The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Friday, June 18, 1999 — 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. 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.

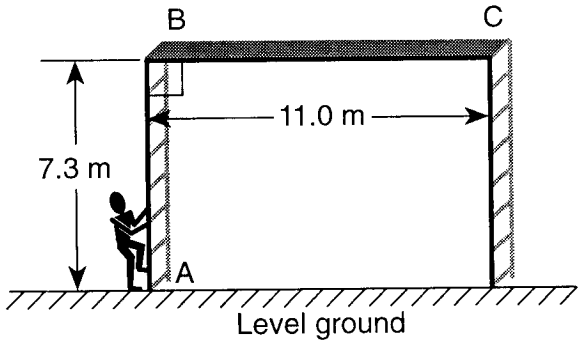
DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL YOU ARE TOLD TO DO SO.

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 As shown in the diagram below, a painter climbs 7.3 meters up a vertical scaffold from *A* to *B* and then walks 11.0 meters from *B* to *C* along a level platform.



The magnitude of the painter's total displacement while moving from *A* to *C* is

(1) 3.7 m
(2) 13.2 m
(3) 18.3 m
(4) 25.6 m

2 A truck with an initial speed of 12 meters per second accelerates uniformly at 2.0 meters per second^2 for 3.0 seconds. What is the total distance traveled by the truck during this 3.0-second interval?

(1) 9.0 m
(2) 25 m
(3) 36 m
(4) 45 m

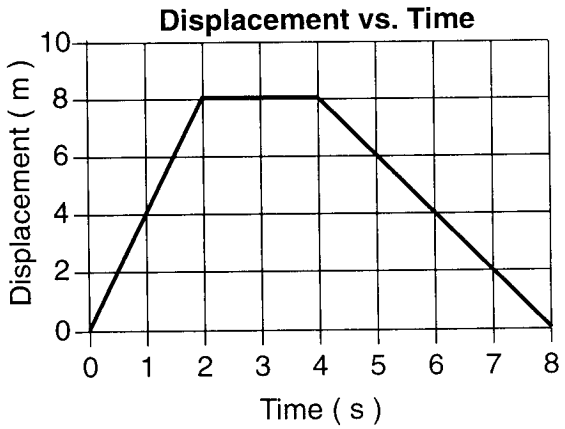
3 The mass of a physics textbook is closest to

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

4 A 1.2×10^3-kilogram car is accelerated uniformly from 10. meters per second to 20. meters per second in 5.0 seconds. What is the magnitude of the net force acting on the car during this 5.0-second interval?

(1) 2.4×10^3 N
(2) 4.8×10^3 N
(3) 7.2×10^3 N
(4) 1.2×10^4 N

Base your answers to questions 5 and 6 on the graph below, which represents the relationship between the displacement of an object and its time of travel along a straight line.



5 What is the magnitude of the object's total displacement after 8.0 seconds?

(1) 0 m
(2) 2 m
(3) 8 m
(4) 16 m

6 What is the average speed of the object during the first 4.0 seconds?

(1) 0 m/s
(2) 2 m/s
(3) 8 m/s
(4) 4 m/s

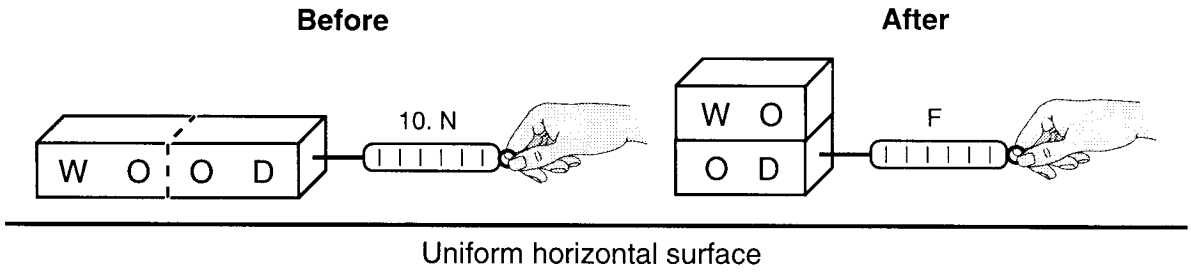
7 Which combination of three concurrent forces acting on a body could *not* produce equilibrium?

(1) 1 N, 3 N, 5 N
(2) 2 N, 2 N, 2 N
(3) 3 N, 4 N, 5 N
(4) 4 N, 4 N, 5 N

8 If a 30-newton force is required to accelerate a 2-kilogram object at 10 meters per second^2, over a level floor, then the magnitude of the frictional force acting on the object is

(1) 0 N
(2) 10 N
(3) 20 N
(4) 30 N

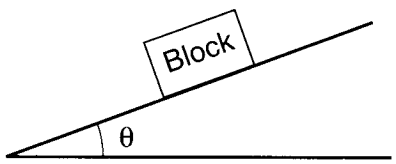
9 The diagram below shows a student applying a 10.-newton force to slide a piece of wood at constant speed across a horizontal surface. After the wood is cut in half, one piece is placed on top of the other, as shown.



What is the magnitude of the force, F, required to slide the stacked wood at constant speed across the surface?

(1) 40. N
(2) 20. N
(3) 10. N
(4) 5.0 N

10 In the diagram below, a block rests on a ramp, making angle θ with the horizontal.



If angle θ is increased, what will occur?

1 The block's mass will decrease.
2 The block's weight will increase.
3 The block's component of weight parallel to the ramp will decrease.
4 The block's component of weight parallel to the ramp will increase.

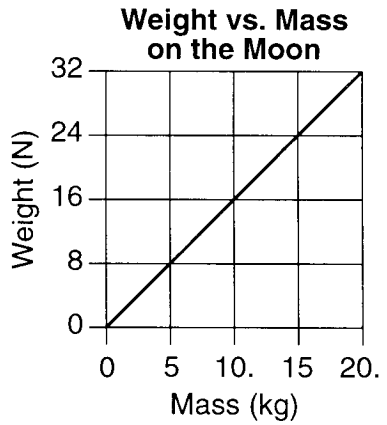
11 Which combination of fundamental units can be used to express the weight of an object?

1 kilogram/second
2 kilogram•meter
3 kilogram•meter/second
4 kilogram•meter/second^2

12 What is the momentum of a 1.5×10^3-kilogram car as it travels at 30. meters per second due east for 60. seconds?

(1) 4.5×10^4 kg•m/s, east
(2) 4.5×10^4 kg•m/s, west
(3) 2.7×10^6 kg•m, east
(4) 2.7×10^6 kg•m, west

13 The graph below shows the relationship between weight and mass for a series of objects on the Moon.



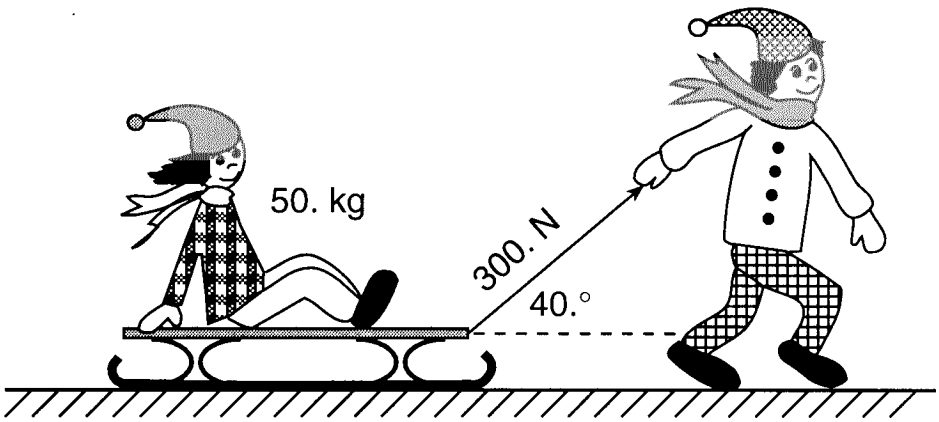
The acceleration due to gravity on the Moon is approximately

(1) 0.63 m/s^2
(2) 1.6 m/s^2
(3) 9.8 m/s^2
(4) 32 m/s^2

14 A 2.0×10^3-kilogram car collides with a tree and is brought to rest in 0.50 second by an average force of 6.0×10^4 newtons. What is the magnitude of the impulse on the car during this 0.50-second interval?

(1) 1.0×10^3 kg•s
(2) 3.0×10^4 N•s
(3) 1.2×10^5 N/s
(4) 6.0×10^7 N•kg•s

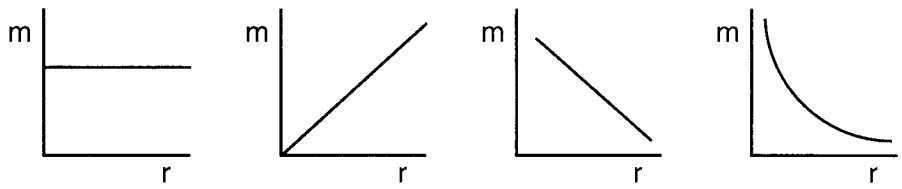
15 The diagram below shows a child pulling a 50.-kilogram friend on a sled by applying a 300.-newton force on the sled rope at an angle of 40.° with the horizontal.



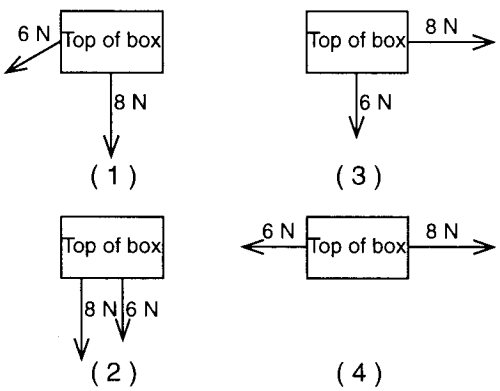
The vertical component of the 300.-newton force is approximately

(1) 510 N
(2) 230 N
(3) 190 N
(4) 32 N

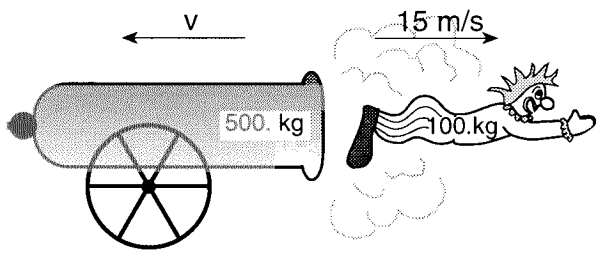
16 Which graph best represents the relationship between the mass (m) of a satellite launched from Earth and the satellite's distance (r) away from Earth?



17 A 6-newton force and an 8-newton force act concurrently on a box located on a frictionless horizontal surface. Which top-view diagram shows the forces producing the *smallest* magnitude of acceleration of the box?



18 In the diagram below, a 100.-kilogram clown is fired from a 500.-kilogram cannon.



If the clown's speed is 15 meters per second after the firing, then the recoil speed (v) of the cannon is

(1) 75 m/s
(2) 15 m/s
(3) 3.0 m/s
(4) 0 m/s

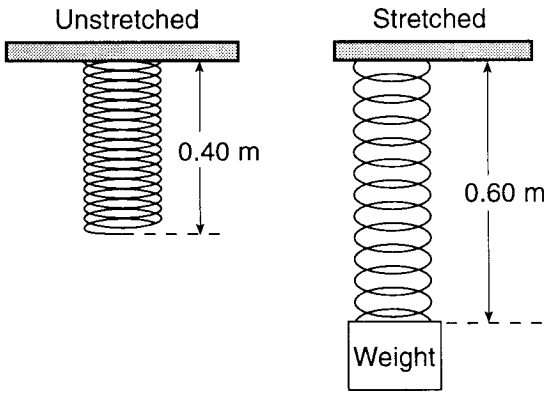
19 A girl rides an escalator that moves her upward at constant speed. As the girl rises, how do her gravitational potential energy and kinetic energy change?

1 Gravitational potential energy decreases and kinetic energy decreases.
2 Gravitational potential energy decreases and kinetic energy remains the same.
3 Gravitational potential energy increases and kinetic energy decreases.
4 Gravitational potential energy increases and kinetic energy remains the same.

20 A student does 300. joules of work pushing a cart 3.0 meters due east and then does 400. joules of work pushing the cart 4.0 meters due north. The total amount of work done by the student is

(1) 100. J
(2) 500. J
(3) 700. J
(4) 2500 J

21 The unstretched spring in the diagram below has a length of 0.40 meter and spring constant k. A weight is hung from the spring, causing it to stretch to a length of 0.60 meter.



How many joules of elastic potential energy are stored in this stretched spring?

(1) $0.020 \times k$
(2) $0.080 \times k$
(3) $0.18 \times k$
(4) $2.0 \times k$

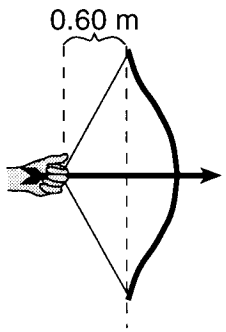
22 A spring has a spring constant of 25 newtons per meter. The minimum force required to stretch the spring 0.25 meter from its equilibrium position is approximately

(1) 1.0×10^{-4} N
(2) 0.78 N
(3) 6.3 N
(4) 1.0×10^{2} N

23 If the time required for a student to swim 500 meters is doubled, the power developed by the student will be

1 halved
2 doubled
3 quartered
4 quadrupled

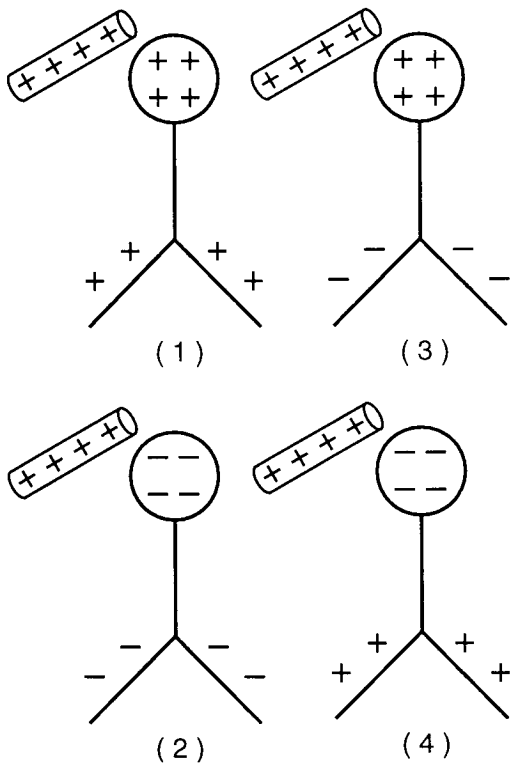
24 In the diagram below, an average force of 20. newtons is used to pull back the string of a bow 0.60 meter.



As the arrow leaves the bow, its kinetic energy is

(1) 3.4 J
(2) 6.0 J
(3) 12 J
(4) 33 J

25 A positively charged rod is held near the knob of a neutral electroscope. Which diagram best represents the distribution of charge on the electroscope?



26 Compared to the charge on a proton, the charge on an electron has the

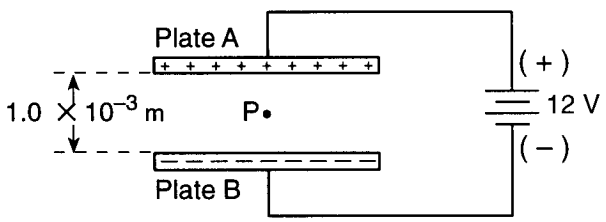
1 opposite sign and a smaller magnitude
2 opposite sign and the same magnitude
3 same sign and a smaller magnitude
4 same sign and the same magnitude

27 A point charge of $+3.0 \times 10^{-7}$ coulomb is placed 2.0×10^{-2} meter from a second point charge of $+4.0 \times 10^{-7}$ coulomb. The magnitude of the electrostatic force between the charges is

(1) 2.7 N
(2) 5.4×10^{-2} N
(3) 3.0×10^{-10} N
(4) 6.0×10^{-12} N

Base your answers to questions 28 and 29 on the information and diagram below.

Two parallel plates separated by a distance of 1.0×10^{-3} meter are charged to a potential difference of 12 volts. An alpha particle with a charge of +2 elementary charges is located at point *P* in the region between the plates.



28 What is the magnitude and direction of the electric field intensity between the plates?

(1) 1.2×10^3 V/m toward plate *A*
(2) 1.2×10^3 V/m toward plate *B*
(3) 1.2×10^4 V/m toward plate *A*
(4) 1.2×10^4 V/m toward plate *B*

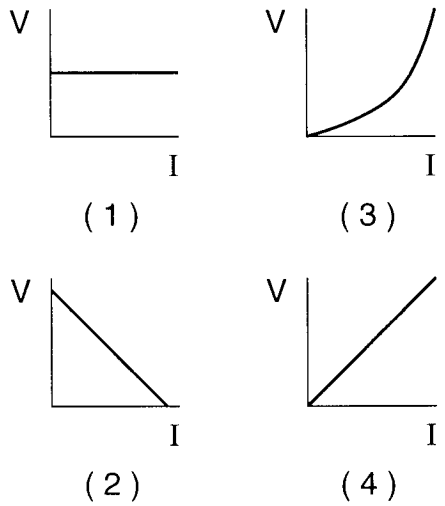
29 The electric field between the plates will cause the alpha particle, starting from rest at point *P*, to

1 accelerate toward the positive plate
2 accelerate toward the negative plate
3 move at constant speed toward the positive plate
4 move at constant speed toward the negative plate

30 If 15 joules of work is required to move 3.0 coulombs of charge between two points, the potential difference between these two points is

(1) 45 V
(2) 15 V
(3) 3.0 V
(4) 5.0 V

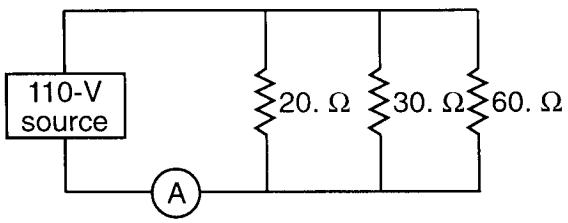
31 A metallic conductor obeys Ohm's law. Which graph best represents the relationship between the potential difference (*V*) across the conductor and the resulting current (*I*) through the conductor?



32 A light bulb operating at 120 volts draws a current of 0.50 ampere for 240 seconds. The power rating of the light bulb is

(1) 30. W
(2) 60. W
(3) 75 W
(4) 120 W

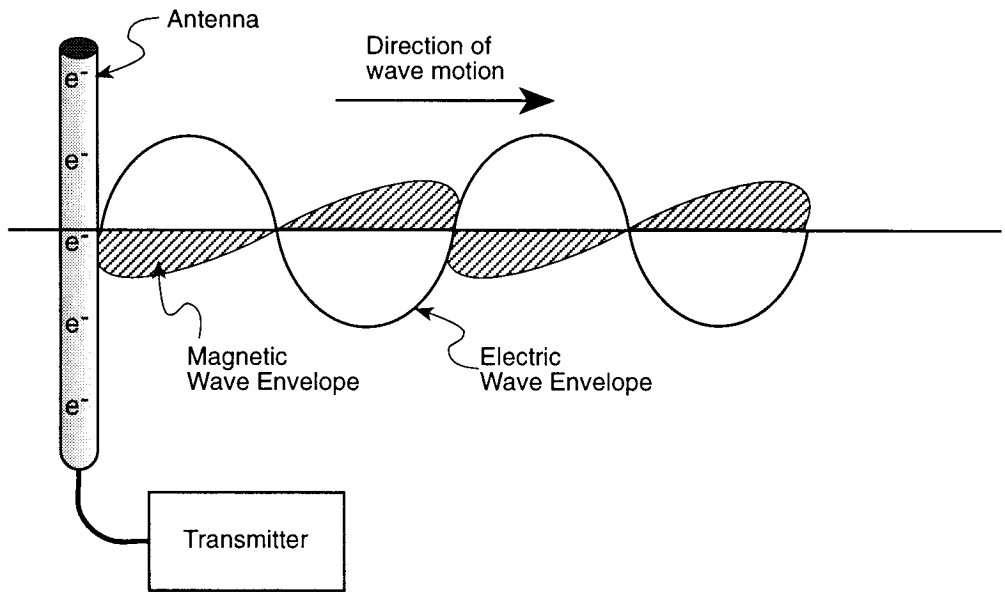
33 In the diagram below of a parallel circuit, ammeter *A* measures the current supplied by the 110-volt source.



The current measured by ammeter *A* is

(1) 1.0 A
(2) 0.10 A
(3) 5.5 A
(4) 11 A

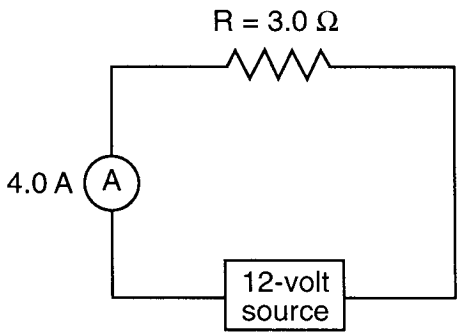
34 The diagram below shows an antenna emitting an electromagnetic wave.



In what way did the electrons in the antenna produce the electromagnetic wave?

1 by remaining stationary
2 by moving at constant speed upward, only
3 by moving at constant speed downward, only
4 by accelerating alternately upward and downward

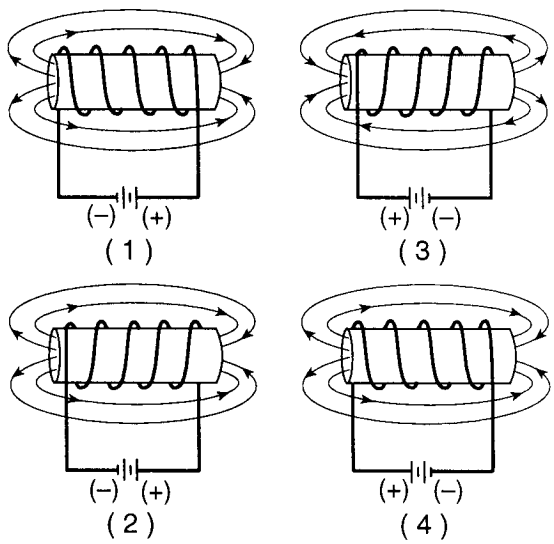
35 The diagram below represents a simple electric circuit.



How much charge passes through the resistor in 2.0 seconds?

(1) 6.0 C
(2) 2.0 C
(3) 8.0 C
(4) 4.0 C

36 In which diagram of a current-carrying solenoid is the magnetic field correctly represented?



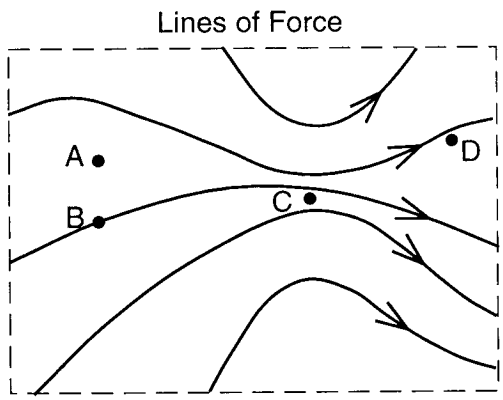
37 The table below shows the length and cross-sectional area of four pieces of copper wire at the same temperature.

Wire	Length (m)	Cross-Sectional Area (m^2)
A	10	2×10^{-6}
B	10	1×10^{-6}
C	1	2×10^{-6}
D	1	1×10^{-6}

Which wire has the highest resistance?

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

38 The diagram below represents magnetic lines of force within a region of space.



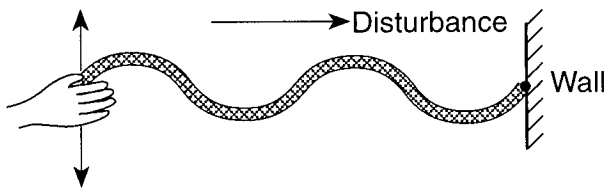
The magnetic field is strongest at point

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

39 An electric circuit contains an operating heating element and a lit lamp. Which statement best explains why the lamp remains lit when the heating element is removed from the circuit?

1 The lamp has less resistance than the heating element.
2 The lamp has more resistance than the heating element.
3 The lamp and heating element were connected in series.
4 The lamp and heating element were connected in parallel.

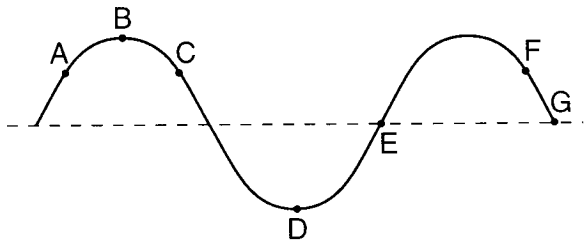
40 The diagram below shows a person shaking the end of a rope up and down, producing a disturbance that moves along the length of the rope.



Which type of wave is traveling in the rope?

1 torsional 3 transverse
2 longitudinal 4 elliptical

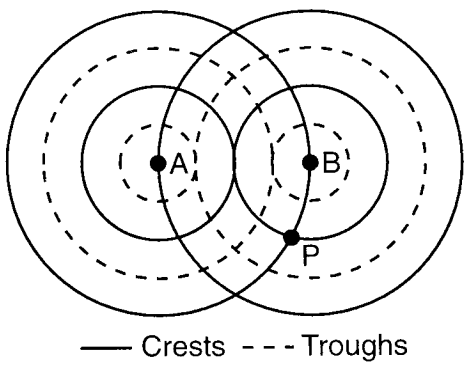
41 The diagram below shows a periodic wave.



Which two points on the wave are in phase?

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

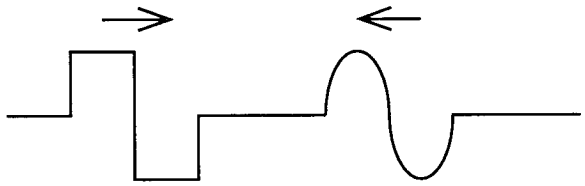
42 The diagram below shows two sources, *A* and *B*, vibrating in phase in the same uniform medium and producing circular wave fronts.



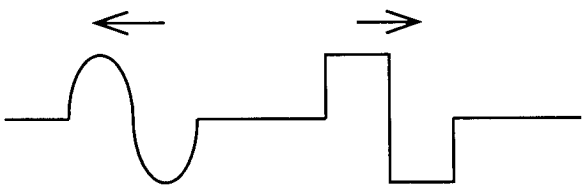
Which phenomenon occurs at point *P*?

1 destructive interference
2 constructive interference
3 reflection
4 refraction

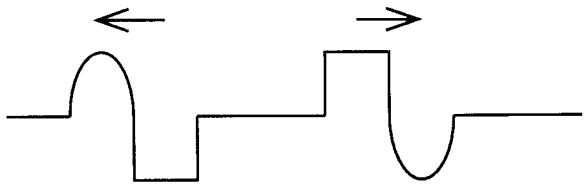
43 The diagram below shows two waves approaching each other in the same uniform medium.



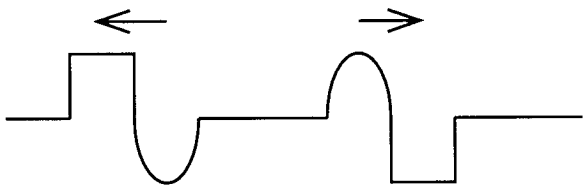
Which diagram best represents the appearance of the medium after the waves have passed through each other?



(1)



(3)



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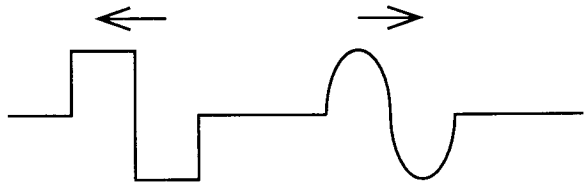
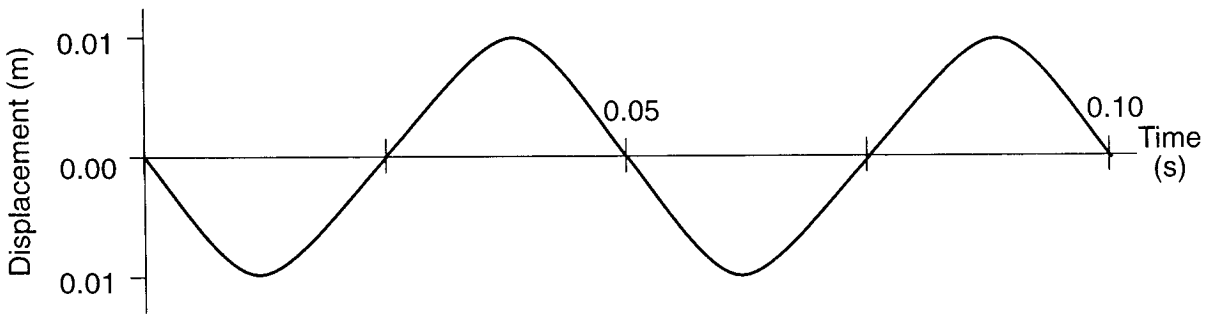


(4)

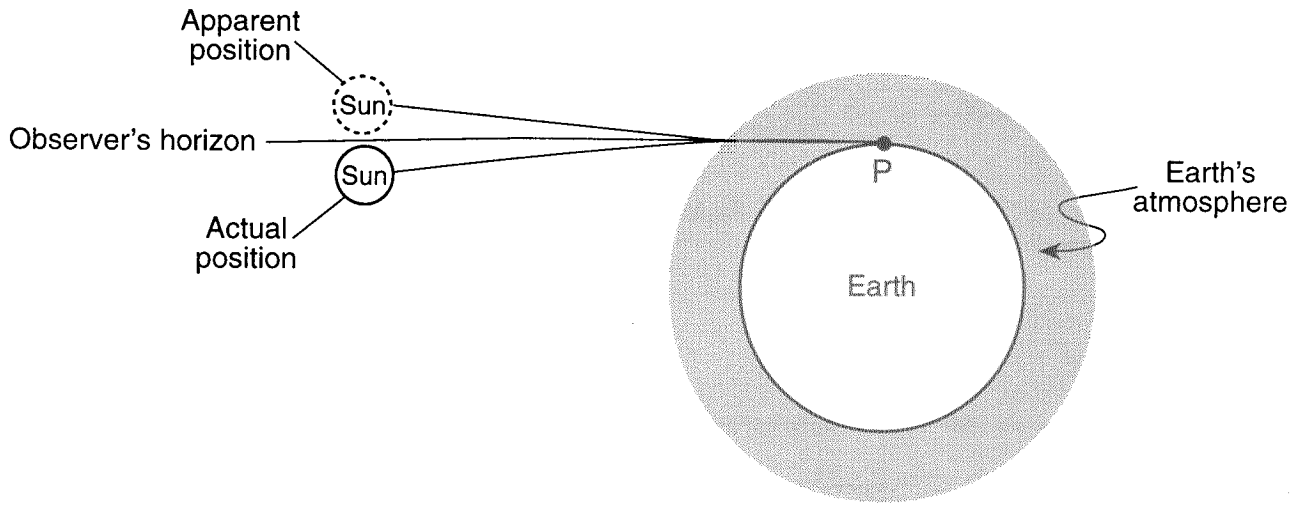
44 The graph below shows displacement versus time for a particle of a uniform medium as a wave passes through the medium.



What is the frequency of the wave?

(1) 10 Hz
(2) 20 Hz
(3) 50 Hz
(4) 100 Hz

45 The diagram below shows how an observer located at point P on Earth can see the Sun when it is below the observer's horizon.



(not drawn to scale)

This observation is possible because of the ability of Earth's atmosphere to

1 reflect light
2 diffract light
3 refract light
4 polarize light

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46 Two identical guitar strings are tuned to the same pitch. If one string is plucked, the other nearby string vibrates with the same frequency. This phenomenon is called

1 resonance
2 reflection
3 refraction
4 destructive interference

47 When a student looks into a plane mirror, she sees a virtual image of herself. However, when she looks into a sheet of paper, no such image forms. Which light phenomenon occurs at the surface of the paper?

1 regular reflection
2 diffuse reflection
3 polarization
4 resonance

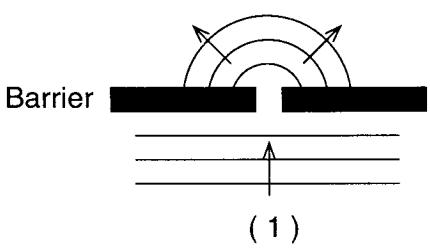
48 Light from the star Betelgeuse displays a Doppler red shift. This shift is best explained by assuming that Betelgeuse is

1 decreasing in temperature
2 increasing in temperature
3 moving toward Earth
4 moving away from Earth

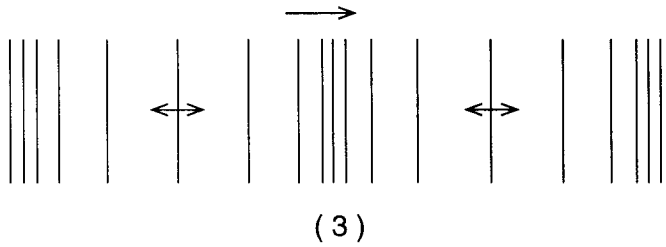
49 Light with a wavelength of 6.0×10^{-7} meter passes through a pair of narrow slits and falls on a screen 2.0 meters away. If the distance between two adjacent bright bands on the screen is 3.0×10^{-2} meter, what is the distance between the slits?

(1) 9.0×10^{-9} m
(2) 1.0×10^{-5} m
(3) 4.0×10^{-5} m
(4) 2.5×10^{4} m

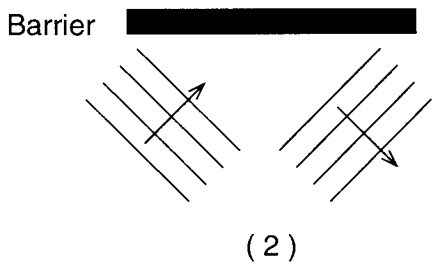
50 Which diagram best illustrates wave diffraction?



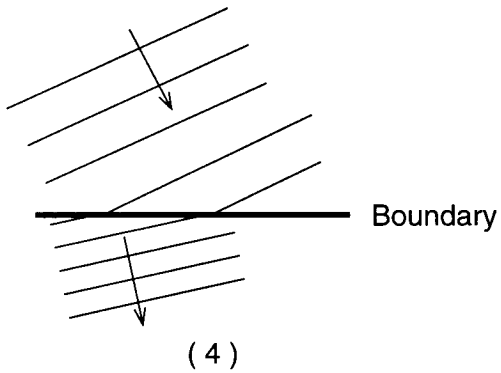
(1)



(3)

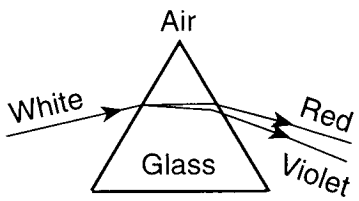


(2)

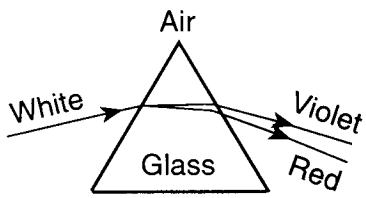


(4)

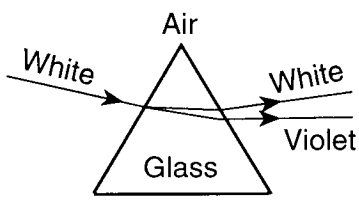
51 Which diagram best represents the path of light rays passing through a glass prism?



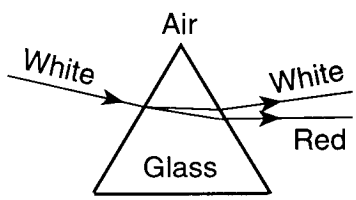
(1)



(3)



(2)



(4)

GO RIGHT ON TO THE NEXT PAGE. ⇨

Part II (20 credits)

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

Group 1
Motion in a Plane

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

Group 2
Internal Energy

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

Group 3
Electromagnetic Applications

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

Group 4
Geometric Optics

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

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Friday, June 18, 1999 — 1:15 to 4:15 p.m., only

ANSWER PAPER

Student ..... Sex: ☐ Male ☐ Female

Teacher .....

School .....

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

Part I (65 credits)

1	1	2	3	4	**21**	1	2	3	4	**41**	1	2	3	4
2	1	2	3	4	**22**	1	2	3	4	**42**	1	2	3	4
3	1	2	3	4	**23**	1	2	3	4	**43**	1	2	3	4
4	1	2	3	4	**24**	1	2	3	4	**44**	1	2	3	4
5	1	2	3	4	**25**	1	2	3	4	**45**	1	2	3	4
6	1	2	3	4	**26**	1	2	3	4	**46**	1	2	3	4
7	1	2	3	4	**27**	1	2	3	4	**47**	1	2	3	4
8	1	2	3	4	**28**	1	2	3	4	**48**	1	2	3	4
9	1	2	3	4	**29**	1	2	3	4	**49**	1	2	3	4
10	1	2	3	4	**30**	1	2	3	4	**50**	1	2	3	4
11	1	2	3	4	**31**	1	2	3	4	**51**	1	2	3	4
12	1	2	3	4	**32**	1	2	3	4	**52**	1	2	3	4
13	1	2	3	4	**33**	1	2	3	4	**53**	1	2	3	4
14	1	2	3	4	**34**	1	2	3	4	**54**	1	2	3	4
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

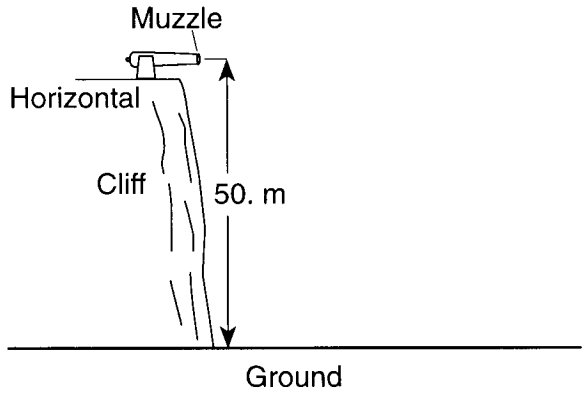
Directions to Teacher:

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 .....

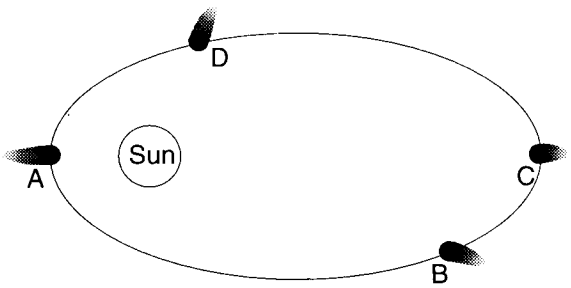
58 The diagram below shows the muzzle of a cannon located 50. meters above the ground. When the cannon is fired, a ball leaves the muzzle with an initial horizontal speed of 250. meters per second. [Neglect air resistance.]



Which action would most likely increase the time of flight of a ball fired by the cannon?

1 pointing the muzzle of the cannon toward the ground
2 moving the cannon closer to the edge of the cliff
3 positioning the cannon higher above the ground
4 giving the ball a greater initial horizontal velocity

59 The diagram below shows the elliptical orbit of a comet around the Sun.



(not drawn to scale)

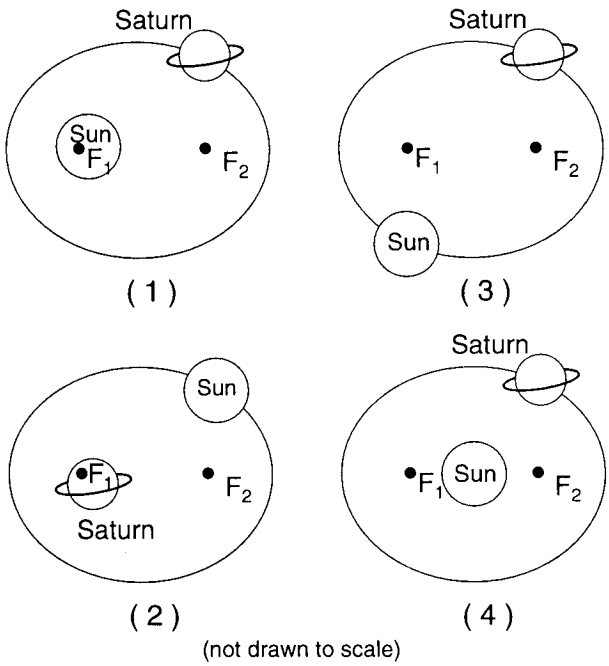
The magnitude of the centripetal acceleration of the comet is greatest at point

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

60 A communications satellite in geosynchronous orbit around Earth remains over the same location on Earth. The satellite's period of revolution about Earth is closest to

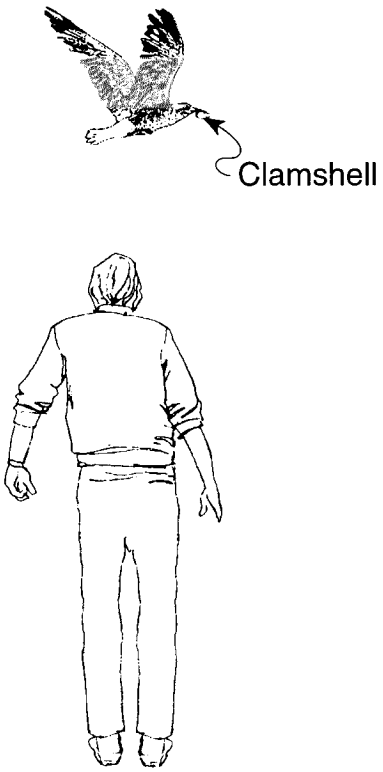
(1) 1 hour (3) 1 month
(2) 1 day (4) 1 year

61 Which orbit diagram best represents the relative motion of the planet Saturn and the Sun? [Points F_1 and F_2 represent foci.]

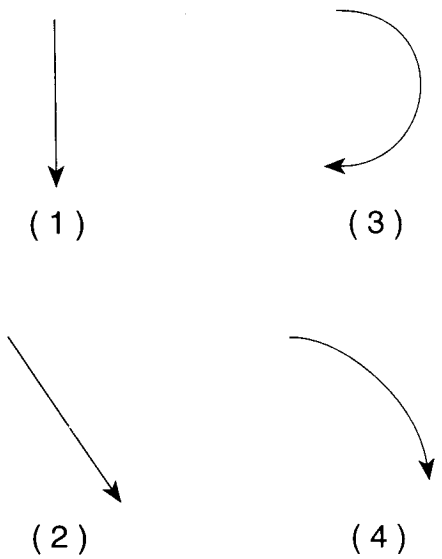


(not drawn to scale)

62 In the diagram below, a stationary observer on the ground watches as a seagull flying horizontally to the right drops a clamshell.

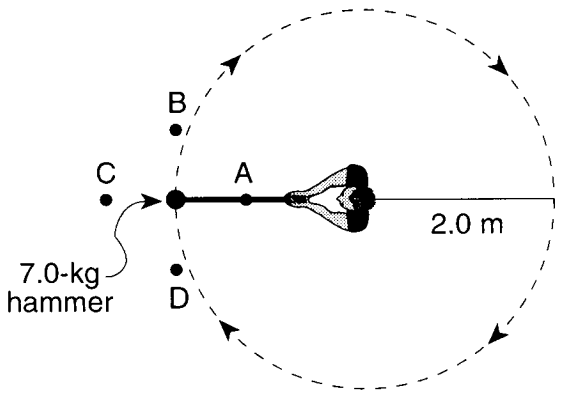


Which diagram best represents the path of the falling clamshell as seen by the observer? [Neglect air resistance.]



Base your answers to questions 63 through 65 on the information and diagram below.

An athlete in a hammer-throw event swings a 7.0-kilogram hammer in a horizontal circle at a constant speed of 12 meters per second. The radius of the hammer's path is 2.0 meters.



63 At the position shown, the centripetal force acting on the hammer is directed toward point

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

64 What is the magnitude of the centripetal acceleration of the hammer?

(1) 6.0 m/s^2
(2) 24 m/s^2
(3) 72 m/s^2
(4) 500 m/s^2

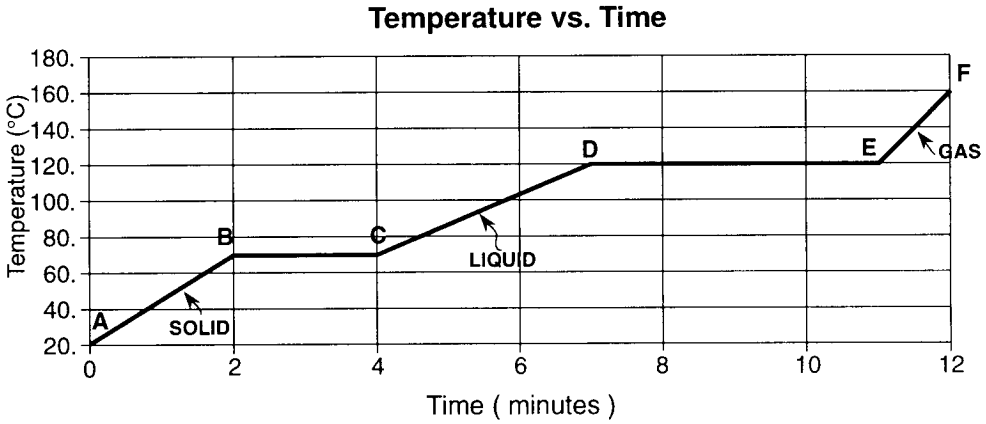
65 If the hammer is released at the position shown, it will travel toward point

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

Group 2 — Internal Energy

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

Base your answers to questions 66 and 67 on the graph below, which represents the changes in a 2.0-kilogram sample of a substance as it absorbs heat at a constant rate of 15 kilojoules per minute.



66 During which two intervals on the graph is the average kinetic energy of the molecules in the sample increasing?

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

67 What is the specific heat of the substance in the solid phase?

(1) 0.21 kJ/kg•C°
(2) 0.30 kJ/kg•C°
(3) 0.43 kJ/kg•C°
(4) 0.60 kJ/kg•C°

68 What is the ratio of a temperature change of 1 Kelvin to a temperature change of 1 Celsius degree?

(1) $\frac{1}{1}$
(2) $\frac{2}{1}$
(3) $\frac{273}{1}$
(4) $\frac{1}{273}$

69 The amount of heat energy liberated by a sample of water depends upon its

1 temperature change, only
2 temperature change and mass, only
3 temperature change and phase, only
4 temperature change, mass, and phase

70 Approximately how much heat is required to vaporize 2.0×10^{-3} kilogram of tungsten at its boiling point?

(1) 0.38 kJ
(2) 4.5 kJ
(3) 8.7 kJ
(4) 11 kJ

71 The temperature at which no thermal energy can be transferred from one object to another is

(1) –273 K
(2) 0 K
(3) 0°C
(4) 273°C

72 A covered Styrofoam cup contains 0.30 kilogram of water at 100.°C. If 0.10 kilogram of water at 20.°C is added to the Styrofoam cup, the temperature of the mixture will be

(1) 40.°C
(2) 60.°C
(3) 80.°C
(4) 100.°C

73 A pot of water is boiling. When a cook throws salt into the water, it stops boiling because the salt

1 lowers the water's specific heat
2 raises the water's specific heat
3 lowers the water's boiling point
4 raises the water's boiling point

74 What do the laws of thermodynamics indicate about the energy and entropy of the universe?

1 Energy is decreasing and entropy is increasing.
2 Energy is increasing and entropy is decreasing.
3 Energy is constant and entropy is decreasing.
4 Energy is constant and entropy is increasing.

Note that question 75 has only three choices.

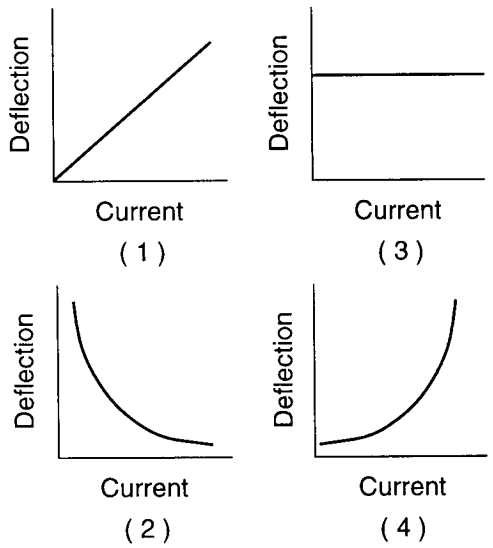
75 Friction between a moving automobile's tires and the pavement causes air inside the tires to heat up. As the temperature of this air increases, the pressure in the tires

1 decreases
2 increases
3 remains the same

Group 3 — Electromagnetic Applications

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

76 Which graph best represents the relationship between the deflection of a galvanometer coil and the current passing through the coil?



77 A positively charged particle traveling at 7.5×10^5 meters per second enters a uniform magnetic field perpendicular to the lines of force. While in the 4.0×10^{-2}-tesla magnetic field, a net force of 9.6×10^{-15} newton acts on the particle. What is the magnitude of the charge on the particle?

(1) 1.6×10^{-19} C
(2) 3.2×10^{-19} C
(3) 9.6×10^{-19} C
(4) 3.2×10^{19} C

78 What did Millikan conclude after performing his oil-drop experiment?

1 The charge on an electron is 1.0 C.
2 The mass of an electron is 1.7×10^{-27} kg.
3 The charge on any oil drop is an integral multiple of the charge on an electron.
4 The charge on an oil drop may have any value larger than 1.6×10^{-19} C.

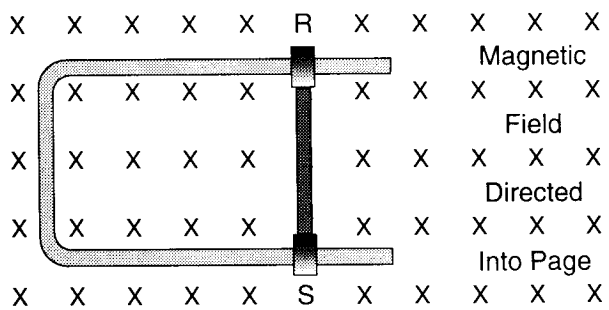
79 A high-resistance wire is connected in series with the coil of a galvanometer. The function of the high-resistance wire is to

1 limit the current in the coil
2 prevent a potential drop across the coil
3 allow the modified meter to get warm
4 decrease the internal temperature of the modified galvanometer

80 An electromagnetic device used to determine the masses of individual atoms is

1 an induction coil
2 an electroscope
3 a galvanometer
4 a mass spectrometer

81 In the diagram below, a segment of wire, *RS*, which is 0.20 meter in length, is free to slide along a U-shaped wire located in a uniform 0.60-tesla magnetic field directed into the page.



If wire segment *RS* is slid to the right at a constant speed of 4.0 meters per second, the potential difference induced across the ends of the wire segment is

(1) 0.12 V
(2) 0.48 V
(3) 2.4 V
(4) 4.8 V

82 A direct-current source is used to operate an electric motor. After each half-rotation of the armature, the split-ring commutator

1 reverses the direction of the field magnet
2 increases the strength of the field magnet
3 reverses the direction of the current in the armature
4 increases the current in the armature

83 In order for a transformer to function, its primary and secondary coils must

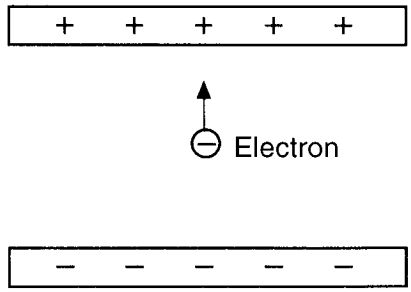
1 be made of different elements
2 be kept at different temperatures
3 have the same weight
4 have continually changing magnetic fields

84 A 100% efficient transformer has an 800.-turn primary coil connected to a 120-volt alternating current source. If the secondary coil has 400. turns, what is the voltage induced in the secondary coil?

(1) 30. V
(2) 60. V
(3) 240 V
(4) 480 V

Note that question 85 has only three choices.

85 An electron is located between two oppositely charged parallel plates as shown in the diagram below.



As the electron moves toward the positive plate, the magnitude of the electric force acting on the electron

1 decreases
2 increases
3 remains the same

Group 4 — Geometric Optics

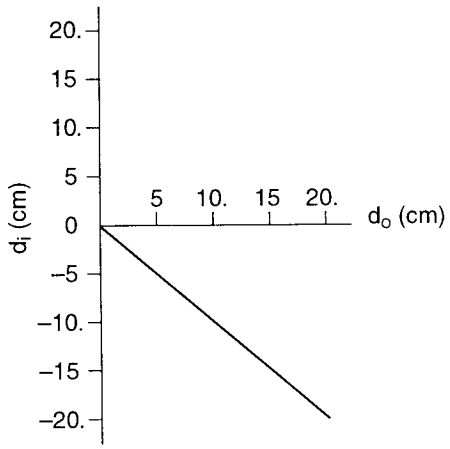
If you choose this group, be sure to answer questions 86–95.

86 A lens produces a real image by causing light rays from a common point to

1 converge and intersect at a point
2 disperse into component wavelengths
3 reflect constructively
4 diverge and appear to come from a point

87 The graph below shows the relationship between a mirror's object distance (d_o) and image distance (d_i).

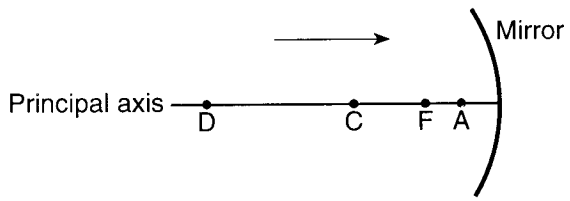
Object Distance vs. Image Distance



From which type of mirror were the data collected?

1 concave
2 convex
3 parabolic
4 plane

88 The diagram below shows a ray of light traveling parallel to the principal axis of a concave spherical mirror. Point F is the principal focus and point C is the center of curvature.

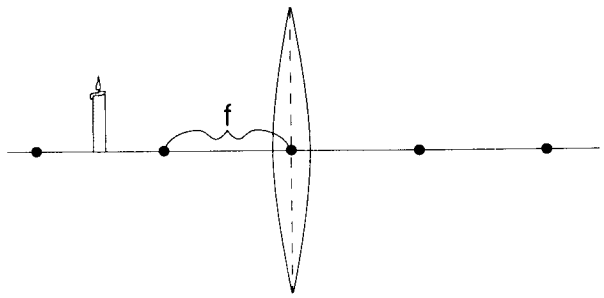


After striking the mirror, the ray of light will be reflected through point

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

Base your answers to questions 89 and 90 on the information and diagram below.

A candle 0.10 meter tall is placed 0.30 meter from a thin converging lens. The crown glass lens has a focal length, f, of 0.20 meter.



89 What is the distance from the lens to the candle's image?

(1) 0.10 m
(2) 0.30 m
(3) 0.40 m
(4) 0.60 m

Note that question 90 has only three choices.

90 Changing the lens material from crown glass to flint glass would cause the focal length to

1 decrease
2 increase
3 remain the same

91 Which type of images can be projected onto a screen?

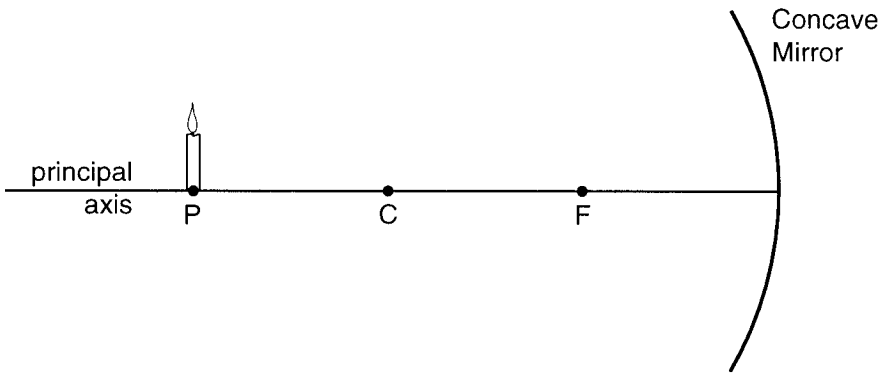
1 real images, only
2 virtual images, only
3 both real images and virtual images
4 neither real images nor virtual images

92 An object is located 0.40 meter in front of a diverging lens having a focal length of –0.20 meter. Compared to the object, the image formed by the lens is

1 smaller, inverted, and real
2 larger, inverted, and real
3 smaller, erect, and virtual
4 larger, erect, and virtual

Note that question 93 has only three choices.

93 In the diagram below, a candle is located at point P in front of a concave spherical mirror. Point F is the principal focus of the mirror, and point C is the center of curvature.



As the candle is moved from point P toward point C, the size of its image

1 decreases
2 increases
3 remains the same

---

94 An object 0.15 meter tall placed 0.25 meter in front of a concave mirror produces an image 0.20 meter tall. The image distance is approximately

(1) 0.12 m
(2) 0.19 m
(3) 0.33 m
(4) 0.45 m

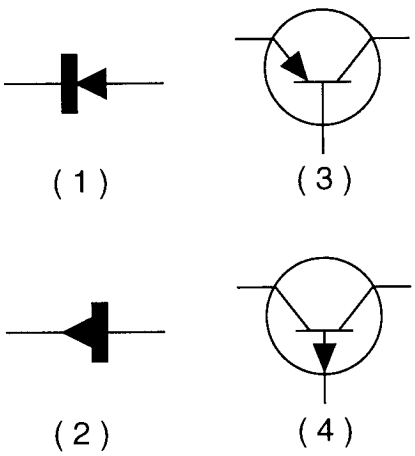
95 Spherical aberration is a defect associated with

1 lenses, only
2 plane mirrors
3 spherical mirrors, only
4 lenses and spherical mirrors

Group 5 — Solid State

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

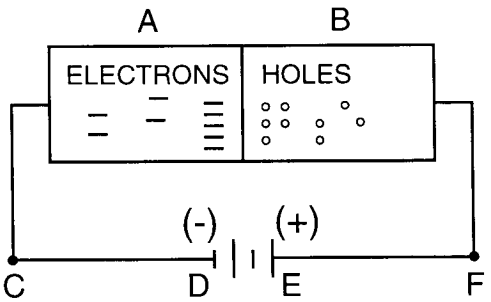
96 Which symbol correctly represents a transistor?



97 For a solid to be an efficient carrier of electric current, its electronic conduction band should

1 overlap its valence band
2 have a large gap with its valence band
3 be smaller than its valence band
4 be at a higher energy level than its valence band

Base your answers to questions 98 and 99 on the diagram below, which represents a germanium semiconductor device.



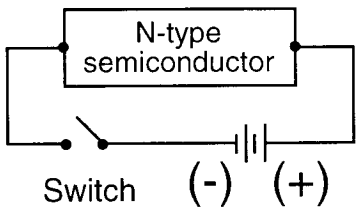
98 In the diagram, section *A* represents the

(1) *N*-type germanium
(2) *P*-type germanium
(3) anode
(4) diode

99 The bias of the *P–N* junction shown in the diagram is

(1) *C* to *D*
(2) *E* to *F*
(3) reverse
(4) forward

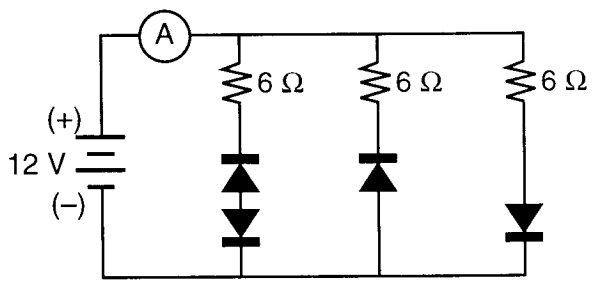
100 The diagram below shows an *N*-type semiconductor connected to a battery and a switch.



When the switch is closed, conduction in the semiconductor consists of

1 majority charge carriers moving toward the right and minority charge carriers moving toward the left
2 majority charge carriers moving toward the left and minority charge carriers moving toward the right
3 both majority and minority charge carriers moving toward the right
4 both majority and minority charge carriers moving toward the left

101 The circuit in the diagram below contains three 6-ohm resistors, four diodes, a 12-volt battery, and an ammeter, *A*.



The current measured by ammeter *A* is

(1) 0.7 A
(2) 2 A
(3) 6 A
(4) 4 A

102 In an *N–P–N* transistor, approximately what percentage of the electrons pass from the emitter through the base and to the collector?

(1) 15%
(2) 2%
(3) 50%
(4) 98%

103 Doping a semiconducting material with a donor impurity results in

1 an excess of positive holes
2 a deficiency of free electrons
3 an excess of free electrons
4 a deficiency of atoms

Note that questions 104 and 105 have only three choices.

104 As the temperature of a solid semiconductor increases, its conductivity

1 decreases
2 increases
3 remains the same

105 When a semiconductor in a circuit at room temperature is replaced by an insulator, the resistance of that section of the circuit

1 decreases
2 increases
3 remains the same

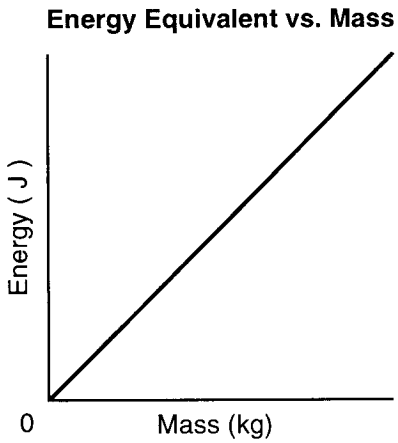
Group 6 — Nuclear Energy

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

106 Which type of force overcomes the repulsive electrostatic force between protons in the nucleus of an atom?

1 magnetic
2 nuclear
3 gravitational
4 centrifugal

107 The graph below represents the relationship between mass and its energy equivalent.



The slope of the graph represents

1 the electrostatic constant
2 gravitational field strength
3 the speed of light squared
4 Planck's constant

108 According to the Uranium Disintegration Series, an atom of uranium-238 changes to an atom of uranium-234 by the emission of

1 one alpha particle followed by one beta particle
2 one beta particle followed by one alpha particle
3 one alpha particle followed by two beta particles
4 one beta particle followed by two alpha particles

109 An atom of $^{131}_{53}\mathrm{I}$ and an atom of $^{127}_{53}\mathrm{I}$ contain the same number of

1 quarks
2 neutrons
3 nucleons
4 protons

110 The chart below lists the rest masses of two particles and a nucleus in atomic mass units.

proton	1.0073 u
neutron	1.0087 u
$^{6}_{3}\mathrm{Li}$ nucleus	6.0135 u

What is the mass defect of a $^{6}_{3}\mathrm{Li}$ nucleus?

(1) 0.0345 u
(2) 0.0615 u
(3) 3.0606 u
(4) 3.9975 u

111 The half-life of a radioactive nuclide is 6 hours. After one day (24 hours), approximately how much of an original 2.4×10^{-2}-kilogram sample of this nuclide remains?

(1) 1.5×10^{-3} kg
(2) 2.4×10^{-3} kg
(3) 4.0×10^{-3} kg
(4) 6.0×10^{-3} kg

112 In the nuclear equation $^{7}_{4}\mathrm{Be} + X \rightarrow {}^{7}_{3}\mathrm{Li}$, X represents

1 a proton
2 a positron
3 a neutron
4 an electron

113 High-energy neutrons are released in all nuclear fission reactions. What material is used in a reactor to reduce the energy of these neutrons to thermal levels?

1 shielding
2 moderators
3 fissionable isotopes
4 thin metal foils

114 Which stable nucleus is formed when an unstable nucleus of $^{137}_{56}\mathrm{Ba}$ emits a gamma ray?

(1) $^{137}_{56}\mathrm{Ba}$
(2) $^{137}_{57}\mathrm{La}$
(3) $^{138}_{55}\mathrm{Cs}$
(4) $^{133}_{54}\mathrm{Xe}$

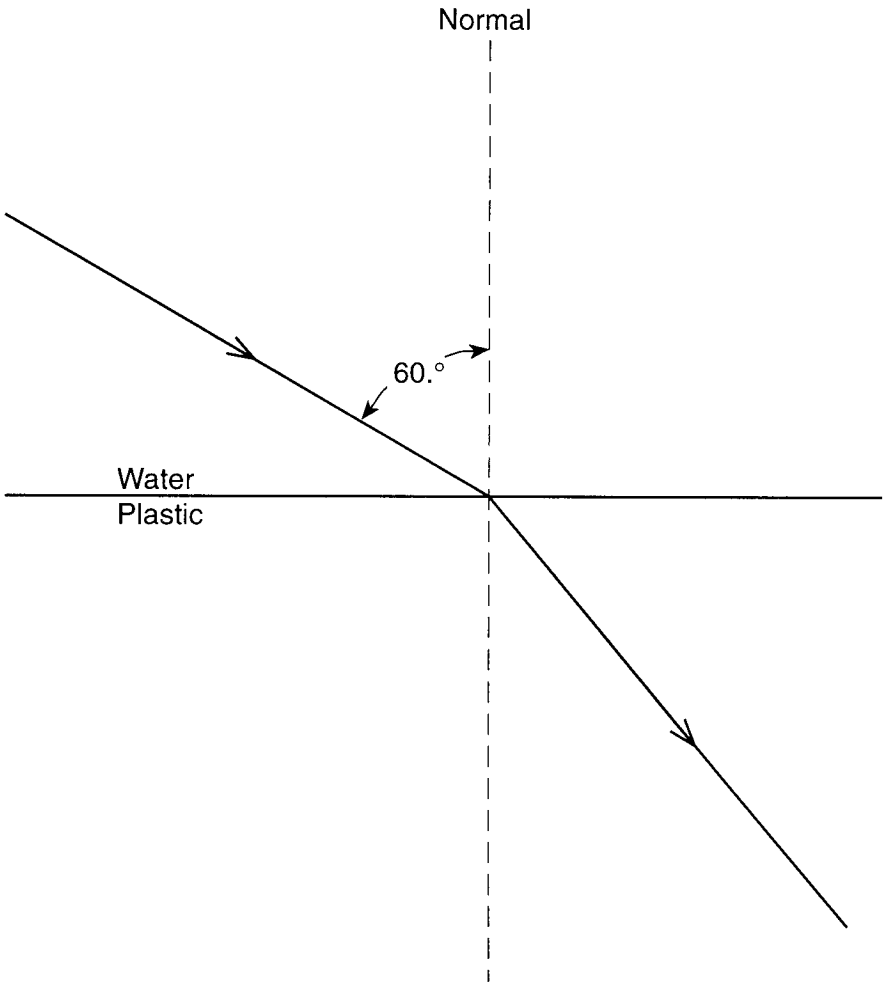
115 The atomic mass unit is defined as $\frac{1}{12}$ the mass of an atom of

(1) $^{8}_{4}\mathrm{Be}$
(2) $^{12}_{6}\mathrm{C}$
(3) $^{22}_{11}\mathrm{Na}$
(4) $^{24}_{12}\mathrm{Mg}$

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 diagram below, which shows a light ray in water incident at an angle of 60.° on a boundary with plastic.

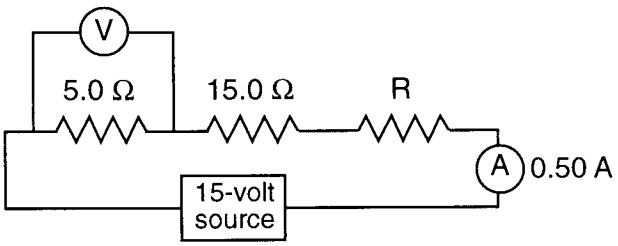


116 Using a protractor, measure the angle of refraction to the *nearest degree.* Record the value *on your answer paper.* [1]

117 Determine the absolute index of refraction for the plastic. [Show all calculations, including the equation and substitution with units.] [2]

Base your answers to questions 118 and 119 on the information and diagram below.

A 5.0-ohm resistor, a 15.0-ohm resistor, and an unknown resistor, R, are connected as shown with a 15-volt source. The ammeter reads a current of 0.50 ampere.



118 Determine the reading of the voltmeter connected across the 5.0-ohm resistor. [Show all calculations, including the equation and substitution with units.] [2]

119 Determine the total electrical energy used in the circuit in 600. seconds. [Show all calculations, including the equation and substitution with units.] [2]

Base your answers to questions 120 through 122 on the information below.

A hydrogen atom emits a 2.55-electronvolt photon as its electron changes from one energy level to another.

120 Using the *Reference Tables for Physics*, determine the energy level change for the electron. [1]

121 Express the energy of the emitted photon in joules. [1]

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

Base your answers to questions 123 through 125 on the information and data table below.

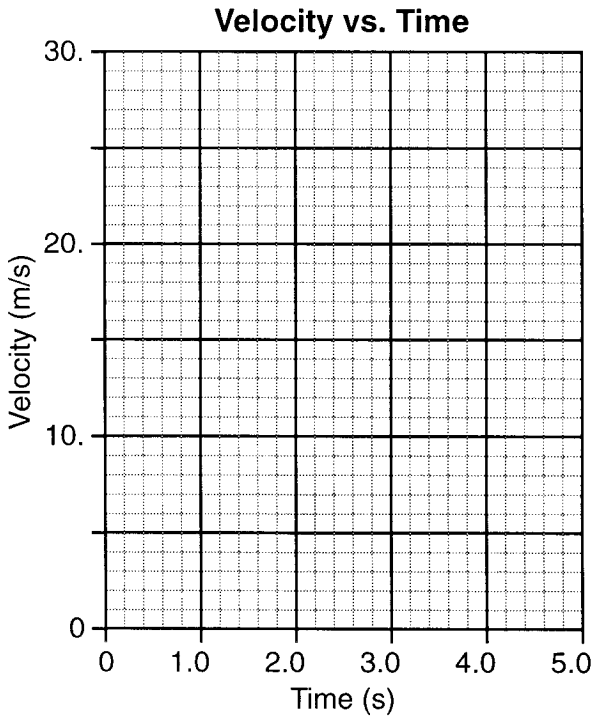
A car is traveling due north at 24.0 meters per second when the driver sees an obstruction on the highway. The data table below shows the velocity of the car at 1.0-second intervals as it is brought to rest on the straight, level highway.

Time (s)	Velocity (m/s)
0.0	24.0
1.0	19.0
2.0	14.0
3.0	10.0
4.0	4.0

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

123 Plot the data points for velocity versus time. [1]

124 Draw the best-fit line. [1]



125 Using your graph, determine the acceleration of the car. [Show all calculations, including the equation and substitution with units.] [2]

Part III (15 credits)

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

116 _____ °

117

118

119

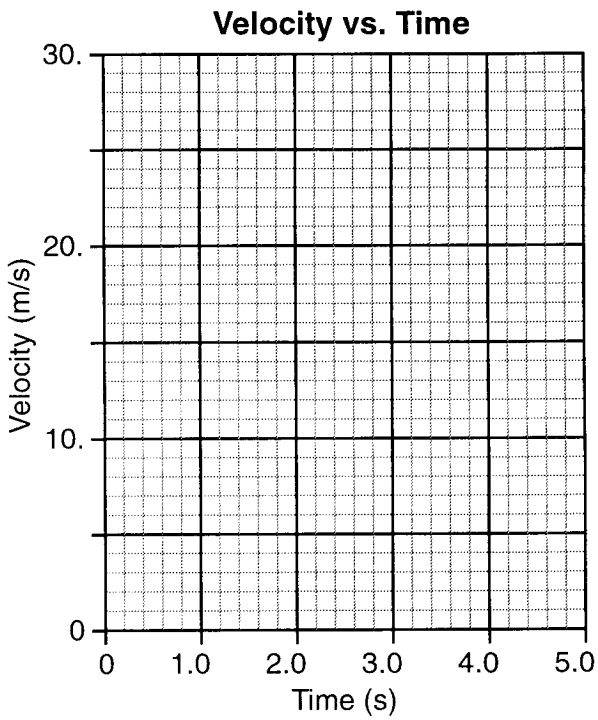
[OVER]

120 level n = _____ to level n = _____

121 _____ J

122

123–124



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

FOR TEACHERS ONLY

P

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Friday, June 18, 1999—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**	X	2	3	4	**41**	1	2	X	4
2	1	2	3	X	**22**	1	2	X	4	**42**	1	X	3	4
3	1	2	X	4	**23**	X	2	3	4	**43**	X	2	3	4
4	X	2	3	4	**24**	1	2	X	4	**44**	1	X	3	4
5	X	2	3	4	**25**	1	2	3	X	**45**	1	2	X	4
6	1	X	3	4	**26**	1	X	3	4	**46**	X	2	3	4
7	X	2	3	4	**27**	X	2	3	4	**47**	1	X	3	4
8	1	X	3	4	**28**	1	2	3	X	**48**	1	2	3	X
9	1	2	X	4	**29**	1	X	3	4	**49**	1	2	X	4
10	1	2	3	X	**30**	1	2	3	X	**50**	X	2	3	4
11	1	2	3	X	**31**	1	2	3	X	**51**	X	2	3	4
12	X	2	3	4	**32**	1	X	3	4	**52**	1	X	3	4
13	1	X	3	4	**33**	1	2	3	X	**53**	1	2	3	X
14	1	X	3	4	**34**	1	2	3	X	**54**	X	2	3	4
15	1	2	X	4	**35**	1	2	X	4	**55**	1	2	X	
16	X	2	3	4	**36**	X	2	3	4					
17	1	2	3	X	**37**	1	X	3	4					
18	1	2	X	4	**38**	1	2	X	4					
19	1	2	3	X	**39**	1	2	3	X					
20	1	2	X	4	**40**	1	2	X	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]

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

Group 2
Internal Energy

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

Group 3
Electromagnetic Applications

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

Group 4
Geometric Optics

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

Group 5
Solid State

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

Group 6
Nuclear Energy

106	1	**X**	3	4
107	1	2	**X**	4
108	1	2	**X**	4
109	1	2	3	**X**
110	**X**	2	3	4
111	**X**	2	3	4
112	1	2	3	**X**
113	1	**X**	3	4
114	**X**	2	3	4
115	1	**X**	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, 122, and 125.

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

116 Allow one credit.

40.° *or* 40° ±2°

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

Examples of Acceptable Responses

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$n_2 = \frac{n_1 \sin \theta_1}{\sin \theta_2}$

$n_2 = \frac{1.33 \sin 60.^\circ}{\sin 40.^\circ}$

$n_2 = 1.79$

or

$n_2 = 1.8$

Allow credit for an answer that is consistent with the student's answer to question 116.

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

Examples of Acceptable Responses

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

$V = IR$

$V = (0.50\ \text{A})(5.0\ \Omega)$

$V = 2.5\ \text{V}$

or

$V = 2.5\ \text{A}\cdot\Omega$

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

Examples of Acceptable Responses

$W = VIt$

$W = (15\ \text{V})(0.50\ \text{A})(600.\ \text{s})$

$W = 4.5 \times 10^3\ \text{J}$

or

$W = 4500\ \text{V}\cdot\text{A}\cdot\text{s}$

120 Allow one credit.

Acceptable Response

$n = 4$ to $n = 2$

Unacceptable Response

$n = 2$ to $n = 4$

121 Allow one credit.

Examples of Acceptable Responses

$4.1 \times 10^{-19}\ \text{J}$

or

$4.08 \times 10^{-19}\ \text{J}$

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

Examples of Acceptable Responses

$$E = hf$$

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

$$f = \frac{4.1 \times 10^{-19}\ \text{J}}{6.6 \times 10^{-34}\ \text{J•s}}$$

$$f = 6.2 \times 10^{14}\ \text{Hz}$$

or

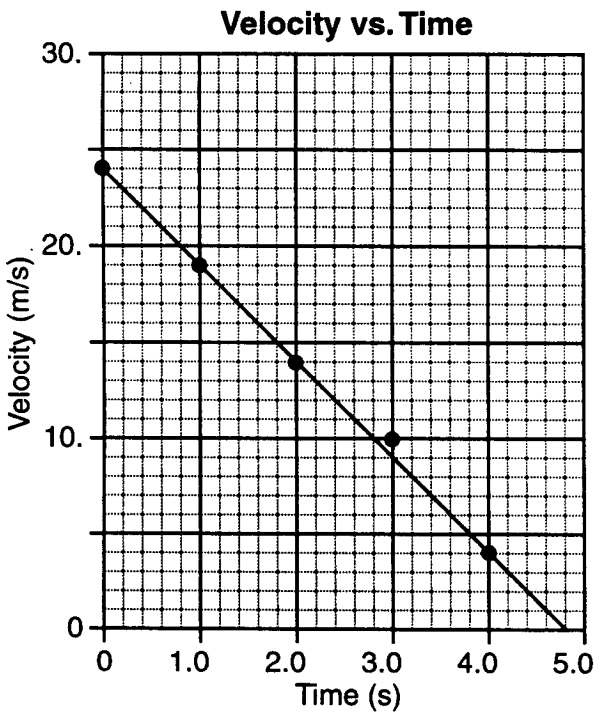
$$E = hf$$

$$4.08 \times 10^{-19}\ \text{J} = (6.6 \times 10^{-34}\ \text{J•s})f$$

$$f = 6.18 \times 10^{14}\ \text{1/s}$$

Allow credit for an answer that is consistent with the student's answer to question 121.

123–124 Example of Acceptable Response



123 Allow one credit.

All points must be plotted accurately (±0.3 grid space).

124 Allow one credit.

The best-fit line must be straight. If one or more points are plotted incorrectly in question 123, but a best-fit line is drawn, allow this credit.

125 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 credit for questions 123 and 124. In that case, credit may be awarded if the student correctly calculates the acceleration using data in the table.

Note: The acceleration *may* be determined by direct substitution into the equation $\bar{a} = \frac{\Delta v}{\Delta t}$, *only if* the best-fit line passes through the data values used for substitution.

Examples of Acceptable Responses

$$\text{slope} = \frac{\Delta y}{\Delta x}$$

$$\text{slope} = \frac{-20\ \text{m/s}}{4\ \text{s}}$$

$$\text{slope} = -5\ \text{m/s}^2\ (\pm 0.3\ \text{m/s}^2)$$

or

$$5\ \text{m/s}^2\ (\pm 0.3\ \text{m/s}^2)\ \text{south}$$

or

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

$$\bar{a} = \frac{1\ \text{m/s} - 21\text{m/s}}{4.6\ \text{s} - 0.6\ \text{s}}$$

$$\bar{a} = -5.0\ \text{m/s}^2\ (\pm 0.3\ \text{m/s}^2)$$

or

$$5.0\ \text{m/s}^2\ (\pm 0.3\ \text{m/s}^2)\ \text{south}$$

Examples of Unacceptable Responses

$-5\ \text{m/s}^2$ south *or* $5.0\ \text{m/s}^2$