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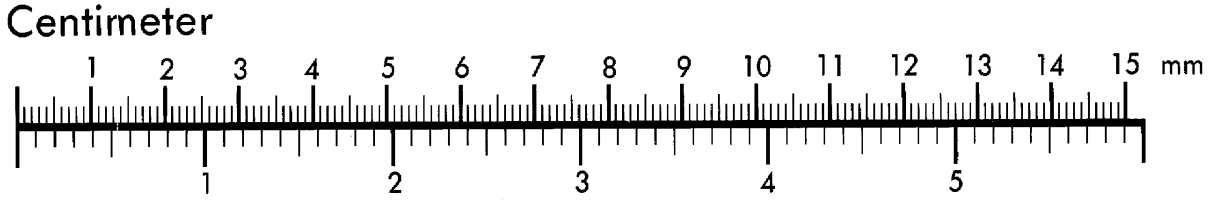


The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

The last page of the booklet is the answer sheet. Fold the last page along the perforations and, slowly and carefully, tear off the answer sheet. Then fill in the heading of your answer sheet.

All of your answers should be recorded on the separate answer sheet. For each question, decide which of the choices given is your answer. Then on the answer sheet, 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 decide later in the examination period that you wish to change an answer, you may erase any previously written circle and encircle another number. When you have finally decided that all of the circled answers represent your best judgment, signal a proctor and surrender all examination material to him except your answer sheet. Then and only then, place an X in ink in each circle. Be sure to mark only one answer with an X for each question. No credit will be given for any item with two or more X's. The sample below indicates how your final choice should appear.

SAMPLE: 1 (X) 3 4

The "Reference Tables for Physics" which you may need to answer some questions in this examination are stapled in the center of this booklet. Open the booklet and carefully remove the reference tables.

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.

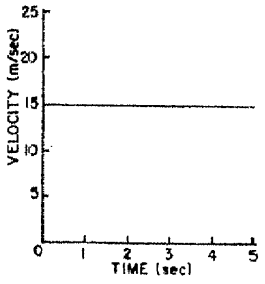
DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN

Part I

Directions (1–60): For *each* statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet. [70]

1 Which is a vector quantity?
1 acceleration due to gravity
2 mechanical equivalent of heat
3 rest mass of an electron
4 speed of an object

2 The graph below represents the relationship between velocity and time for an object moving in a straight line. What is the acceleration of the object?



(1) 0 m/sec^2
(2) 5 m/sec^2
(3) 3 m/sec^2
(4) 15 m/sec^2

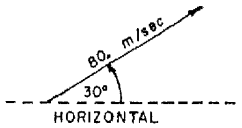
3 Starting from rest, an object rolls freely down an incline that is 10 meters long in 2 seconds. The acceleration of the object is approximately
(1) 5 m/sec
(2) 5 m/sec^2
(3) 10 m/sec
(4) 10 m/sec^2

4 An object, initially at rest, falls freely near the Earth's surface. How long does it take the object to attain a speed of 98 meters per second?
(1) 0.1 sec
(2) 10 sec
(3) 98 sec
(4) 960 sec

5 Two 10.0-newton forces act concurrently on a point at an angle of 180° to each other. The magnitude of the resultant of the two forces is
(1) 0.00 nt
(2) 10.0 nt
(3) 18.0 nt
(4) 20.0 nt

6 A 15-newton force acts on an object in a direction due east for 3.0 seconds. What will be the change in momentum of the object?
(1) 45 kg-m/sec due east
(2) 45 kg-m/sec due west
(3) 5.0 kg-m/sec due east
(4) 0.20 kg-m/sec due west

7 What is the magnitude of the vertical component of the velocity vector shown below?



(1) 10. m/sec
(2) 69 m/sec
(3) 30. m/sec
(4) 40. m/sec

8 An object with a mass of 2 kilograms is accelerated at 5 m/sec^2. The net force acting on the mass is
(1) 5 nt
(2) 2 nt
(3) 10 nt
(4) 20 nt

9 The fundamental units for a force of one newton are
1 meters/second^2
2 kilograms
3 meters/second^2/kilogram
4 kilogram-meters/second^2

10 An object traveling at 4.0 meters per second has a momentum of 16 kilogram-meters per second. What is the mass of the object?
(1) 64 kg
(2) 20 kg
(3) 12 kg
(4) 4.0 kg

11 Two carts resting on a frictionless surface are forced apart by a spring. One cart has a mass of 2 kilograms and moves to the left at a speed of 3 meters per second. If the second cart has a mass of 3 kilograms, it will move to the right at a speed of
(1) 1 m/sec
(2) 2 m/sec
(3) 3 m/sec
(4) 6 m/sec

12 A force of 80. newtons pushes a 50.-kilogram object across a level floor for 8.0 meters. The work done is
(1) 10 joules
(2) 400 joules
(3) 640 joules
(4) 3,920 joules

13 Which will generally occur when a pulse reaches a boundary between two different media?
1 The entire pulse will be reflected.
2 The entire pulse will be absorbed.
3 The entire pulse will be transmitted.
4 Part of the pulse will be transmitted and part will be reflected.

14 A unit for kinetic energy is the

1 watt
2 joule
3 newton
4 kilogram-meter/second

15 A 2.0-newton book falls from a table 1.0 meter high. After falling 0.5 meter, the book's kinetic energy is

(1) 1.0 joule
(2) 2.0 joules
(3) 10 joules
(4) 20 joules

16 The direction of exchange of internal energy between objects is determined by their relative

1 inertias
2 momentums
3 temperatures
4 masses

17 What temperature reading on the Kelvin scale is equivalent to a reading of zero degrees Celsius?

(1) −273°K
(2) −100°K
(3) 100°K
(4) 273°K

18 Longitudinal waves are involved in the transmission of

1 light
2 radar
3 sound
4 photons

19 If the frequency of a sound wave is 440. cycles per second, its period is closest to

(1) 2.27×10^{-3} second/cycle
(2) 0.75 second/cycle
(3) 1.33 seconds/cycle
(4) 3.31×10^{2} seconds/cycle

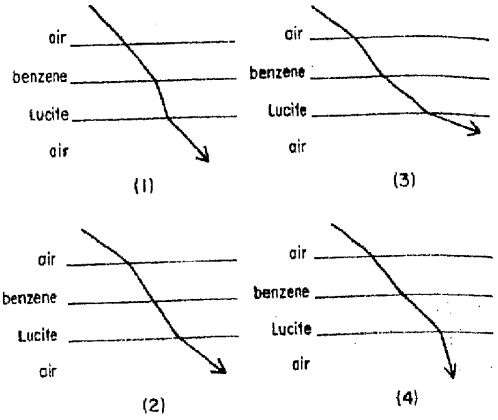
20 A medium in which waves of different frequencies travel at different speeds and may be separated is called

1 a dispersive medium
2 a nondispersive medium
3 an inelastic medium
4 a coherent medium

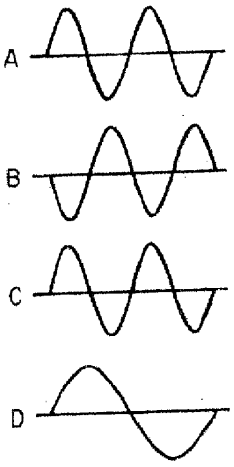
21 The pattern of bright and dark bands observed when monochromatic light passes through two narrow slits is due to

1 polarization
2 reflection
3 refraction
4 interference

22 Which arrow best represents the path that a monochromatic ray of light will travel as it passes through air, benzene, Lucite, and back into air?

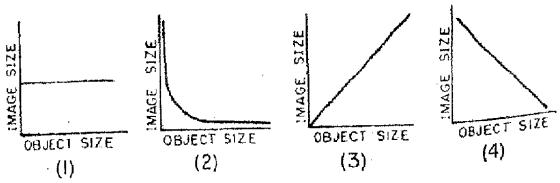


23 The diagrams below show four waves that pass simultaneously through a region. Which two waves will produce maximum constructive interference if they are combined?



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

24 Which graph best represents the relationship between the image size and the object size for an object reflected in a plane mirror?



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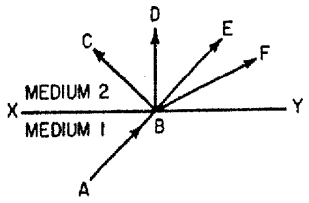
25 In the diagram below, ray AB is incident on surface XY at point B. If medium 2 has a lower index of refraction than medium 1, through which point will the ray most likely pass?



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

26 The critical angle is the angle of incidence for which the angle of refraction is
(1) 0° (3) 45°
(2) 30° (4) 90°

27 A longitudinal wave can *not* be
1 polarized 3 refracted
2 diffracted 4 reflected

28 Which is *not* in the electromagnetic spectrum?
(1) light waves (3) sound waves
(2) radio waves (4) X-rays

29 A beam of monochromatic red light passes obliquely from air into water. Which characteristic of the light does *not* change?
1 direction 3 frequency
2 velocity 4 wavelength

30 The electrostatic force of attraction between two small spheres that are 1.0 meter apart is F. If the distance between the spheres is decreased to 0.5 meter, the electrostatic force will then be

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

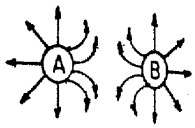
(2) $2F$ (4) $4F$

31 After a neutral object loses 2 electrons, it will have a net charge of
(1) -2 elementary charges
(2) $+2$ elementary charges
(3) -3.2×10^{-19} elementary charge
(4) $+3.2 \times 10^{-19}$ elementary charge

32 A pith ball may become charged by losing or gaining
1 electrons, only 3 protons and electrons
2 protons, only 4 neutrons and protons

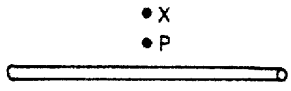
33 If the charge on one of two small charged spheres is doubled while the distance between them remains the same, the electrostatic force between the point sources will be
1 halved 3 tripled
2 doubled 4 unchanged

34 Two charged spheres are shown in the diagram. Which polarities will produce the electric field shown?



(1) A and B both negative
(2) A and B both positive
(3) A positive and B negative
(4) A negative and B positive

35 In the diagram, point P is located 0.2 meter from the uniformly charged rod, and point X is located 0.4 meter from the rod.



UNIFORMLY CHARGED ROD

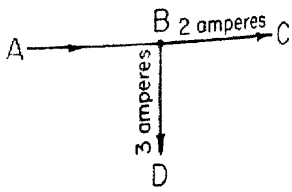
Compared to the electric field intensity at P, the electric field intensity at X is
(1) $\frac{1}{2}$ as great (3) $\frac{1}{4}$ as great
(2) 2 times greater (4) 4 times greater

36 A rod and a piece of cloth are rubbed together. If the rod acquires a charge of $+1 \times 10^{-6}$ coulomb, the cloth acquires a charge of
(1) 0 coulombs (3) -1×10^{-6} coulomb
(2) $+1 \times 10^{-6}$ coulomb (4) $+1 \times 10^{6}$ coulombs

37 Most metals are good electrical conductors because
1 their molecules are close together
2 they have high melting points
3 they have many intermolecular spaces through which the current can flow
4 they have a large number of free electrons

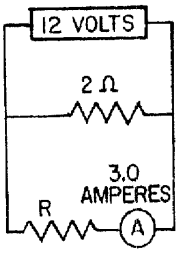
38 A potential difference of 12 volts is applied across a circuit which has a 4.0-ohm resistance. What is the magnitude of the current in the circuit?
(1) 0.33 ampere (3) 3.0 amperes
(2) 48 amperes (4) 4.0 amperes

39 The diagram at the right represents a segment of an electrical circuit. What is the current in wire AB?



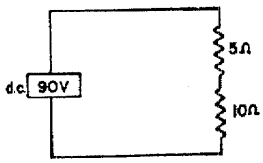
(1) 1 ampere (3) 5 amperes
(2) 2 amperes (4) 6 amperes

40 Two resistors are connected in parallel to a 12-volt battery as shown in the diagram. If the current in resistance R is 3.0 amperes, the rate at which R consumes electrical energy is



(1) 1.1×10^2 watts
(2) 36 watts
(3) 24 watts
(4) 4.0 watts

41 Compared to the potential drop across the 10-ohm resistor shown in the diagram, the potential drop across the 5-ohm resistor is

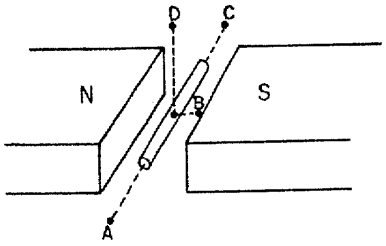


1 the same
2 twice as great
3 one-half as great
4 four times as great

42 An ampere-volt is a unit of

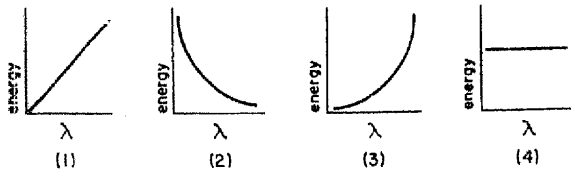
1 work
2 resistance
3 energy
4 power

43 The diagram below shows a copper wire located between the poles of a magnet. Maximum electric potential will be induced in the wire when it is moved at a constant speed toward which point?



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

44 Which graph best represents the relationship between the energy of a photon and its wavelength?



45 All of the following particles are traveling at the same speed. Which has the greatest wavelength?

1 proton
2 alpha particle
3 neutron
4 electron

46 In alpha particle scattering, the nucleus produces an effect on the scattering angles. This is primarily due to the fact that the nucleus

1 has a small total charge
2 has a mass close to that of the alpha particles
3 exerts coulomb forces
4 is widely dispersed throughout the atom

47 An atom changing from an energy state of −0.54 ev to an energy state of −0.85 ev will emit a photon whose energy is

(1) 0.31 ev
(2) 0.54 ev
(3) 0.85 ev
(4) 1.39 ev

48 Which device makes visual observation of the path of a charged particle possible?

1 Geiger counter
2 Van de Graaff generator
3 cyclotron
4 cloud chamber

49 What is the maximum amount of kinetic energy that may be gained by a proton accelerated through a potential difference of 50 volts?

(1) 1 ev
(2) 10 ev
(3) 50 ev
(4) 100 ev

Note that questions 50 through 60 have only three choices.

50 A ball is thrown upward from the Earth's surface. While the ball is rising, its gravitational potential energy will

1 decrease
2 increase
3 remain the same

51 As the power of a machine is increased, the time required to move an object a fixed distance

1 decreases
2 increases
3 remains the same

52 As the temperature of a substance increases, the average kinetic energy of its molecules

1 decreases
2 increases
3 remains the same

53 If the frequency of a light wave in a vacuum is increased, its wavelength

1 decreases
2 increases
3 remains the same

54 Compared to the speed of light in a vacuum, the speed of light in a dispersive medium is
1 less
2 greater
3 the same

55 If the cross-sectional area of a fixed length of wire were decreased, the resistance of the wire would
1 decrease
2 increase
3 remain the same

56 If the temperature of a metal conductor is reduced, its resistance will
1 decrease
2 increase
3 remain the same

57 Compared to the energy of the photons of blue light, the energy of the photons of red light is
1 less
2 greater
3 the same

58 A monochromatic light incident upon a photoemissive surface emits electrons. If the intensity of the incident light is increased, the rate of electron emission will
1 decrease
2 increase
3 remain the same

59 When compared to the total mass of its nucleons, the mass of the nucleus is
1 less
2 greater
3 the same

60 The nucleus of isotope *A* of an element has a larger mass than isotope *B* of the same element. Compared to the number of protons in the nucleus of isotope *A*, the number of protons in the nucleus of isotope *B* is
1 less
2 greater
3 the same

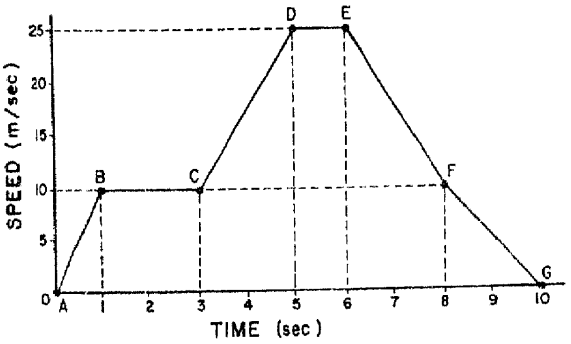
Part II

This part consists of four groups, each group testing a major area of the course. Choose two of these four groups. [30]

Group 1 — Mechanics

Answer all fifteen questions, 61 through 75, in this group. Each question counts 1 credit. Record your answer to each of the fifteen questions on the separate answer sheet in accordance with the directions on the front page of this booklet.

Base your answers to questions 61 through 66 on the graph below which represents the relationship between speed and time for an object in motion along a straight line.



61 What is the acceleration of the object during the time interval t = 3 seconds to t = 5 seconds?

(1) 5.0 m/sec^2 (3) 12.5 m/sec^2
(2) 7.5 m/sec^2 (4) 17.5 m/sec^2

62 What is the average speed of the object during the time interval t = 6 seconds to t = 8 seconds?

(1) 7.5 m/sec (3) 15 m/sec
(2) 10 m/sec (4) 17.5 m/sec

63 What is the total distance traveled by the object during the first 3 seconds?

(1) 15 m (3) 25 m
(2) 20 m (4) 30 m

64 During which interval is the object's acceleration the greatest?

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

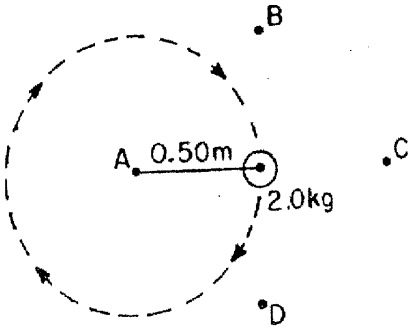
65 During the interval t = 8 seconds to t = 10 seconds, the speed of the object is

1 zero 3 decreasing
2 increasing 4 constant, but not zero

66 What is the maximum speed reached by the object during the 10 seconds of travel?

(1) 10 m/sec (3) 150 m/sec
(2) 25 m/sec (4) 250 m/sec

Base your answers to questions 67 through 70 on the diagram below which represents a 2.0-kilogram mass moving in a circular path on the end of a string 0.50 meter long. The mass moves in a horizontal plane at a constant speed of 4.0 meters per second.



67 The force exerted on the mass by the string is

(1) 8 nt (3) 32 nt
(2) 16 nt (4) 64 nt

68 In the position shown in the diagram, the momentum of the mass is directed toward point

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

69 The centripetal force acting on the mass is directed toward point

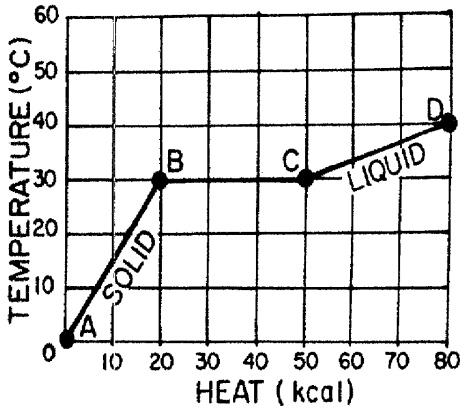
(1) *A* (3) *C*
(2) *B* (4) *D*

70 The speed of the mass is changed to 2.0 meters per second. Compared to the centripetal acceleration of the mass when moving at 4.0 meters per second, its centripetal acceleration when moving at 2.0 meters per second would be

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

☞ GO RIGHT ON TO THE NEXT PAGE.

Base your answers to questions 71 through 75 on the graph below which represents the temperature vs. heat of 2.0 kilograms of a substance originally in the solid state.



71 The melting point of the substance is
(1) 10°C (3) 30°C
(2) 20°C (4) 50°C

72 How much heat energy is necessary to raise the temperature of the substance in the liquid phase from 30°C to 40°C?
(1) 15 kcal (3) 50 kcal
(2) 30 kcal (4) 60 kcal

73 The total amount of heat energy necessary to raise the temperature of the substance from a solid at 30°C to a liquid at 40°C is
(1) 20 kcal (3) 60 kcal
(2) 30 kcal (4) 80 kcal

74 During which interval is the average kinetic energy of the molecules of the substance unchanged?
(1) *AB* (3) *CD*
(2) *BC* (4) *AC*

75 The specific heat of the substance in the solid phase is approximately
(1) 1.0 kcal/kg-°C (3) 0.33 kcal/kg-°C
(2) 0.25 kcal/kg-°C (4) 1.5 kcal/kg-°C

754

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12224

PHYSICS REFERENCE TABLES

LIST OF PHYSICAL CONSTANTS

Gravitational Constant (G)	6.67×10^{-11} newton-meters^2/kg^2
Acceleration of gravity (g) (near earth's surface)	9.81 meters/second^2
Speed of light (c)	3.00×10^8 meters/second
Speed of sound at S.T.P.	3.31×10^2 meters/second
Mechanical equivalent of heat	J = 4.19×10^3 joules/kilocalorie
	$\frac{1}{J} = 2.39 \times 10^{-4}$ kilocalories/joule
Mass energy relationship	1 amu = 9.31×10^2 Mev
Electrostatic constant	k = 9.00×10^9 newton-meters^2/coul^2
Charge of the electron = 1 elementary charge	1.60×10^{-19} coulomb
One coulomb	6.25×10^{18} electrons
	6.25×10^{18} elementary charges
Electron volt (ev)	1.60×10^{-12} joule
Planck's Constant (h)	6.63×10^{-34} joule-second
Rest mass of the electron (m_e)	9.11×10^{-31} kilogram
Rest mass of the proton (m_p)	1.67×10^{-27} kilogram
Rest mass of the neutron (m_n)	1.67×10^{-27} kilogram

TRIGONOMETRIC FUNCTIONS

sine 0° = .000
sine 30° = .500
sine 45° = .707
sine 60° = .866
sine 90° = 1.000

WAVELENGTHS OF LIGHT IN A VACUUM

VIOLET	$<4.5 \times 10^{-7}$ meters
BLUE	$4.5 - 5.0 \times 10^{-7}$ meters
GREEN	$5.0 - 5.7 \times 10^{-7}$ meters
YELLOW	$5.7 - 5.9 \times 10^{-7}$ meters
ORANGE	$5.9 - 6.1 \times 10^{-7}$ meters
RED	$>6.1 \times 10^{-7}$ meters

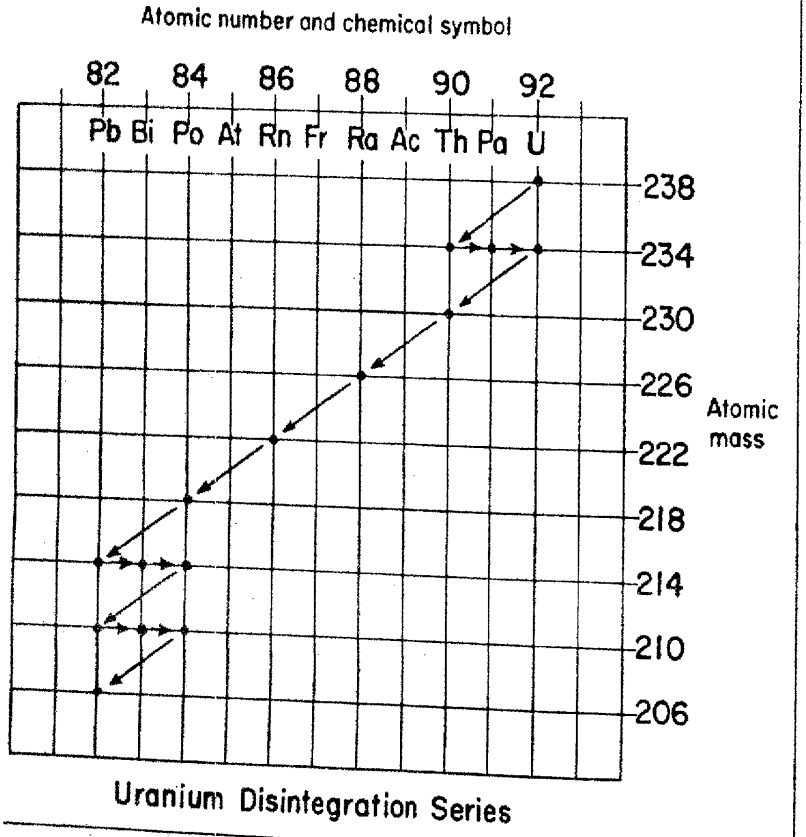
HEAT CONSTANTS

	Specific Heat (average)	*Melting Point*	*Boiling Point*	*Heat of Fusion*	*Heat of Vaporization*
	——	°C.	°C.	$\frac{\text{kcal}}{\text{kg}}$	$\frac{\text{kcal}}{\text{kg}}$
Alcohol, ethyl	0.58 (liq.)	—115	78	25	204
Aluminum	0.21 (sol.)	660	2057	77	2520
Ammonia	1.13 (liq.)	—78	—33	84	327
Copper	0.09 (sol.)	1083	2336	49	1150
Ice	0.50 (sol.)	0	—	80	—
Iron	0.11 (sol.)	1535	3000	7.9	1600
Lead	0.03 (sol.)	327	1620	5.9	207
Mercury	0.03 (liq.)	—39	357	2.8	71
Platinum	0.03 (sol.)	1774	4300	27	—
Silver	0.06 (sol.)	961	1950	26	565
Steam	0.48 (gas)	—	—	—	—
Water	1.00 (liq.)	—	100	—	540
Tungsten	0.04 (sol.)	3370	5900	43	—
Zinc	0.09 (sol.)	419	907	23	420

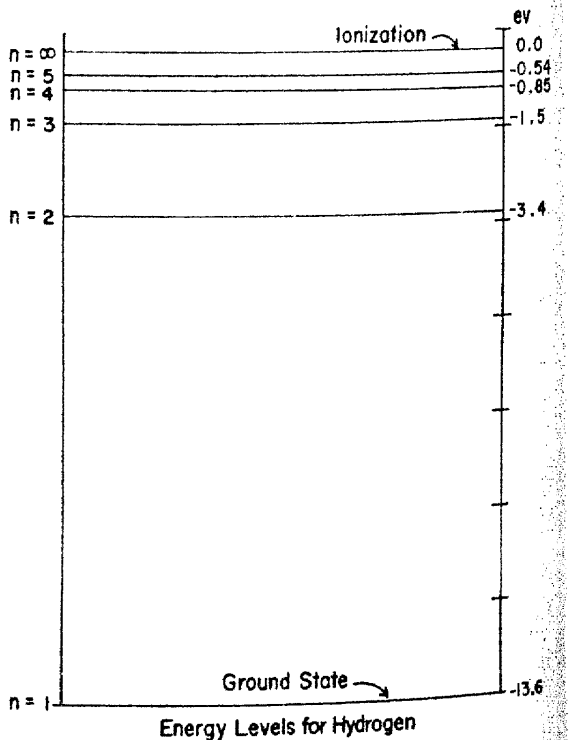
ABSOLUTE INDICES OF REFRACTION

($\lambda = 5.9 \times 10^{-7}$m.)

Air 1.00	Carbon Tetrachloride.. 1.46	Glycerol 1.47
Alcohol 1.36	Diamond 2.42	Lucite 1.50
Benzene 1.50	Glass, Crown..... 1.52	Quartz, Fused..... 1.46
Canada Balsam..... 1.53	Glass, Flint 1.61	Water 1.33



Uranium Disintegration Series



Energy Levels for Hydrogen

Summary of Equations Used in New York State Physics Course

Unit I MECHANICS

$\bar{v} = \frac{s}{t}$ $\quad \bar{v} = \frac{v_f + v_i}{2}$

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

$s = \frac{1}{2} at^2$

$v^2 = 2as$

$F = ma$

$w = mg$

$F_c = \frac{mv^2}{r}$ $\quad a_c = \frac{v^2}{r}$

$F\Delta t = \Delta mv$ $\quad m_1 v_1 = m_2 v_2$

$W = Fs$

$E_p = mgh$

$E_k = \frac{1}{2} mv^2$

$P = \frac{W}{t} = \frac{Fs}{t} = Fv$

$\Delta E_p = -\Delta E_k$

$T_k = t_c + 273$

$\Delta Q = mc\Delta t_c$

$Q_e = Q_g$

$Q_f = mH_f$

$Q_v = mH_v$

$F = \frac{Gm_1 m_2}{d^2}$

P = power

T_k = Kelvin temperature

t_c = Celsius temperature

Q = heat

Q_e = heat lost

Q_g = heat gained

c = specific heat

H_f = heat of fusion

H_v = heat of vaporization

v_i = initial speed

v_f = final speed

$\bar{v}$ = average speed

a = acceleration

s = distance

F = force

m = mass

g = acceleration of gravity

w = weight

F_c = centripetal force

r = radius of curvature

t = time

W = work

E_p = potential energy

E_k = kinetic energy

G = Universal gravitational constant

d = distance

a_c = centripetal acceleration

Unit 2 - WAVE PHENOMENA

$T = \frac{1}{f}$

$v = f\lambda$

$\frac{\sin \theta_1}{\sin \theta_2} = \frac{n_2}{n_1} = \frac{v_1}{v_2} = K$

$v = \frac{c}{n}$

$\sin \theta_c = \frac{1}{n}$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$\frac{s_o}{s_i} = \frac{d_o}{d_i}$

$\lambda = \frac{dx}{L}$ (first order)

T = period

f = frequency

v = speed

λ = wavelength

θ_1 = angle of incidence

θ_2 = angle of refraction

n = index of refraction

θ_c = critical angle

d_o = object to lens distance

d_i = image to lens distance

s_o = size of object

s_i = size of image

f = focal length

d = distance between slits

x = distance from central maximum to line

L = distance from slit to screen

K = relative index of refraction

Unit 3 - ELECTRICITY

$$F = k\frac{q_1 q_2}{d^2}$$

$$E = \frac{F}{q}$$

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

$$E = \frac{V}{d}$$

$$V = IR$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$W = Pt$$

$$JQ = VIt = I^2Rt = Pt$$

$$F = qvB$$

$$V = Blv$$

Series Circuits

$$I_t = I_1 = I_2 = I_3 = \ldots.$$

$$V_t = V_1 + V_2 + V_3 + \ldots.$$

$$R_t = R_1 + R_2 + R_3 + \ldots.$$

Parallel Circuits

$$I_t = I_1 + I_2 + I_3 + \ldots.$$

$$V_t = V_1 = V_2 = V_3 = \ldots.$$

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots.$$

F = force

q = charge

d = distance

E = electric field intensity

V = electric potential

I = current

R = resistance

P = power

t = time

W = energy

Q = heat

B = flux density

l = length of conductor

v = velocity

k = electrostatic constant

J = mechanical equivalent of heat

Unit 4 - ATOMIC AND NUCLEAR ENERGY

$$E = hf$$

$$E_k = hf - W_o$$

$$E_{photon} = E_i - E_f = hf$$

$$m_f = \frac{1}{2^n} m_i$$

$$E = mc^2$$

E = energy

h = Planck's constant

f = frequency

W_o = work function

E_k = kinetic energy of photoelectron

E_i = initial energy level

E_f = final energy level

m_f = final mass

m_i = initial mass

n = number of half lives

m = mass

c = speed of light

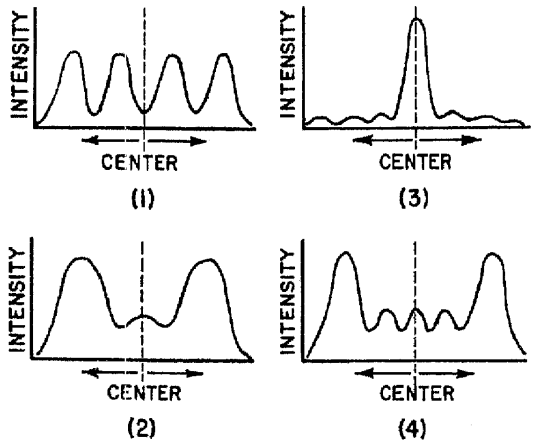
Group 2 — Wave Phenomena

Answer all fifteen questions, 76 through 90, in this group. Each question counts 1 credit. Record your answer for each of the fifteen questions on the separate answer sheet in accordance with the directions on the front page of this booklet.

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

Monochromatic light passes through a single narrow slit forming a diffraction pattern on a screen.

76 Which graph best represents the light intensity of the single-slit diffraction pattern for monochromatic light?

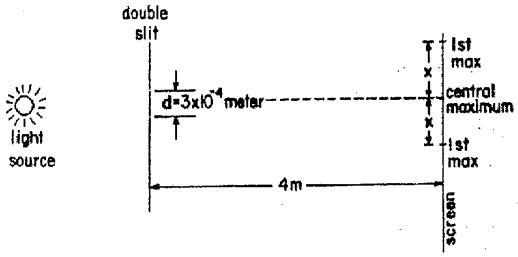


Note that questions 77 and 78 have only three choices.

77 If the wavelength of the light is decreased, the width of the central maximum in the diffraction pattern will
1 decrease
2 increase
3 remain the same

78 If the intensity of the light is increased, the width of the central maximum in the diffraction pattern will
1 decrease
2 increase
3 remain the same

Base your answers to questions 79 and 80 on the diagram below which shows light from a monochromatic source incident on a screen after passing through a double slit.



79 What is the wavelength of the light source if the distance between the central maximum and the first maximum is 0.01 meter?
(1) 6.7×10^{5} m
(2) 8.3 m
(3) 3.3×10^{-1} m
(4) 7.5×10^{-7} m

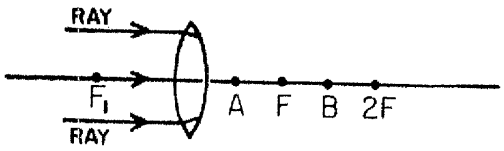
Note that question 80 has only three choices.

80 If the distance d between the slits is decreased, the distance x between the central maximum and the first maximum will
1 decrease
2 increase
3 remain the same

☞ GO RIGHT ON TO THE NEXT PAGE.

757

Base your answers to questions 81 through 85 on the information and diagram below. The diagram represents a converging lens made of Lucite, which is used to focus the parallel monochromatic yellow light rays shown. F and F_1 are the principal foci.



81 The rays will pass through point

(1) A
(2) B
(3) F
(4) $2F$

82 If an object is placed between F_1 and the lens, the image formed would be

1 real and smaller
2 real and larger
3 virtual and smaller
4 virtual and larger

83 If an object which is placed 0.04 meter to the left of the lens will produce a real image at a distance of 0.08 meter to the right of the lens, the focal length of the lens is approximately

(1) 0.015 m
(2) 0.027 m
(3) 0.040 m
(4) 0.080 m

Note that questions 84 and 85 have only three choices.

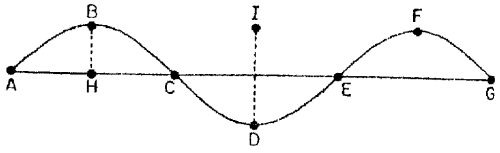
84 As the light emerges from the lens, its speed will

1 decrease
2 increase
3 remain the same

85 The Lucite lens is replaced by a flint glass lens of identical shape. Compared to the focal length of the Lucite lens, the focal length of the flint glass lens will be

1 smaller
2 larger
3 the same

Base your answers to questions 86 through 90 on the diagram below which represents a transverse wave.



86 Which two points are in phase?

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

87 The amplitude of the wave is the distance between points

(1) A and C
(2) A and E
(3) B and H
(4) I and D

88 How many cycles are shown in the diagram?

(1) 1
(2) 2
(3) 3
(4) 1.5

89 A wavelength is the distance between points

(1) A and C
(2) A and E
(3) B and H
(4) I and D

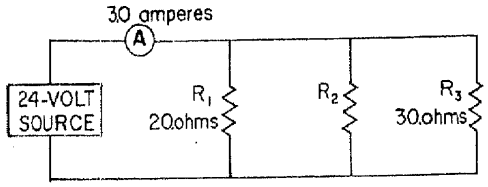
90 If the period of the wave is 2 seconds, its frequency is

(1) 0.5 cycle/sec
(2) 2.5 cycles/sec
(3) 3.0 cycles/sec
(4) 1.5 cycles/sec

Group 3 — Electricity

Answer all fifteen questions, 91 through 105, in this group. Each question counts 1 credit. Record your answer to each of the fifteen questions on the separate answer sheet in accordance with the directions on the front page of this booklet.

Base your answers to questions 91 through 95 on the diagram below which represents three resistors connected in parallel across a 24-volt source. The ammeter reads 3 amperes.



91 The equivalent resistance in the circuit is
(1) 0.13 ohm
(2) 8.0 ohms
(3) 58 ohms
(4) 72 ohms

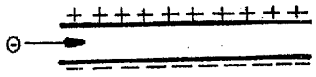
92 The current in R_1 is
(1) 0.83 ampere
(2) 1.5 amperes
(3) 3.0 amperes
(4) 1.2 amperes

93 The potential difference across R_3 is
(1) 8.0 volts
(2) 24 volts
(3) 48 volts
(4) 72 volts

94 If the ratio of the current in R_3 to the current in R_2 is 4:5, the resistance of R_2 is
(1) 5.0 ohms
(2) 8.0 ohms
(3) 24 ohms
(4) 60. ohms

95 The power supplied to the circuit is
(1) 220 watts
(2) 190 watts
(3) 72 watts
(4) 24 watts

Base your answers to questions 96 through 100 on the diagram below which represents an electron projected into the region between two parallel charged plates which are 10^{-3} meter apart. The electric field intensity between the plates is 10^6 volts per meter.



96 In which direction will the electron be deflected?
1 into the page
2 out of the page
3 toward the bottom of the page
4 toward the top of the page

97 What is the potential difference across the two plates?
(1) 10^{-3} volt
(2) 10^3 volts
(3) 10^6 volts
(4) 10^9 volts

98 What is the magnitude of the force acting on the electron when it is in the electric field?
(1) 1.6×10^{-25} nt
(2) 1.6×10^{-13} nt
(3) 1.0×10^6 nt
(4) 1.6×10^{25} nt

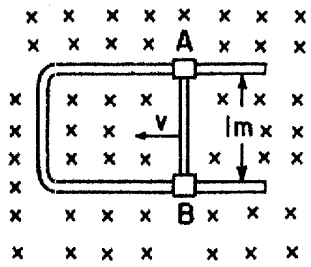
Note that questions 99 and 100 have only three choices.

99 As an electron moves from the negatively charged plate to the positively charged plate, the force on the electron due to the electric field
1 decreases
2 increases
3 remains the same

100 The electron is replaced by a proton. Compared to the magnitude of the force on the electron, the magnitude of the force on the proton will be
1 less
2 greater
3 the same

☞ GO RIGHT ON TO THE NEXT PAGE.

Base your answers to questions 101 through 105 on the diagram below which represents a U-shaped wire conductor positioned perpendicular to a uniform magnetic field which acts into the page. *AB* represents a second wire which is free to slide along the U-shaped wire. The length of wire *AB* is one meter, and the magnitude of the magnetic field is 8.0 webers/meter^2.



101 If wire *AB* is moved to the left at a constant speed, the direction of the induced electron motion in wire *AB* will be

1 toward *A*, only
2 toward *B*, only
3 first toward *A* and then toward *B*
4 first toward *B* and then toward *A*

102 If wire *AB* is moved to the left with a constant speed of 10. meters per second, the potential difference induced across wire *AB* will be

(1) 0.8 volt
(2) 8.0 volts
(3) 10 volts
(4) 80 volts

103 Wire *AB* is moved at a constant speed to the left. The current induced in the conducting loop will produce a force on wire *AB* which acts

1 to the right
2 to the left
3 into the page
4 out of the page

Note that questions 104 and 105 have only three choices.

104 The resistance of wire *AB* is increased, and the wire is moved to the left at a constant speed of 10 meters per second. Compared to the induced potential difference before the resistance was increased, the new potential difference will be

1 less
2 greater
3 the same

105 If wire *AB* is accelerating to the left, the potential difference induced across *AB*

1 decreases
2 increases
3 remains the same

Group 4 — Atomic and Nuclear Physics

Answer all fifteen questions, 106 through 120, in this group. Each question counts 1 credit. Record your answer to each of the fifteen questions on the separate answer sheet in accordance with the directions on the front page of this booklet.

Base your answers to questions 106 through 110 on the information below.

Photons of wavelength 2×10^{-7} meter are incident upon a photoemissive surface whose work function is 6.6×10^{-19} joule.

106 The speed of the incident photons is approximately
(1) 2.0×10^{-7} m/sec (3) 1.3×10^{-25} m/sec
(2) 6.6×10^{-19} m/sec (4) 3.0×10^{8} m/sec

107 The maximum kinetic energy of the photoelectrons is approximately
(1) 0 joules (3) 6.6×10^{-19} joule
(2) 3.3×10^{-19} joule (4) 9.9×10^{-19} joule

Note that questions 108 through 110 have only three choices.

108 If the frequency of the incident photons is increased, the kinetic energy of the emitted photoelectrons will
1 decrease
2 increase
3 remain the same

109 If the intensity of the incident photons is decreased, the rate of emission of photoelectrons will
1 decrease
2 increase
3 remain the same

110 Photons of the same wavelength are incident upon a photoemissive surface with a lower work function. Compared to the original situation, the maximum kinetic energy of the photoelectrons emitted from the new surface would be
1 less
2 greater
3 the same

Base your answers to questions 111 through 115 on the nuclear equation below.

$$^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + {}^{4}_{2}\text{He}$$

111 What is represented by $^{4}_{2}$He?
1 an alpha particle 3 a gamma ray
2 a beta particle 4 a positron

112 In $^{226}_{88}$Ra, the 88 represents the
1 number of neutrons 3 mass number
2 number of nucleons 4 atomic number

113 In $^{222}_{86}$Rn, the 222 represents the
1 atomic number 3 number of neutrons
2 mass number 4 number of electrons

114 How many nucleons are in an atom of $^{226}_{88}$Ra?
(1) 88 (3) 226
(2) 138 (4) 314

115 This equation represents the process of
1 alpha decay 3 fission
2 beta decay 4 fusion

116 In the decay series of U-238, the change from Th-234 to U-234 involves the emission of
1 neutrons 3 alpha particles
2 positrons 4 beta particles

117 How much energy would be produced if 1.0×10^{-3} kilogram of matter was entirely converted to energy?
(1) 9.0×10^{13} joules (3) 9.0×10^{16} joules
(2) 3.0×10^{16} joules (4) 3.0×10^{19} joules

118 An atom of U-235 splits into two nearly equal parts. This is an example of
1 alpha decay 3 fusion
2 beta decay 4 fission

76

119 In which reaction does X represent a beta particle?

(1) $^{234}_{92}U \rightarrow {}^{230}_{90}Th + X$

(2) $^{214}_{84}Pa \rightarrow {}^{210}_{82}Pb + X$

(3) $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + X$

(4) $^{214}_{82}Pb \rightarrow {}^{214}_{83}Bi + X$

120 A certain radioactive isotope has a half-life of 2 days. If 8 kilograms of the isotope is placed in a sealed container, how much of the isotope will be left after 6 days?

(1) 1 kg
(2) 2 kg
(3) 0.5 kg
(4) 4 kg

164

fe of 2 days,
in a sealed
be left after

Part II (30 credits)

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

Group 1

Answer all fifteen of the questions in this group.

61	1	2	3	4	71	1	2	3	4
62	1	2	3	4	72	1	2	3	4
63	1	2	3	4	73	1	2	3	4
64	1	2	3	4	74	1	2	3	4
65	1	2	3	4	75	1	2	3	4
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					

Group 2

Answer all fifteen of the questions in this group.

76	1	2	3	4	86	1	2	3	4
77	1	2	3		87	1	2	3	4
78	1	2	3		88	1	2	3	4
79	1	2	3	4	89	1	2	3	4
80	1	2	3		90	1	2	3	4
81	1	2	3	4					
82	1	2	3	4					
83	1	2	3	4					
84	1	2	3						
85	1	2	3						

Group 3

Answer all fifteen of the questions in this group.

91	1	2	3	4	101	1	2	3	4
92	1	2	3	4	102	1	2	3	4
93	1	2	3	4	103	1	2	3	4
94	1	2	3	4	104	1	2	3	
95	1	2	3	4	105	1	2	3	
96	1	2	3	4					
97	1	2	3	4					
98	1	2	3	4					
99	1	2	3						
100	1	2	3						

Group 4

Answer all fifteen of the questions in this group.

106	1	2	3	4	116	1	2	3	4
107	1	2	3	4	117	1	2	3	4
108	1	2	3		118	1	2	3	4
109	1	2	3		119	1	2	3	4
110	1	2	3		120	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					

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

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICS

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

ANSWER SHEET

Pupil .....

Teacher .....

School .....

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

Part I (70 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	
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	
14	1	2	3	4	34	1	2	3	4	54	1	2	3	
15	1	2	3	4	35	1	2	3	4	55	1	2	3	
16	1	2	3	4	36	1	2	3	4	56	1	2	3	
17	1	2	3	4	37	1	2	3	4	57	1	2	3	
18	1	2	3	4	38	1	2	3	4	58	1	2	3	
19	1	2	3	4	39	1	2	3	4	59	1	2	3	
20	1	2	3	4	40	1	2	3	4	60	1	2	3	

FOR TEACHER USE ONLY

Credits

Part I ....
(Use table below)

Part II ....

Total ....

Rater's Initials: .....

PART I CREDITS

Directions to the 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
60	70	29	39
59	69	28	38
58	68	27	37
57	67	26	36
56	66	25	35
55	65	24	34
54	64	23	33
53	63	22	32
52	62	21	31
51	61	20	30
50	60	19	29
49	59	18	28
48	58	17	27
47	57	16	26
46	56	15	25
45	55	14	23
44	54	13	22
43	53	12	20
42	52	11	18
41	51	10	17
40	50	9	15
39	49	8	13
38	48	7	12
37	47	6	10
36	46	5	8
35	45	4	7
34	44	3	5
33	43	2	3
32	42	1	2
31	41	0	0
30	40		

No. Right.....

Record your answers for Part II on the back of this sheet.

FOR TEACHERS ONLY

SCORING KEY

P PHYSICS

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

Part I

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

Part I (70 credits)

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

Directions to the teacher:

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

To facilitate scoring, the scoring key has been printed in the same format as the answer sheet. By punching out the correct answers, the scoring key may be made into a scoring stencil that can be placed directly over each answer sheet. Be sure that the stencil is correctly aligned with the answer sheet so that the holes correspond to the correct answers. This may be achieved by punching out the first and last item numbers on the left-hand side of each key and using the resulting holes as guides.

Scan each answer sheet to make certain that the pupil has marked only one answer for each question. If a pupil has marked two or more answers, draw a red line through the row of numbers for that question so that no credit will be allowed for that question in scoring.

[OVER]

Part II

Allow a total of 30 credits, one credit for each question, for only two of the four groups in this part. If more than two groups are answered, only the first two answered should be considered.

Group 1

61	1	X	3	4	71	1	2	X	4
62	1	2	3	X	72	1	X	3	4
63	1	2	X	4	73	1	2	X	4
64	X	2	3	4	74	1	X	3	4
65	1	2	X	4	75	1	2	X	4
66	1	X	3	4					
67	1	2	3	X					
68	1	2	3	X					
69	X	2	3	4					
70	1	2	X	4					

Group 2

76	1	2	X	4	86	1	2	3	X
77	X	2	3		87	1	2	X	4
78	1	2	X		88	1	2	3	X
79	1	2	3	X	89	1	X	3	4
80	1	X	3		90	X	2	3	4
81	1	2	X	4					
82	1	2	3	X					
83	1	X	3	4					
84	1	X	3						
85	X	2	3						

Group 3

91	1	X	3	4	101	X	2	3	4
92	1	2	3	X	102	1	2	3	X
93	1	X	3	4	103	X	2	3	4
94	1	2	X	4	104	1	2	X	
95	1	2	X	4	105	1	X	3	
96	1	2	3	X					
97	1	X	3	4					
98	1	X	3	4					
99	1	2	X						
100	1	2	X						

Group 4

106	1	2	3	X	116	1	2	3	X
107	1	X	3	4	117	X	2	3	4
108	1	X	3		118	1	2	3	X
109	X	2	3		119	1	2	3	X
110	1	X	3		120	X	2	3	4
111	X	2	3	4					
112	1	2	3	X					
113	1	X	3	4					
114	1	2	X	4					
115	X	2	3	4					

The University of the State of New York

THE STATE EDUCATION DEPARTMENT

EXAMINATION IN

GENERAL PHYSICS

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

The last page of the booklet is the answer sheet. Fold the last page along the perforations and, slowly and carefully, tear off the answer sheet. Then fill in the heading of your answer sheet.

All of your answers should be recorded on the separate answer sheet. For each question, decide which of the choices given is the correct answer. Then on the answer sheet, in the row of numbers for that question, mark an X on the number of the choice that you have selected. The sample below indicates how to mark your answers.

SAMPLE: 1 X 3 4

Be sure to mark only one answer for each question. If you change an answer, be sure that your final choice is clearly indicated.

On page 13, which is perforated, you will find the "Reference Tables for General Physics" which you will need to answer some questions in this examination. Fold this page along the perforations and then, slowly and carefully, tear it off.

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

77

Part I

Answer all 60 questions in this part. [60]

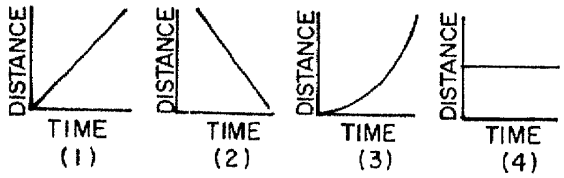
Directions (1–60): For *each* statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet.

Unit 1 — Mechanics

1 A 1.0-kilogram mass has a weight of
(1) 1.0 nt
(2) 10 nt
(3) 100 nt
(4) 1,000 nt

2 Power is measured in which unit?
1 joules
2 newtons
3 kilograms
4 watts

3 Which graph illustrates an object moving with uniformly accelerated motion?



4 A distance of 4,000 meters is equal to
(1) 400 kilometers
(2) 4 kilometers
(3) 400 centimeters
(4) 4 centimeters

5 The specific gravity of aluminum is 2.7. The density of aluminum is
(1) 4.14 g/ℓ
(2) 2.7 g/ℓ
(3) 4.14 g/cm^3
(4) 2.7 g/cm^3

6 Which solid has a density of 11.34 grams per cubic centimeter?
1 copper
2 lead
3 iron
4 zinc

7 Which term is a unit of volume?
(1) m
(2) m^2
(3) m^3
(4) m^4

8 If a person walks 3 meters east and then 4 meters west, the resultant displacement is
(1) 1 m west
(2) 2 m east
(3) 5 m northwest
(4) 7 m east

9 Which is a vector quantity?
1 distance
2 speed
3 mass
4 force

10 Which property of an object is a measure of the Earth's gravitational attraction for the object?
1 potential energy
2 momentum
3 mass
4 weight

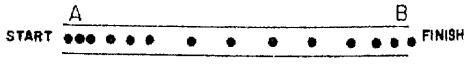
11 A 10-kilogram mass moving at 10 meters per second has a momentum of
(1) 1 kg-m/sec
(2) 10 kg-m/sec
(3) 100 kg-m/sec
(4) 1,000 kg-m/sec

12 A cart and rider whose total mass is 200 kilograms are accelerated by the engine's thrust of 20 newtons. What is the rate of acceleration?
(1) .1 m/sec^2
(2) .5 m/sec^2
(3) 10 m/sec^2
(4) 4 m/sec^2

13 If a heart beats 80. times in 60. seconds, what is the period of the beating heart?
(1) .75 sec
(2) 1.3 sec
(3) 80. sec
(4) 4,800 sec

14 The rate of change of velocity is
1 momentum
2 force
3 speed
4 acceleration

15 A cart is moved along a horizontal table and the data are recorded on the timing tape below. What is the motion of the cart from *A* to *B*?



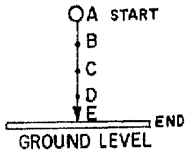
1 deceleration and then constant speed
2 acceleration and then constant speed
3 acceleration and then deceleration
4 deceleration and then acceleration

16 Fifteen joules of work is required to raise a 3-kilogram mass vertically. The potential energy gained by the object is
(1) 5 joules
(2) 15 joules
(3) 45 joules
(4) 450 joules

17 A car moves 20 meters in 10 seconds. Its average speed is

(1) 10 m/sec
(2) 2 m/sec
(3) .5 m/sec
(4) 200 m/sec

18 The diagram shows an object that starts from rest and falls freely. At what point will the kinetic energy be equal to the potential energy?



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

Note that questions 19 through 22 have only three choices.

19 As the unbalanced force applied to a mass increases, the acceleration of the mass

1 decreases
2 increases
3 remains the same

20 As the length of a pendulum is decreased, the period of the pendulum

1 decreases
2 increases
3 remains the same

21 A person in an airplane is holding a package. As the airplane starts to accelerate upward, the weight of the package appears to be

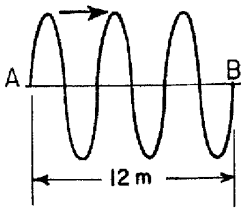
1 less
2 greater
3 the same

22 As a raindrop falls, its gravitational potential energy will

1 decrease
2 increase
3 remain the same

Unit 2 — Waves

23 A train of waves is moving from *A* to *B*, a distance of 12 meters. What is the number of meters in one wavelength?



(1) 24
(2) 12
(3) 6
(4) 4

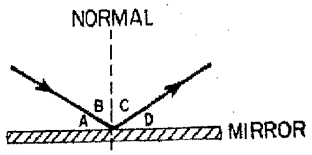
24 A wave in which the particles vibrate parallel to the direction of wave travel is a

1 longitudinal wave
2 helical wave
3 transverse wave
4 torsional wave

25 What is the distance a light wave will travel in air in one second?

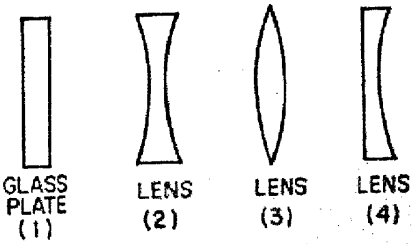
(1) 300,000,000 cm
(2) 3,000,000,000 cm
(3) 30,000,000,000 cm
(4) 300,000,000,000 cm

26 The diagram below represents a ray of light being reflected from a plane mirror. Which letter indicates the angle of reflection?



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

27 Which would be used to concentrate sunlight?

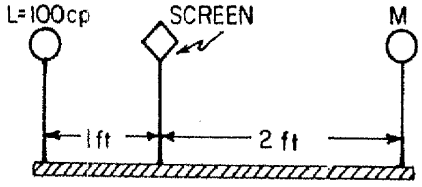


28 The image formed by a diverging lens will always be
1 inverted
2 enlarged
3 real
4 virtual

29 The image produced by a plane mirror is
1 real
2 inverted
3 upright
4 enlarged

30 The apparent bending of a pencil as it enters water is caused by a phenomenon known as
1 reflection
2 refraction
3 dispersion
4 diffraction

31 The diagram below shows a screen illuminated equally by lamps L and M. If lamp L has a candlepower of 100, what is the candlepower of lamp M?

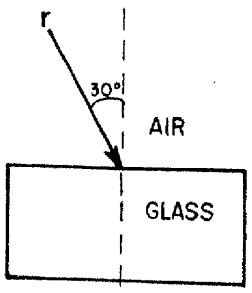


(1) 25 cp
(2) 50 cp
(3) 200 cp
(4) 400 cp

32 A wave has a frequency of 50 vibrations per second and a wavelength of 5 meters. What is the velocity of the wave?
(1) 10 m/sec
(2) 25 m/sec
(3) 50 m/sec
(4) 250 m/sec

Note that questions 33 through 38 have only three choices.

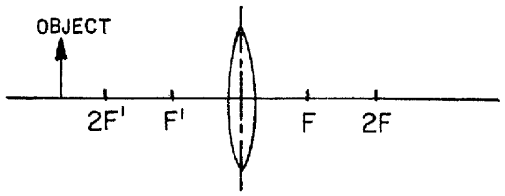
33 The diagram below shows incident ray of light r entering a glass block. If the angle of incidence is 30°, what is the angle of refraction?
1 less than 30°
2 more than 30°
3 equal to 30°



34 A ray of light is reflected from a plane mirror. As the angle of incidence increases, the angle of reflection will
1 decrease
2 increase
3 remain the same

35 An object is in front of a plane mirror. Compared to the size of the object, the size of the image is
1 smaller
2 larger
3 the same

Base your answers to questions 36 and 37 on the diagram below which shows a convex lens with an object.



36 As the object is moved toward F', the size of the image produced by the lens will
1 decrease
2 increase
3 remain the same

37 As the object is moved toward F', the distance between the image and the lens will
1 decrease
2 increase
3 remain the same

38 As the energy used to produce a wave increases, the amplitude of the wave
1 decreases
2 increases
3 remains the same

39 Materials that best resist the flow of electrons are
1 metals
2 semiconductors
3 conductors
4 insulators

40 Which particles are found in the nucleus of an atom?
1 neutrons, only
2 protons and neutrons
3 protons and electrons
4 neutrons and electrons

41 In a neutral atom, the number of electrons must be
1 less than the number of protons
2 greater than the number of neutrons
3 the same as the number of protons
4 the same as the number of neutrons

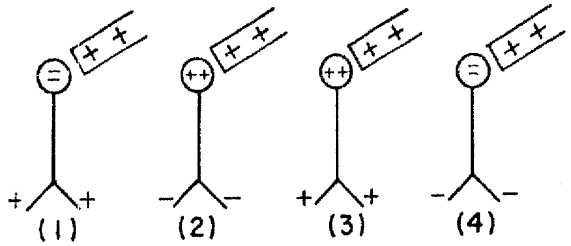
42 By which charging process does an object acquire an electrostatic charge opposite to that of the charging object?
1 induction
2 conduction
3 contact
4 radiation

43 The work done on an electron while moving it toward a negatively charged object is measured in
1 amperes
2 watts
3 ohms
4 joules

44 Sixteen joules of energy is needed to move 4 coulombs of electrical charge through a complete circuit. The voltage source for this circuit is
(1) 20 volts
(2) 16 volts
(3) 0.25 volt
(4) 4 volts

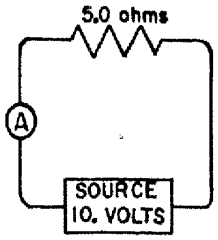
45 Which could convert the heat from concentrated sunlight into electrical energy?
1 motor
2 dry cell
3 thermocouple
4 generator

46 A positively charged rod is held near the knob of an uncharged electroscope. Which diagram best shows the charge distribution?



47 If 2.0 coulombs of charge passes a point in an electrical circuit in 4.0 seconds, the current is
(1) 0.50 ampere
(2) 2.0 amperes
(3) 6.0 amperes
(4) 8.0 amperes

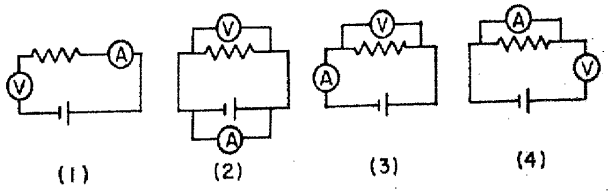
48 What is the current through the resistor shown in the diagram?



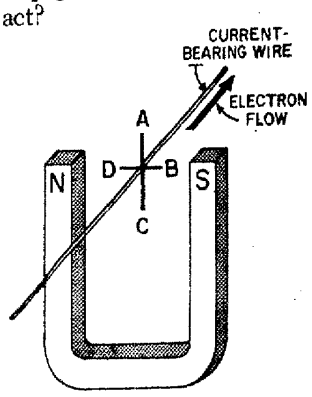
(1) 0.50 ampere
(2) 2.0 amperes
(3) 15 amperes
(4) 50. amperes

49 What is the combined resistance of six 1-ohm resistors connected in parallel?
(1) 1 ohm
(2) $\frac{1}{6}$ ohm
(3) 6 ohms
(4) 36 ohms

50 In the circuits represented below, the symbol for the ammeter is *A* and the symbol for the voltmeter is *V*. Which diagram represents the proper connections for determining the resistance of the circuit?



51 A magnet is placed around a current-carrying wire as indicated in the diagram. Assuming the electrons move into the page, in which direction will the force on the wire act?



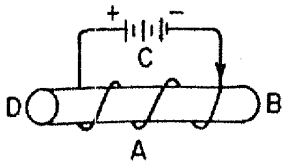
(1) *A*
(2) *B*
(3) *C*
(4) *D*

[OVER]

52 An electric heater operating at 100. volts and drawing 15 amperes was operated for 20. seconds. How many joules of heat were produced?

(1) 240 joules
(2) 1,500 joules
(3) 7,200 joules
(4) 30,000 joules

53 At which point is the north pole of the coil shown below located?

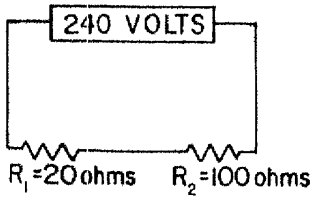


(1) *A*
(2) *B*
(3) *C*
(4) *D*

54 If 20 centimeters of copper wire has a resistance of 6 ohms, then 10 centimeters of the same wire will have a resistance of

(1) 6 ohms
(2) 2 ohms
(3) 3 ohms
(4) 12 ohms

55 In the circuit below, what is the total resistance?



(1) 16.6 ohms
(2) 2.0 ohms
(3) 80 ohms
(4) 120 ohms

Note that questions 56 through 60 have only three choices.

56 If the current through a coil is kept constant and the number of turns of wire is decreased, the magnetic field strength

1 decreases
2 increases
3 remains the same

57 As an iron core is added to the center of a direct-current-carrying coil, the magnetic field strength of the coil

1 decreases
2 increases
3 remains the same

58 As more resistors are added in parallel to a circuit, the resistance of the circuit

1 decreases
2 increases
3 remains the same

59 As the cross-sectional area of a conductor increases, its resistance

1 decreases
2 increases
3 remains the same

60 As the temperature of a metal conductor increases, its resistance

1 decreases
2 increases
3 remains the same

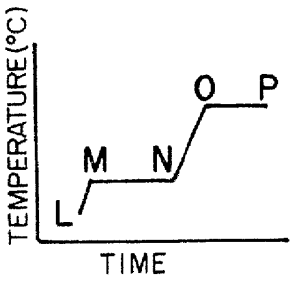
Part II

This part consists of five groups, each containing fifteen questions. Choose two of these five groups. Be sure that you answer all questions in each group chosen. Record the answers to the questions on the separate answer sheet in accordance with the directions on the front page of this booklet. [30]

Group 1 — Unit 4 — Heat

If you choose this group, be sure to answer questions 61 through 75.

Base your answers to questions 61 and 62 on the graph below which shows the change in the temperature of a given quantity of a heat-retaining substance stored in a greenhouse during the daylight hours.



61 The part of the graph represented by segment *LM* indicates that the substance is in the

1 solid phase, only
2 solid and liquid phases
3 liquid phase, only
4 liquid and gas phases

62 Which segment of the graph represents the substance vaporizing?

(1) *LM* (3) *NO*
(2) *MN* (4) *OP*

63 Zinc remains a liquid through a temperature difference of

(1) 23 C° (3) 420 C°
(2) 419 C° (4) 488 C°

64 Which material has the highest specific heat?

1 water 3 ethanol
2 iron 4 lead

65 If 10. joules of sunlight is converted into heat energy by a solar collector, how many calories would result?

(1) 1 cal (3) 10 cal
(2) 2.4 cal (4) 24 cal

66 The boiling point of 50 milliliters of water will change if there is a change in which factor?

1 time 3 pressure
2 temperature 4 volume

67 The minimum quantity of heat required to convert 100. grams of water at 100°C to steam at 100°C is

(1) 100 cal (3) 10,000 cal
(2) 800 cal (4) 54,000 cal

68 Which occurs when 1 gram of ethanol condenses?

(1) 204 cal of heat is absorbed.
(2) 204 cal of heat is released.
(3) 25 cal of heat is absorbed.
(4) 25 cal of heat is released.

69 At a temperature of 2000°C, lead is

1 in the liquid phase
2 in the solid phase
3 in the gaseous phase
4 going through a change of phase

70 Solid carbon dioxide changes directly into carbon dioxide gas. This is an example of

1 condensation 3 fusion
2 sublimation 4 evaporation

71 If the absolute temperature of a gas is tripled and the pressure kept constant, the volume of the gas will be

1 one-third as great
2 nine times as great
3 three times as great
4 unchanged

72 For which phase of matter is the rate of diffusion greatest?

1 gas
2 liquid
3 solid
4 It is the same for all three phases.

73 To find the number of calories that will raise the temperature of 5 grams of water from 30°C to 40°C, it is necessary to know the

1 coefficient of expansion of water
2 heat of vaporization of water
3 heat of fusion of water
4 specific heat of water

[OVER]

Note that questions 74 and 75 have only three choices.

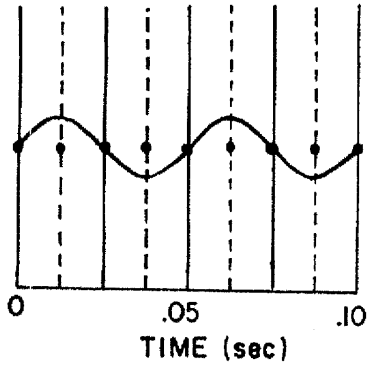
74 Compared to the boiling point of pure water, the boiling point of salt water is
1 less
2 greater
3 the same

75 As water evaporates from a surface, the temperature of the surface
1 decreases
2 increases
3 remains the same

Group 2 — Unit 5 — Sound

If you choose this group, be sure to answer questions 76 through 90.

76 The diagram represents a sound wave as shown on an oscilloscope. What is the frequency of the sound wave?



(1) 5 vibrations/sec
(2) 10 vibrations/sec
(3) 20 vibrations/sec
(4) 30 vibrations/sec

77 Sound has the greatest speed through
1 a vacuum
2 water
3 air
4 steel

78 What is the wavelength of a tuning fork that resonates with a 6-meter tube open at both ends?
(1) 6 m
(2) 12 m
(3) 3 m
(4) 24 m

79 An echo is evidence that waves
1 disperse
2 reflect
3 refract
4 resonate

80 The speed of sound in air increases about 0.6 meter per second for every 1 C° increase in temperature above 20°C. How fast will sound travel at 60°C?
(1) 320 m/sec
(2) 338 m/sec
(3) 344 m/sec
(4) 368 m/sec

81 The pitch of a musical sound is most closely related to its
1 amplitude
2 velocity
3 frequency
4 resonance

82 What is the wavelength of a tuning fork that resonates with a 4-meter tube that is closed at one end?
(1) 16 m
(2) 2 m
(3) 8 m
(4) 4 m

83 When one vibrating object causes another object to vibrate, the phenomenon is known as
1 interference
2 resonance
3 refraction
4 reflection

84 At 10°C all sound waves in air have the same
1 frequency
2 wavelength
3 speed
4 amplitude

85 Two tuning forks of different frequencies are struck at the same time. This method may be used to illustrate
1 the Doppler effect
2 forced vibrations
3 resonance
4 beats

Note that questions 86 through 90 have only three choices.

86 As the frequency of a sound is increased, the wavelength of the sound produced
1 decreases
2 increases
3 remains the same

87 A stationary observer hears a sound having a constant frequency. If the observer starts to move rapidly toward the source of the sound, the frequency the observer hears will
1 decrease
2 increase
3 remain the same

88 As the distance between a vibrating tuning fork and an observer increases, the amplitude of the wave heard by the observer
1 decreases
2 increases
3 remains the same

89 When sound is reflected, its speed
1 decreases
2 increases
3 remains the same

90 As the length of a vibrating string increases, its frequency
1 decreases
2 increases
3 remains the same

Group 3 — Unit 6 — Atomic and Nuclear Physics

If you choose this group, be sure to answer questions 91 through 105.

91 Solar energy is released from the Sun when lighter nuclei combine to form heavier nuclei. This process is called
1 radioactive decay
2 chain reaction
3 fission
4 fusion

92 When an atom gains or loses electrons, it becomes
1 an ion
2 an isotope
3 a neutron
4 a nucleon

93 In the nuclear symbol $^{14}_{6}C$, the 6 represents the
1 number of nucleons
2 atomic number
3 mass number
4 number of neutrons

94 Energy from nuclear fission in an atomic reactor is primarily in the form of
1 heat energy
2 electrical energy
3 light energy
4 magnetic energy

95 Which has the greatest mass?
1 an electron
2 a proton
3 a neutron
4 an alpha particle

96 An alpha particle is a nucleus of an atom of
1 hydrogen
2 carbon
3 helium
4 uranium

97 In the reaction $^{234}_{90}X \rightarrow {}^{234}_{91}Y + Z$, what is represented by the letter Z?
1 a beta particle
2 a neutron
3 a positron
4 an alpha particle

98 Fission occurs when a nucleus captures
1 an electron
2 a neutron
3 a proton
4 an alpha particle

99 Isotopes of the same element have different numbers of
1 ions
2 electrons
3 protons
4 neutrons

100 A radioactive element has a half-life of 15 days. How many grams of a 60-gram sample of the element remain unchanged after 30 days?
(1) 15 g
(2) 30 g
(3) 45 g
(4) 60 g

101 The minimum quantity of fissionable material necessary to sustain a fission reaction is called the
1 half-life
2 mass defect
3 binding energy
4 critical mass

102 What is the primary function of shielding in a nuclear reactor?
1 to cool the materials
2 to serve as a source of electrons
3 to absorb radiations
4 to increase radiations

103 Graphite moderators in a reactor are used to
1 undergo fission
2 slow neutrons
3 absorb neutrons
4 absorb gamma rays

[OVER]

104 Vapor trails produced by ionizing particles may be seen in

1 an atomic explosion
2 a nuclear reactor
3 a cloud chamber
4 a Geiger tube

Note that question 105 has only three choices.

105 As the distance between a radioactive source and an observer decreases, the intensity of radiation received by the observer's body will

1 decrease
2 increase
3 remain the same

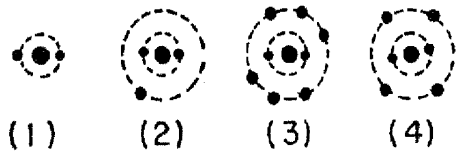
Group 4 — Unit 7 — Semiconductors

If you choose this group, be sure to answer questions 106 through 120.

106 The particles located in shells around the nucleus of an atom are called

1 protons
2 neutrons
3 electrons
4 alpha particles

107 Which of the atomic models below represents an atom of a semiconductor?



108 Conduction in metals is due to current carriers called

1 electrons
2 protons
3 neutrons
4 holes

109 Conductance is equal to

(1) $\frac{\text{voltage}}{\text{resistance}}$
(2) $\frac{\text{voltage}}{\text{current}}$
(3) current × resistance
(4) $\frac{1}{\text{resistance}}$

110 A *p*-type semiconductor can be made by the addition to a semiconductor of small amounts of elements with how many valence electrons?

(1) 5
(2) 6
(3) 3
(4) 4

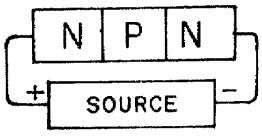
111 Which is *not* a semiconductor material?

1 carbon
2 copper
3 silicon
4 germanium

112 The minority charge carriers in *n*-type semiconductors are

1 electrons
2 protons
3 holes
4 neutrons

113 Which is the base of the *n-p-n* semiconductor device shown below?



(1) *p*
(2) left *n*
(3) right *n*
(4) *p-n* junction

114 A semiconductor that is heat-sensitive is called

1 an emitter
2 a collector
3 a thermistor
4 a transistor

115 What is the charge on a *p*-type semiconductor crystal?

1 positive in the center
2 negative at the edges
3 negative in the center
4 neutral

116 Transistor amplification is based on

1 differences in resistance between emitter and collector
2 connecting wires with zero resistance
3 current increase in the collector
4 current increase in the emitter

117 Pulsating direct current results when a *p-n* junction is connected to

1 a battery
2 an oscilloscope
3 a source of d.c. voltage
4 an alternating current

780

Note that questions 118 through 120 have only three choices.

118 When a semiconductor is replaced in a circuit by an insulator, the resistance of that section of the circuit
1 decreases
2 increases
3 remains the same

119 Compared to transistors with similar functions, the energy requirements for vacuum tubes are
1 smaller
2 larger
3 the same

120 When a diode type semiconductor has its reverse bias changed to forward bias, the current will
1 decrease
2 increase
3 remain the same

Group 5 — Unit 8 — Space Systems

If you choose this group, be sure to answer questions 121 through 135.

121 The centripetal acceleration of the Earth orbiting the Sun is caused by
1 inertia
2 velocity
3 gravitation
4 speed

122 An object is traveling in a circular path at 8 meters per second. If the radius of the orbit is 16 meters, the centripetal acceleration of the object will be
(1) 0.5 m/sec^2
(2) 2 m/sec^2
(3) 128 m/sec^2
(4) 4 m/sec^2

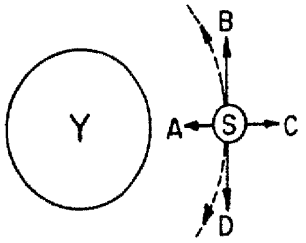
123 The speed necessary to maintain an artificial satellite in orbit about the Earth is called orbital
1 force
2 inertia
3 velocity
4 acceleration

124 The natural orbits of the planets around the Sun are
1 round
2 parabolic
3 circular
4 elliptical

125 A chief advantage of chemical rocket engines is that the chemical engine
1 can be used for very long time periods
2 is much lighter in weight than ion engines
3 produces greater thrust than ion engines
4 produces less heat than ion engines

126 The unbalanced force that accelerates a rocket engine is called
1 thrust
2 centripetal
3 centrifugal
4 pull

Base your answers to questions 127 through 129 on the diagram below which represents satellite *S* orbiting satellite *Y*.



127 The centripetal force on satellite *S* is directed toward point
(1) *A*
(2) *B*
(3) *C*
(4) *D*

Note that questions 128 and 129 have only three choices.

128 If the distance between satellite *S* and satellite *Y* decreases, the centripetal force on satellite *S* will
1 decrease
2 increase
3 remain the same

129 If the distance of satellite *S* from satellite *Y* increases, the period of its orbit will
1 decrease
2 increase
3 remain the same

[OVER]

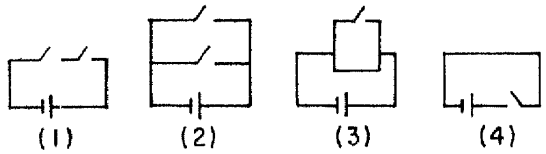
130 The propulsion of a rocket by an engine is best explained by conservation of

1 heat
2 energy
3 mass
4 momentum

131 How is the number 13 represented in the binary system?

(1) 1001
(2) 1010
(3) 1011
(4) 1101

132 Which is an "AND" circuit?



Note that questions 133 through 135 have only three choices.

133 As the frequency of radio waves is increased from standard frequency to vhf, the amount of refraction of the waves in the ionosphere

1 decreases
2 increases
3 remains the same

134 As the velocity of a moving mass increases, the momentum of the mass

1 decreases
2 increases
3 remains the same

135 If the orbital radius of an object is held constant and its velocity is increased, the centripetal force acting on it must

1 decrease
2 increase
3 remain the same

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12224

GENERAL PHYSICS REFERENCE TABLES

Physical Constants

Acceleration of gravity (g) (near earth's surface) ..... $10 \frac{\text{m.}}{\text{sec.}^2}$

Mechanical equivalent of heat ..... 1 joule = .24 calorie

Speed of light (c) ..... $30{,}000{,}000{,}000 \frac{\text{cm.}}{\text{sec.}}$

Speed of sound m./sec. at 20° C.	water	1,460
	air	344
	steel	4,990

Heat Constants

	Specific Gravity $\frac{\text{g.}}{\text{cm.}^3}$	*Specific Heat* $\frac{\text{cal.}}{\text{g.-C.°}}$	*Melting Point* °C.	*Boiling Point* °C.	*Heat of Fusion* $\frac{\text{cal.}}{\text{g.}}$	*Heat of Vaporization* $\frac{\text{cal.}}{\text{g.}}$
Aluminum	2.7	0.2	660	2,057	77	2,520
Copper	8.9	0.1	1,083	2,336	49	1,150
Ethanol	.789	0.6	—115	78	25	204
Iron	7.1–7.9	0.1	1,535	3,000	8	1,600
Lead	11.34	0.03	327	1,620	6	207
Water	1.0	1.0	0	100	80	540
Zinc	7.1	0.1	419	907	23	420

UNIT 1 — MECHANICS

Density	$D = \frac{m}{V}$
Velocity	$v = \frac{s}{t}$
Acceleration	$a = \frac{v}{t}$
Newton's Second Law	$a = \frac{F}{m}$
Momentum	$p = mv$ $m_1v_1 = m_2v_2$
Work	$W = Fs$
Power	$P = \frac{W}{t}$
Potential energy	$E_p = Fs$
Kinetic energy	$E_k = \frac{1}{2}mv^2$
Weight	$w = mg$

Equations

a = acceleration
D = density
E_k = kinetic energy
E_p = potential energy
F = force
g = acceleration of gravity
m = mass
p = momentum
P = power
s = distance
t = time
v = velocity
V = volume
W = work
w = weight

UNIT 2 — WAVES

Velocity	$v = f\lambda$
Illumination	$ft\text{—}c = \frac{cp}{d^2}$
Photometry	$\frac{cp_1}{d_1^2} = \frac{cp_2}{d_2^2}$

cp = candlepower
d = distance
f = frequency
$ft\text{—}c$ = footcandle
λ = wavelength
v = velocity

UNIT 3 — ELECTRICITY

Current	$I = \frac{q}{t}$
Voltage	$V = \frac{W}{q}$
Ohm's law	$I = \frac{V}{R}$
Electrical energy	$W = VIt$
Heat energy	$Q = .24\ VIt$
Power	$P = VI$

I = current
P = power
q = charge
Q = heat energy
R = resistance
t = time
V = voltage
W = energy or work

UNIT 4 — HEAT

Heat law	$mc\Delta t = mc\Delta t$
Heat	$Q = mc\Delta t$
Heat for melting	$Q = mL_f$
Heat for vaporization	$Q = mL_v$
Heat from work	$Q = \frac{W\ .24\ \text{cal.}}{1\ \text{joule}}$

c = specific heat
m = mass
Q = heat energy
Δt = change in temperature
L_f = heat of fusion
L_v = heat of vaporization
W = work

UNIT 5 — SOUND

$V = f\lambda$

$V = v_o + \frac{\Delta v}{\Delta t}\, t$

$\lambda_c = 4l$

$\lambda_o = 2l$

$N = f_2 - f_1$

f = frequency
l = length
N = number of beats per second
t = temperature
v = velocity
v_o = initial velocity
λ_c = wavelength for closed tube
λ_o = wavelength for open tube

UNIT 8 — SPACE SYSTEMS

Centripetal acceleration	$a_c = \frac{v^2}{r}$

a_c = centripetal acceleration
v = tangential speed
r = radius of path

Part II

Answer the questions in only two of the five groups in this part. Be sure to mark the answers to the groups you choose in accordance with the instructions on the front cover of the test booklet. Leave blank the spaces for the three groups of questions you do not choose to answer.

Group 1

61	1	2	3	4	69	1	2	3	4
62	1	2	3	4	70	1	2	3	4
63	1	2	3	4	71	1	2	3	4
64	1	2	3	4	72	1	2	3	4
65	1	2	3	4	73	1	2	3	4
66	1	2	3	4	74	1	2	3	
67	1	2	3	4	75	1	2	3	
68	1	2	3	4					

Group 2

76	1	2	3	4	84	1	2	3	4
77	1	2	3	4	85	1	2	3	4
78	1	2	3	4	86	1	2	3	
79	1	2	3	4	87	1	2	3	
80	1	2	3	4	88	1	2	3	
81	1	2	3	4	89	1	2	3	
82	1	2	3	4	90	1	2	3	
83	1	2	3	4					

Group 3

91	1	2	3	4	99	1	2	3	4
92	1	2	3	4	100	1	2	3	4
93	1	2	3	4	101	1	2	3	4
94	1	2	3	4	102	1	2	3	4
95	1	2	3	4	103	1	2	3	4
96	1	2	3	4	104	1	2	3	4
97	1	2	3	4	105	1	2	3	
98	1	2	3	4					

Group 4

106	1	2	3	4	114	1	2	3	4
107	1	2	3	4	115	1	2	3	4
108	1	2	3	4	116	1	2	3	4
109	1	2	3	4	117	1	2	3	4
110	1	2	3	4	118	1	2	3	
111	1	2	3	4	119	1	2	3	
112	1	2	3	4	120	1	2	3	
113	1	2	3	4					

Group 5

121	1	2	3	4	129	1	2	3	
122	1	2	3	4	130	1	2	3	4
123	1	2	3	4	131	1	2	3	4
124	1	2	3	4	132	1	2	3	4
125	1	2	3	4	133	1	2	3	
126	1	2	3	4	134	1	2	3	
127	1	2	3	4	135	1	2	3	
128	1	2	3						

Examination Score	.....
Local lab activity score	.....
Total Score on Examination	.....
Final Grade for Year	.....

The University of the State of New York

THE STATE EDUCATION DEPARTMENT

EXAMINATION IN GENERAL PHYSICS

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

ANSWER SHEET

Pupil ..... Teacher .....

School .....

All of your answers should be recorded on this answer sheet in accordance with the directions on the front page of the test booklet.

Part I

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

FOR TEACHERS ONLY

SCORING KEY

GENERAL PHYSICS EXAMINATION

Wednesday, June 18, 1980 — 1:15 to 4:15 p.m., only

Directions to the Teacher:

To facilitate scoring, the scoring key has been printed in the same format as the answer sheet. The scoring key may be made into a scoring stencil by punching out the correct answers. To assure correct alignment, punch out the first and last item numbers on the scoring stencil. Place the scoring stencil on the answer sheet so that these item numbers appear through the appropriate holes.

Scan each answer sheet to make certain that the pupil has marked only one answer for each question. If a pupil has marked two or more answers and has not clearly indicated which was the final answer, draw a red line through the row of numbers for that question so that no credit will be allowed for that question in scoring.

Part I

Allow a total of 60 credits on Part I, one credit for each correct answer.

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

[OVER]

787

Part II

Allow a total of 30 credits on Part II, one credit for each correct answer in two of the five groups.

Group 1

61	**1**	2	3	4	69	1	2	**3**	4
62	1	2	3	**4**	70	1	**2**	3	4
63	1	2	3	**4**	71	1	2	**3**	4
64	**1**	2	3	4	72	**1**	2	3	4
65	1	**2**	3	4	73	1	2	3	**4**
66	1	2	**3**	4	74	1	**2**	3	
67	1	2	3	**4**	75	**1**	2	3	
68	1	**2**	3	4					

Group 2

76	1	2	**3**	4	84	1	2	**3**	4
77	1	2	3	**4**	85	1	2	3	**4**
78	1	**2**	3	4	86	**1**	2	3	
79	1	**2**	3	4	87	1	**2**	3	
80	1	2	3	**4**	88	**1**	2	3	
81	1	2	**3**	4	89	1	2	**3**	
82	**1**	2	3	4	90	**1**	2	3	
83	1	**2**	3	4					

Group 3

91	1	2	3	**4**	99	1	2	3	**4**
92	**1**	2	3	4	100	**1**	2	3	4
93	1	**2**	3	4	101	1	2	3	**4**
94	**1**	2	3	4	102	1	2	**3**	4
95	1	2	3	**4**	103	1	**2**	3	4
96	1	2	**3**	4	104	1	2	**3**	4
97	**1**	2	3	4	105	1	**2**	3	
98	1	**2**	3	4					

Group 4

106	1	2	**3**	4	114	1	2	**3**	4
107	1	2	3	**4**	115	1	2	3	**4**
108	**1**	2	3	4	116	**1**	2	3	4
109	1	2	3	**4**	117	1	2	3	**4**
110	1	2	**3**	4	118	1	**2**	3	
111	1	**2**	3	4	119	1	**2**	3	
112	1	2	**3**	4	120	1	**2**	3	
113	**1**	2	3	4					

Group 5

121	1	2	**3**	4	129	1	**2**	3	
122	1	2	3	**4**	130	1	2	3	**4**
123	1	2	**3**	4	131	1	2	3	**4**
124	1	2	3	**4**	132	**1**	2	3	4
125	1	2	**3**	4	133	**1**	2	3	
126	**1**	2	3	4	134	1	**2**	3	
127	**1**	2	3	4	135	1	**2**	3	
128	1	**2**	3						

Allow a maximum of 10 credits for laboratory-centered activities at the local level.

7790