels along a rope, the pulse loses energy and its amplitude

1 decreases
2 increases
3 remains the same

52 The diagram below shows a ray of light passing through two media.



When the wave travels from medium *A* into medium *B*, its speed

1 decreases
2 increases
3 remains the same

53 Experiments performed with light indicate that light exhibits

1 particle properties, only
2 wave properties, only
3 both particle and wave properties
4 neither particle nor wave properties

54 What is the energy of a quantum of light having a frequency of 6.0×10^{14} hertz?

(1) 1.6×10^{-19} J
(2) 4.0×10^{-19} J
(3) 3.0×10^8 J
(4) 5.0×10^{-7} J

55 Photons with an energy of 7.9 electronvolts strike a zinc plate, causing the emission of photoelectrons with a maximum kinetic energy of 4.0 electronvolts. The work function of the zinc plate is

(1) 11.9 eV
(2) 7.9 eV
(3) 3.9 eV
(4) 4.0 eV

Part II

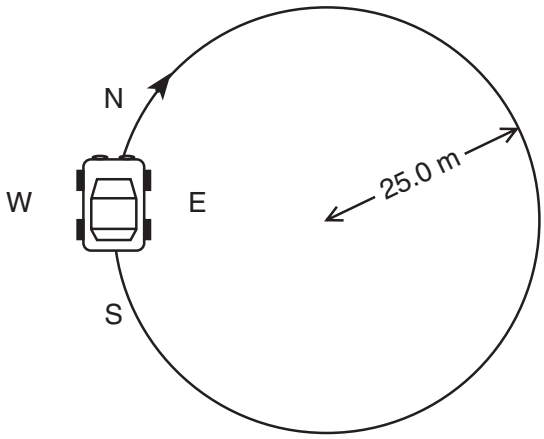
This part consists of six groups, each containing ten questions. Each group tests an optional area of the course. Choose two of these six groups. Be sure that you answer all ten questions in each group chosen. Record the answers to the questions in accordance with the directions on the front page of 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 through 59 on the information and diagram below.

A 1.00×10^3-kilogram car is driven clockwise around a flat circular track of radius 25.0 meters. The speed of the car is a constant 5.00 meters per second.



56 What minimum friction force must exist between the tires and the road to prevent the car from skidding as it rounds the curve?

(1) 1.25×10^5 N
(2) 9.80×10^4 N
(3) 5.00×10^3 N
(4) 1.00×10^3 N

57 If the circular track were to suddenly become frictionless at the instant shown in the diagram, the car's direction of travel would be

1 toward *E*
2 toward *N*
3 toward *W*
4 a clockwise spiral

58 At the instant shown in the diagram, the car's centripetal acceleration is directed

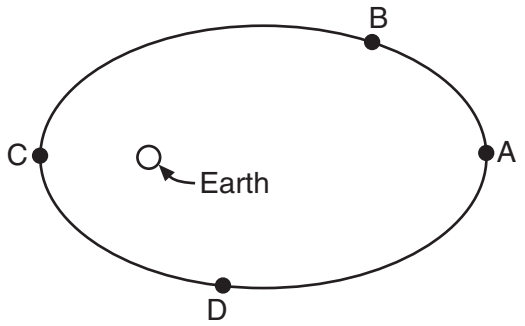
1 toward *E*
2 toward *N*
3 toward *W*
4 clockwise

59 Which factor, when doubled, would produce the greatest change in the centripetal force acting on the car?

1 mass of the car
2 radius of the track
3 velocity of the car
4 weight of the car

GO RIGHT ON TO THE NEXT PAGE.

60 The diagram below shows four different locations of a satellite in its elliptical orbit about Earth.



At which location is the magnitude of the satellite's velocity greatest?

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

61 Which statement is consistent with Kepler's laws of planetary motion?

1 The planets move at a constant speed around the Sun.
2 The speed of a planet is directly proportional to the radius of the path of motion.
3 The more massive the planet, the slower the planet moves around the Sun.
4 An imaginary line from a planet to the Sun sweeps out equal areas in equal time intervals.

62 The path of a projectile fired at a 30° angle to the horizontal is best described as

1 parabolic
2 linear
3 circular
4 hyperbolic

63 A projectile is launched with an initial velocity of 200 meters per second at an angle of 30° above the horizontal. What is the magnitude of the vertical component of the projectile's initial velocity?

(1) $200 \text{ m/s} \times \cos 30°$
(2) $200 \text{ m/s} \times \sin 30°$
(3) $\frac{200 \text{ m/s}}{\sin 30°}$
(4) $\frac{200 \text{ m/s}}{\cos 30°}$

Note that questions 64 and 65 have only three choices.

64 The table below gives the mean radius of orbit and orbital period for two moons of a planet.

Moon	Mean Radius of Orbit	Orbital Period
A	*R*	*T*
B	4*R*	8*T*

Compared to the ratio of the orbital radius cubed to the period squared for Moon *A*, the ratio of the orbital radius cubed to the period squared for Moon *B* is

1 less
2 greater
3 the same

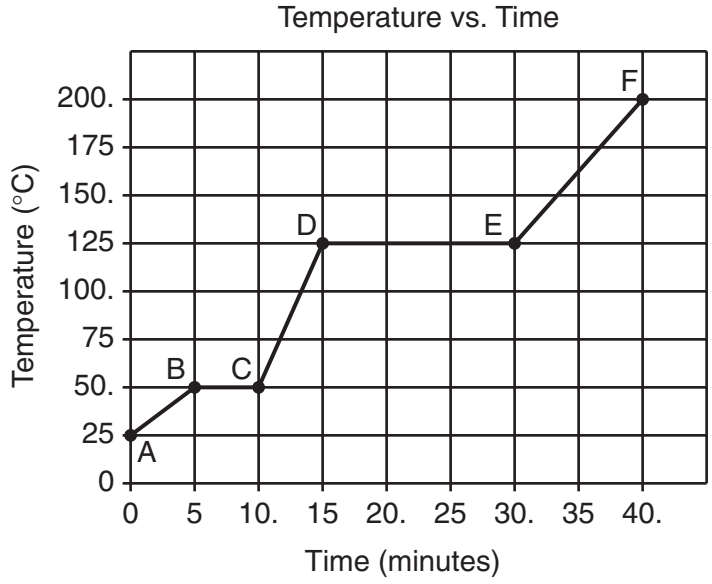
65 A satellite is in geosynchronous orbit. Compared to Earth's period of rotation, the satellite's period of revolution is

1 less
2 greater
3 the same

Group 2 — Internal Energy

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

Base your answers to questions 66 through 68 on the graph below, which represents changes in a 5.00-kilogram sample of a substance as it absorbs heat at a constant rate of 41.9 kilojoules per minute.



66 What is the minimum amount of heat absorbed by 1.00 kilogram of the substance during interval *BE*?

(1) 105 kJ
(2) 210. kJ
(3) 419 kJ
(4) 1050 kJ

67 The heat of vaporization of the substance is

(1) 210. kJ/kg
(2) 126 kJ/kg
(3) 12.6 kJ/kg
(4) 629 kJ/kg

68 The boiling point of the substance is

(1) 25°C
(2) 50.°C
(3) 125°C
(4) 150.°C

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69 Gas molecules at the same temperature are always assumed to have

1 uniform velocity
2 uniform acceleration
3 straight-line motion
4 random motion

70 A 1.0×10^3-kilogram block absorbs 2.4×10^3 kilojoules of heat as its temperature rises from 710.°C to 720.°C. What is the specific heat of the block?

(1) 2.4×10^5 kJ/kg•C°
(2) 0.24 kJ/kg•C°
(3) 4.2×10^{-7} kJ/kg•C°
(4) 4.2×10^{-8} kJ/kg•C°

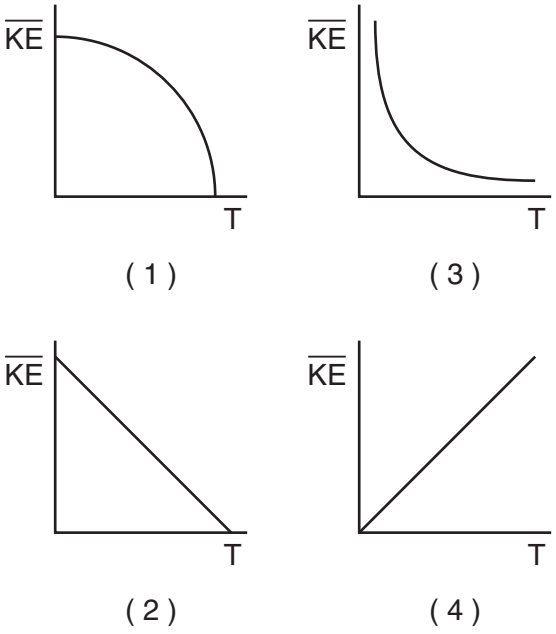
71 Which property determines the direction of the exchange of internal energy between two objects?

1 temperature
2 specific heat
3 mass
4 density

72 Which two quantities are measured in the same units?

1 mechanical energy and heat
2 energy and power
3 momentum and work
4 work and power

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



Note that questions 74 and 75 have only three choices.

74 Equal masses of zinc and copper at room temperature are placed in an oven that supplies heat energy at a rate of 1 kilojoule per minute. Compared to the time needed for the zinc sample to reach its melting point, the time needed for the copper sample to reach its melting point will be

1 less
2 greater
3 the same

75 As the volume of a fixed mass of an ideal gas increases at constant temperature, the product of the pressure and the volume of the gas

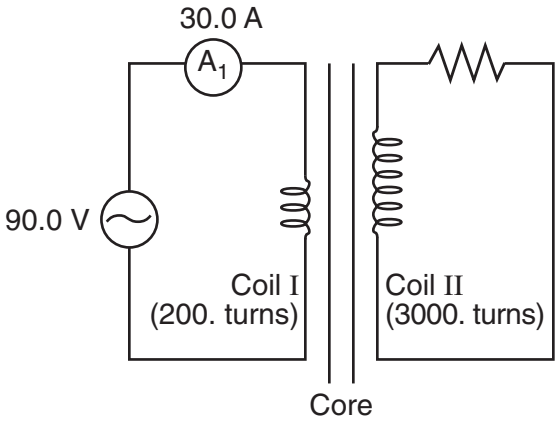
1 decreases
2 increases
3 remains the same

Group 3 — Electromagnetic Applications

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

Base your answers to questions 76 through 78 on the information and diagram below.

Two coils of wire are wound around the same permeable core. Coil I has 200. turns and coil II has 3000. turns. Coil I is supplied with 30.0 amperes of alternating current at 90.0 volts.



76 What does the diagram above represent?

1 a step-up transformer
2 a step-down transformer
3 a transistor
4 an ammeter

77 What potential difference is induced in coil II?

(1) 6.00 V
(2) 90.0 V
(3) 1350 V
(4) 2700 V

78 What is the power developed in coil I?

(1) 1.80×10^2 W
(2) 2.70×10^3 W
(3) 4.05×10^3 W
(4) 4.00×10^2 W

79 A torque exists on the armature of an operating electric motor. The magnitude of this torque would decrease if there were an increase in the

1 current in the armature coil
2 magnetic field strength of the field magnet
3 potential difference applied to the armature coil
4 resistance of the wire in the armature

80 In order to measure the current through an electrical device, an ammeter is placed in series with the device. Compared to the electrical device, the ammeter should have a much

1 lower permeability
2 higher permeability
3 lower resistance
4 higher resistance

81 As the armature of an operating electric motor turns, a voltage is induced. This voltage is opposite in direction to the applied voltage and referred to as

1 conduction
2 reverse current
3 magnetic levitation
4 back emf

82 A voltmeter is made by connecting the current-carrying wire loop of a galvanometer in

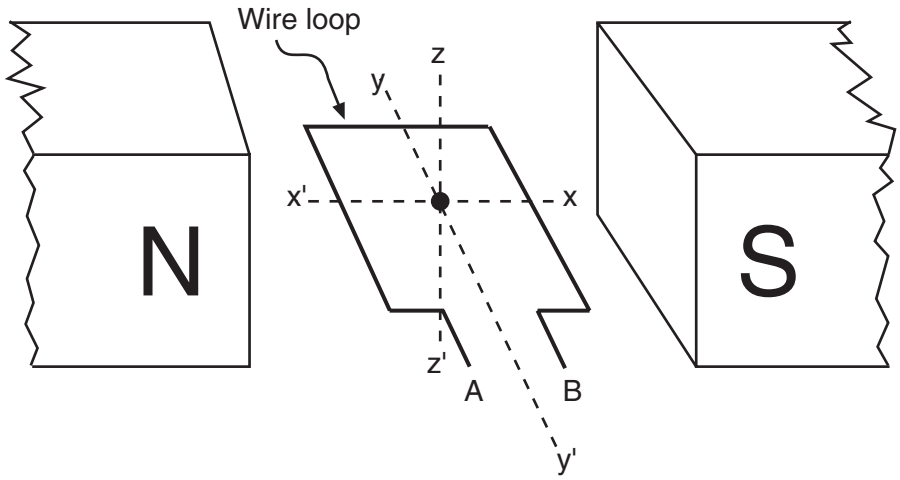
1 series with a high resistance
2 series with a low resistance
3 parallel with a high resistance
4 parallel with a low resistance

83 The phenomenon by which an incandescent object gives off electrons is known as

1 thermionic emission
2 laser emission
3 induction
4 spectroscopy

GO RIGHT ON TO THE NEXT PAGE.

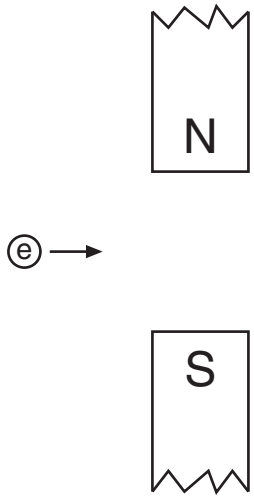
84 A single loop of wire is placed between the poles of permanent magnets, as shown in the diagram below.



If a potential difference is applied to the ends of loop *AB*, in which direction will the loop move?

1 up toward z
2 down toward z'
3 around the y–y'-axis
4 around the x–x'-axis

85 The diagram below shows electron *e* about to enter the region between the poles of two magnets.



Upon entering the region between the poles, the moving electron will experience a magnetic force directed

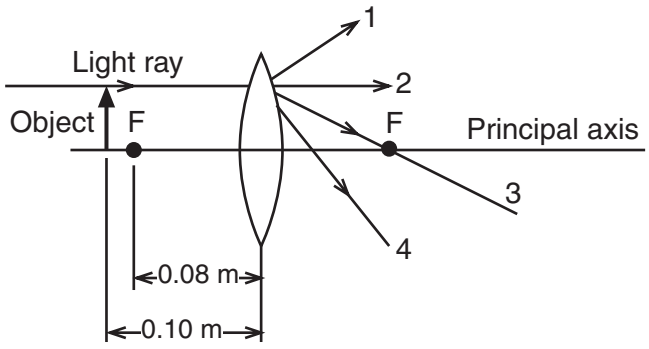
1 toward the north pole
2 toward the south pole
3 into the page
4 out of the page

Group 4 — Geometric Optics

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

Base your answers to questions 86 through 90 on the information and diagram below.

A converging lens has a focal length of 0.080 meter. A light ray travels from the object to the lens parallel to the principal axis.



86 Which line best represents the path of the ray after it leaves the lens?

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

87 How far from the lens is the image formed?

(1) 0.020 m (3) 0.40 m
(2) 0.18 m (4) 0.80 m

88 If the lens is made of crown glass, the speed of light in the lens is closest to

(1) 1.5×10^8 m/s (3) 3.0×10^8 m/s
(2) 2.0×10^8 m/s (4) 4.0×10^8 m/s

89 Which phenomenon best explains the path of the light ray through the lens?

1 diffraction 3 reflection
2 dispersion 4 refraction

Note that question 90 has only three choices.

90 If the lens were placed in water, its focal length would

1 decrease
2 increase
3 remain the same

---

91 Which characteristics best describe the image produced by a plane mirror?

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

92 When an object is placed at the focal point of a concave mirror, the mirror produces

1 an image that is smaller than the object
2 an image that is larger than the object
3 an image that is the same size as the object
4 no image of the object

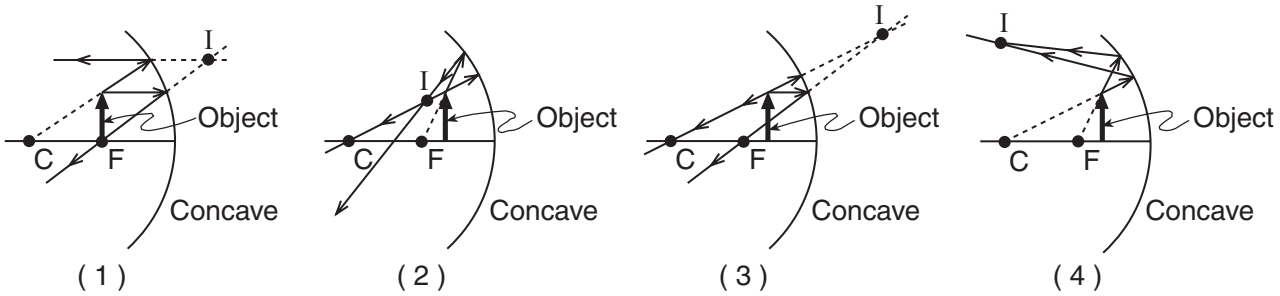
93 Which optical device causes parallel light rays to diverge?

1 convex mirror 3 plane mirror
2 concave mirror 4 convex lens

94 When a boy who is 1.00 meter tall stands in front of a vertical plane mirror, he is able to see the image of his entire body. What is the *minimum* height, from top to bottom, of the mirror?

(1) 1.00 m (3) 0.50 m
(2) 2.00 m (4) 0.25 m

95 An object arrow is placed in front of a concave mirror having center of curvature *C* and principal focus *F*. Which diagram best shows the location of point *I*, the image of the tip of the object arrow?



Group 5 — Solid State

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

Base your answers to questions 96 through 98 on the diagram below of a semiconductor.

96 The semiconductor represented in the diagram is a

1 transistor
2 resistor
3 emitter
4 diode

97 This device is called a semiconductor because

1 positive holes move from *X* to *Z*
2 positive holes move from *Z* to *X*
3 negative holes flow from *Z* to *X*
4 negative electrons flow from *X* to *Z*

98 The part of the semiconductor labeled *X* is called the

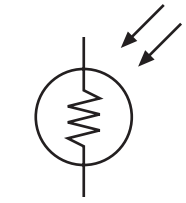
1 cathode
2 emitter
3 anode
4 collector

---

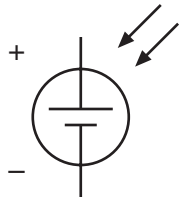
99 A diode can be used in a circuit to

1 convert direct current to alternating current
2 convert alternating current to direct current
3 amplify voltage
4 amplify current

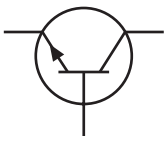
100 Which diagram represents an *N–P–N* transistor?



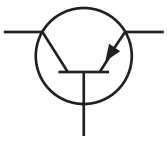
(1)



(3)



(2)



(4)

101 An impurity that is added to a semiconductor in order to provide holes is classified as

1 a donor
2 a receptor
3 an acceptor
4 a bias

102 Current in a semiconductor is caused by the movement of

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

103 In a *P–N–P* transistor, the section that has the thinnest segment is the

1 emitter
2 acceptor
3 collector
4 base

Note that questions 104 and 105 have only three choices.

104 Compared to the current flow when a forward bias is applied to a *P–N* junction, the current flow when a reverse bias is applied to a *P–N* junction is

1 less
2 greater
3 the same

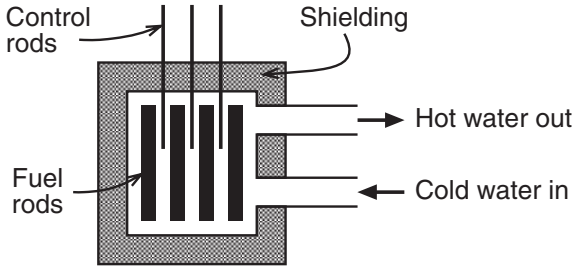
105 Donor materials are added to semiconductors so that the number of available electrons will

1 decrease
2 increase
3 remain the same

Group 6 — Nuclear Energy

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

Base your answers to questions 106 through 109 on the diagram below, which shows a nuclear reactor designed to obtain energy in the form of heat from a nuclear fission reaction.



106 In the fission reaction

$$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow F_1 + F_2 + 3{}^{1}_{0}\text{n} + \text{heat},$$

the fission fragments F_1 and F_2 might be

(1) $^{141}_{56}$Ba and $^{92}_{36}$Kr
(2) $^{141}_{56}$Ba and $^{93}_{36}$Kr
(3) $^{131}_{51}$Sb and $^{99}_{41}$Nb
(4) $^{132}_{51}$Sb and $^{99}_{41}$Nb

107 What is the total energy produced by converting 1.0 kilogram of $^{235}_{92}$U to energy in the reactor?

(1) 9.0×10^{16} J
(2) 2.4×10^{16} J
(3) 9.0×10^{8} J
(4) 3.0×10^{8} J

108 One of the radioactive waste products of the reactor has a half-life of 250 years. What fraction of a given sample of this product will remain after 1,000 years?

(1) $\frac{1}{2}$
(2) $\frac{1}{4}$
(3) $\frac{1}{8}$
(4) $\frac{1}{16}$

109 The water in the reactor acts both as a heat transfer agent and a moderator. In its capacity as a moderator, the water

1 accelerates the neutrons to higher speeds so that they can interact with nuclei more energetically
2 slows the neutrons to increase the probability of nuclear interaction
3 prevents a chain reaction from occurring
4 absorbs neutrons and slows the nuclear reaction

110 The number of nucleons in a $^{206}_{82}$Pb nucleus is

(1) 0
(2) 82
(3) 124
(4) 206

111 An atomic nucleus emits energy as it decays from an excited state to a more stable state without a change in its atomic number. This energy is emitted in the form of

1 an alpha particle
2 an electron
3 a gamma ray
4 a beta particle

112 Which process occurs as nitrogen nuclei are bombarded by alpha particles to produce an isotope of oxygen?

1 photoelectric emission
2 thermionic emission
3 fission
4 transmutation

113 The particle $^{0}_{+1}$e is called a

1 positron
2 proton
3 neutron
4 photon

114 High temperatures are required for controlled nuclear fusion because nuclei must overcome the forces of

1 electrostatic attraction
2 electrostatic repulsion
3 magnetic attraction
4 magnetic repulsion

115 The nuclear force that holds nucleons together is

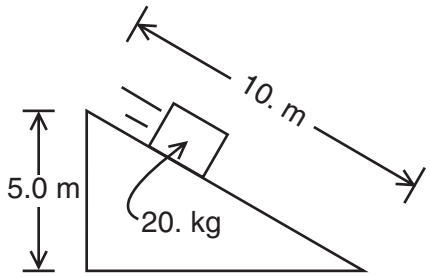
1 weak and short range
2 weak and long range
3 strong and short range
4 strong and long range

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 118 on the information and diagram below.

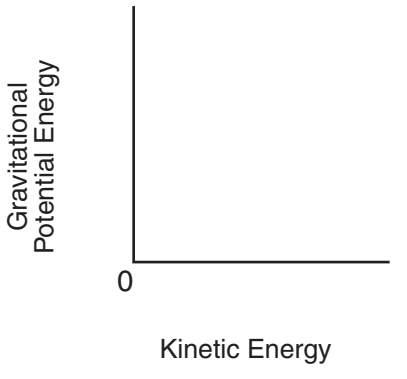
A 20.-kilogram block is placed at the top of a 10.-meter-long inclined plane. The block starts from rest and slides without friction down the length of the incline.



116 Determine the gravitational potential energy of the block at the top of the incline. [Show all calculations, including the equation and substitution with units.] [2]

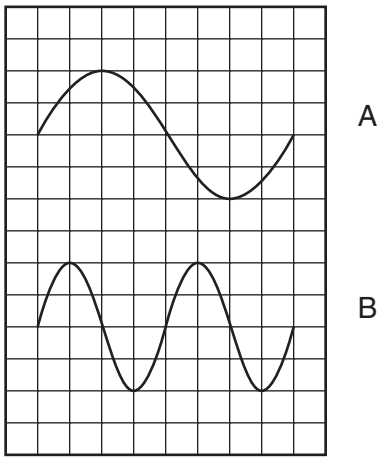
117 Determine the kinetic energy of the block just as it reaches the bottom of the incline. [1]

118 On the axes provided on your answer paper, sketch a graph of the gravitational potential energy of the block as a function of its kinetic energy for the complete slide. *Label your graph with appropriate values and units.* The axes below are provided for practice purposes only. Be sure your final answer appears *on your answer paper.* [2]

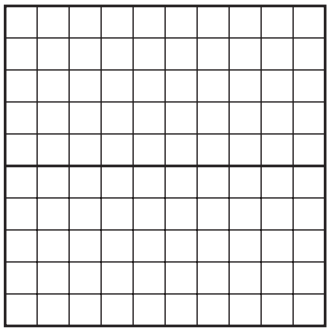


Base your answers to questions 119 through 121 on the information and wave diagrams below.

Two waves, *A* and *B*, pass through the same medium at the same time.



119 On the grid provided on your answer paper, sketch the wave pattern produced when the two waves interfere. The grid below is provided for practice purposes only. Be sure your final answer appears *on your answer paper.* [3]



120 Name a wave characteristic that is the same for both wave *A* and wave *B*. [1]

121 Name a wave charactertistic that is different for wave *A* and wave *B*. [1]

Base your answers to questions 122 through 125 on the information below.

A mercury atom makes a direct transition from energy level *e* to energy level *b*.

122 Determine the energy, in electronvolts, given off in the transition. [1]

123 What is the energy of the emitted photon in joules? [1]

124 Determine the frequency of the radiation corresponding to the emitted photon. [Show all calculations, including the equation and substitution with units.] [2]

125 Explain what would happen if a 4.50-electronvolt photon were incident on a mercury atom in the ground state. [1]

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, January 23, 2001 — 9:15 a.m. to 12:15 p.m., only

ANSWER PAPER

Student . . . . . Sex: ☐ Female ☐ Male

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	
10	1	2	3	4	**30**	1	2	3	4	**50**	1	2	3	
11	1	2	3	4	**31**	1	2	3	4	**51**	1	2	3	
12	1	2	3	4	**32**	1	2	3	4	**52**	1	2	3	
13	1	2	3	4	**33**	1	2	3	4	**53**	1	2	3	4
14	1	2	3		**34**	1	2	3	4	**54**	1	2	3	4
15	1	2	3		**35**	1	2	3	4	**55**	1	2	3	4
16	1	2	3	4	**36**	1	2	3	4					
17	1	2	3		**37**	1	2	3						
18	1	2	3		**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	**45**
54	**64**	26	**44**
53	**64**	25	**43**
52	**63**	24	**43**
51	**62**	23	**42**
50	**61**	22	**41**
49	**61**	21	**41**
48	**60**	20	**40**
47	**59**	19	**39**
46	**59**	18	**38**
45	**58**	17	**38**
44	**57**	16	**37**
43	**56**	15	**36**
42	**56**	14	**36**
41	**55**	13	**35**
40	**54**	12	**32**
39	**54**	11	**30**
38	**53**	10	**27**
37	**52**	9	**24**
36	**51**	8	**22**
35	**51**	7	**19**
34	**50**	6	**16**
33	**49**	5	**13**
32	**48**	4	**11**
31	**48**	3	**8**
30	**47**	2	**5**
29	**46**	1	**3**
28	**46**	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	

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	
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	
91	1	2	3	4
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	
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

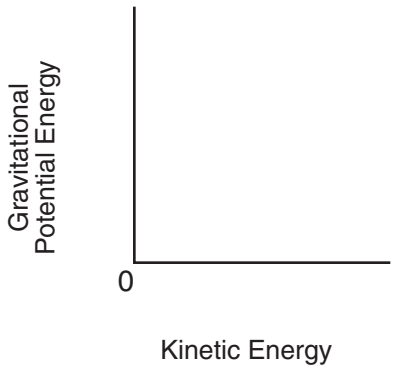
Part III (15 credits)

Answer all questions in this part.

116

117

118



119

120 _____

121 _____

122 _____ **eV**

123 _____ **J**

124

125 _____

_____

_____

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

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 116 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 two credits. Refer to *Scoring Criteria for Calculations* in this scoring key.

Examples of Acceptable Responses

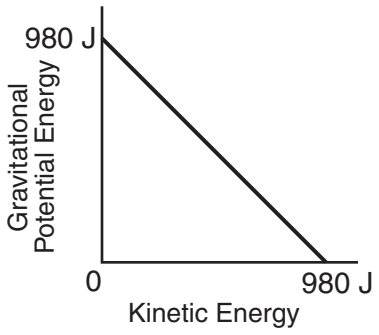
$\Delta PE = mg\Delta h$
$\Delta PE = (20.\ kg)(9.8\ m/s^2)(5.0\ m)$
$\Delta PE = 980\ J$
or
$\Delta PE = 9.8 \times 10^2\ kg \bullet m^2/s^2$

117 Allow one credit.

980 J
Allow credit for an answer that is consistent with (equal to) the student's answer to question 116.

118 Allow a total of two credits.

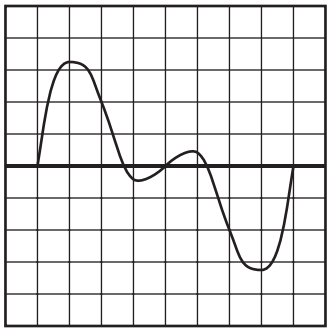
Example of Acceptable Response



Allow one credit for a straight diagonal line with negative slope.
Allow one credit for both values labeled. Allow this credit if labeled values correspond to the student's answers to questions 116 and 117.

119 Allow a total of three credits.

Example of Acceptable Response



Allow one credit if the beginning, middle, and end points are correct (zero displacement).
Allow one credit if the maximum displacements are correct (±0.3 grid space).
Allow one credit if the destructive interference points are correct (±0.3 grid space).

120 Allow one credit.

Examples of Acceptable Responses

amplitude
or
speed

121 Allow one credit.

Examples of Acceptable Responses

wavelength
or
frequency
or
period

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

Group 2
Internal Energy

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

Group 3
Electromagnetic Applications

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

Group 4
Geometric Optics

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

Group 5
Solid State

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

Group 6
Nuclear Energy

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

FOR TEACHERS ONLY

P

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Tuesday, January 23, 2001 —9:15 a.m. to 12:15 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	2	**X**	4	**21**	1	2	**X**	4	**41**	1	**X**	3	4
2	1	2	3	**X**	**22**	**X**	2	3	4	**42**	1	2	3	**X**
3	1	**X**	3	4	**23**	**X**	2	3	4	**43**	**X**	2	3	4
4	1	**X**	3	4	**24**	1	2	3	**X**	**44**	1	2	**X**	4
5	1	2	**X**	4	**25**	1	2	3	**X**	**45**	1	2	**X**	4
6	**X**	2	3	4	**26**	1	**X**	3	4	**46**	1	2	**X**	4
7	1	2	**X**	4	**27**	1	2	**X**	4	**47**	1	2	3	**X**
8	1	2	3	**X**	**28**	1	2	3	**X**	**48**	1	**X**	3	4
9	1	2	**X**	4	**29**	**X**	2	3	4	**49**	1	**X**	3	
10	1	2	**X**	4	**30**	1	2	3	**X**	**50**	**X**	2	3	
11	1	2	3	**X**	**31**	1	2	**X**	4	**51**	**X**	2	3	
12	1	2	**X**	4	**32**	1	2	**X**	4	**52**	**X**	2	3	
13	1	**X**	3	4	**33**	1	**X**	3	4	**53**	1	2	**X**	4
14	1	2	**X**		**34**	**X**	2	3	4	**54**	1	**X**	3	4
15	**X**	2	3		**35**	1	2	**X**	4	**55**	1	2	**X**	4
16	**X**	2	3	4	**36**	1	**X**	3	4					
17	1	**X**	3		**37**	1	**X**	3						
18	1	2	**X**		**38**	1	2	3	**X**					
19	1	2	3	**X**	**39**	**X**	2	3	4					
20	**X**	2	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]

122 Allow one credit.

2.03 eV

123 Allow one credit.

Examples of Acceptable Responses

3.2×10^{-19} J

or

$(2.03 \text{ eV})(1.6 \times 10^{-19} \text{ J/eV}) = 3.248 \times 10^{-19}$ J

Allow credit for an answer that is consistent with the student's answer to question 122.

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

Examples of Acceptable Responses

$E = hf$

$f = \frac{E}{h}$

$f = \frac{3.2 \times 10^{-19} \text{ J}}{6.6 \times 10^{-34} \text{ J•s}}$

$f = 4.8 \times 10^{14}$ Hz

or

$f = 4.848 \times 10^{14} \frac{1}{\text{s}}$

Allow credit for answer that is consistent with the student's answer to question 123.

125 Allow one credit.

Examples of Acceptable Responses

Nothing will happen.

or

The photon will not be absorbed.

or

The mercury atom will remain in the ground state.