

This examination was prepared by members of the high school physics examination development committee appointed by the American Association of Physics Teachers and the National Science Teachers Association.

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Directions:

- 1) **DO NOT OPEN** this examination booklet until you are asked to do so by your teacher.
- 2) **DO NOT WRITE** anything in the examination booklet. Your teacher will provide you with scrap paper and an answer sheet.
- 3) Copy the **VERSION NUMBER** onto your answer sheet. See number at the top right of this page.
- 4) Each question or incomplete statement has a single best answer. When you decide which answer is correct for a question, completely blacken the corresponding space on the answer sheet with a soft pencil. Make a heavy black mark that completely fills the space to record your answer. Mark only one answer for each question. If you wish to change your answer, completely erase the first mark.
- 5) This examination is divided into five sections as follows:

PART I

SECTION A. Mechanics	24 questions	27 minutes	page 2
SECTION B. Waves, Optics, & Sound	16 questions	18 minutes	page 5
	40 questions	45 minutes	

PART II

SECTION C. Heat & Kinetic Theory	8 questions	9 minutes	page 8
SECTION D. Electricity & Magnetism	20 questions	23 minutes	page 9
SECTION E. Modern Physics	12 questions	13 minutes	page 13
	40 questions	45 minutes	

You should answer only the questions in the section(s) that your teacher instructs you to answer.

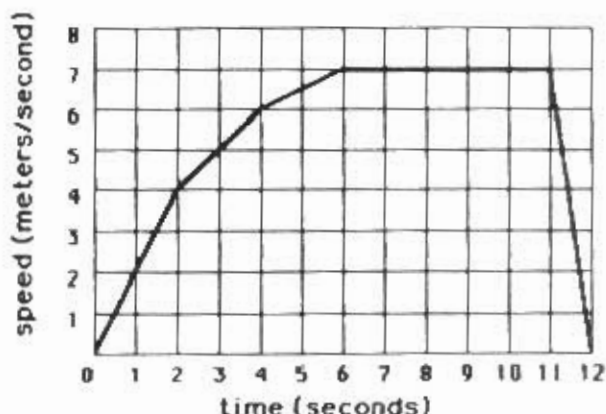
- 6) The score on this examination is equal to the number of correct answers given. Thus it is to your advantage to answer every question in the section(s) assigned by your teacher.
- 7) The following values are given:
 - a) magnitude of acceleration due to gravity at earth's surface = 10 meters/second²
 - b) 4.2 joules = 1.0 calorie
 - c) speed of light in a vacuum = 3.0×10^8 meters/second
 - d) speed of sound in air at room temperature = 330 meters/second
- 8) When you are instructed to stop working, put down your pencil, close this examination booklet, and await directions from your teacher.

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Part I - SECTION A Mechanics

DIAGRAM FOR QUESTIONS 1, 2, AND 3

The graph below represents the speed versus time of an automobile traveling in a straight line.



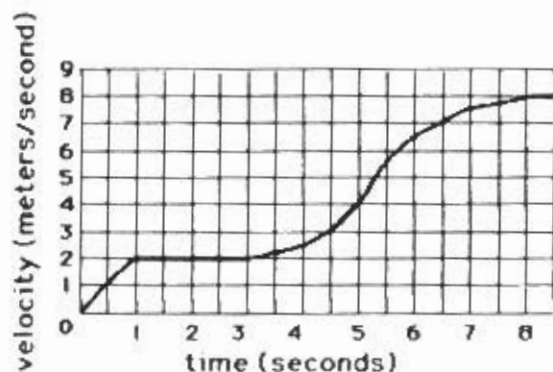
1. During which time interval is the acceleration of the automobile zero?
 - (A) 0 to 2 seconds
 - (B) 2 to 4 seconds
 - (C) 4 to 6 seconds
 - (D) 6 to 11 seconds
 - (E) 11 to 12 seconds

2. During which time interval is the speed of the automobile the greatest?
 - (A) 0 to 2 seconds
 - (B) 2 to 4 seconds
 - (C) 4 to 6 seconds
 - (D) 6 to 11 seconds
 - (E) 11 to 12 seconds

3. During which time interval did the automobile travel the *least* distance?
 - (A) 0 to 2 seconds
 - (B) 2 to 4 seconds
 - (C) 4 to 6 seconds
 - (D) 6 to 11 seconds
 - (E) 11 to 12 seconds

DIAGRAM FOR QUESTION 4

The graph below represents the velocity versus time of an object traveling in a straight line.

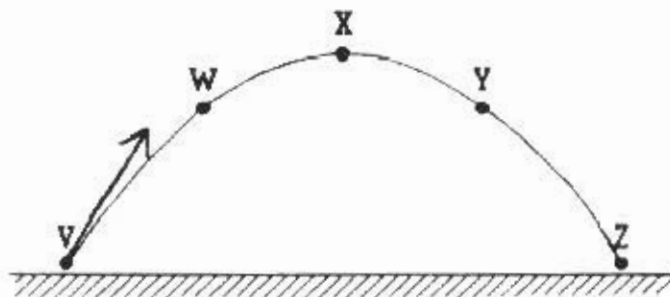


4. Which describes the acceleration of the object from 5 seconds to 8 seconds?
 - (A) constant
 - (B) positive and increasing
 - (C) positive and decreasing
 - (D) negative and increasing
 - (E) negative and decreasing

5. Which equation(s) can be used to describe the motion of an object moving in a horizontal circle with a radius R , period T and constant speed v ?
 - I. $F = ma$
 - II. $v = 2\pi R/T$
 - III. $a = v^2/R$
 - (A) I only
 - (B) II only
 - (C) III only
 - (D) II and III only
 - (E) I, II, and III

DIAGRAM FOR QUESTIONS 6, 7, AND 8

The drawing below represents the path followed by a projectile. Assume the ground is level and air resistance is negligible. Note: The heights of points W and Y are the same.



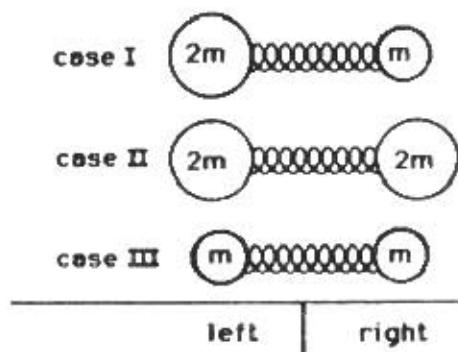
6. The projectile is launched at an angle from point V with a speed of 10 meters/second. Which characteristic(s) of the motion change(s) while the projectile is moving from point W to Z (just before hitting the ground)?
- horizontal component of velocity
 - vertical component of velocity
 - acceleration
- (A) I only
(B) II only
(C) III only
(D) II and III only
(E) I and III only
7. At what points is the kinetic energy of the projectile the same?
- (A) V and W
(B) V and X
(C) W and X
(D) W and Y
(E) none of the above
8. At what points is the momentum of the projectile the same?
- (A) V and W
(B) V and X
(C) W and X
(D) W and Y
(E) none of the above
9. An object is moving at a constant speed of 20 meters/second in a circle with a radius of 10 meters. What is the period of rotation of this object?
- (A) 1π seconds
(B) 2π seconds
(C) 4π seconds
(D) 10 seconds
(E) 20 seconds
10. The mass of an elevator and its occupants is 800 kilograms. The tension in the cable supporting the elevator is 8800 newtons. Assume the effect of friction is negligible; what is the acceleration of the elevator?
- (A) more than 0.5 meter/second² upward
(B) between 0 and 0.5 meter/second² upward
(C) zero
(D) between 0 and 0.5 meter/second² downward
(E) more than 0.5 meter/second² downward
11. An object with a mass of 6.0 kilograms is accelerated at 3.0 meters/second² by a constant net force. A second object is accelerated at 12 meters/second² by another identical net force. What is the mass of the second object?
- (A) 1.5 kilograms
(B) 3.0 kilograms
(C) 12 kilograms
(D) 18 kilograms
(E) 24 kilograms
12. If an object is moving with a constant velocity, what conclusion can be drawn?
- (A) There is a constant net force acting on the object in the direction it is moving.
(B) There is an increasing net force acting on the object in the direction it is moving.
(C) The net force acting on the object is zero.
(D) There is no force acting on the object.
(E) There are two equal and opposite forces acting on the object.
13. The maximum possible sum of a 13-newton force and a 5-newton force acting on an object is
- (A) 8 newtons.
(B) 12 newtons.
(C) 13 newtons.
(D) 14 newtons.
(E) 18 newtons.
14. An object has a mass of 50 grams. What is the object's approximate weight on the surface of the earth?
- (A) 0.50 newton
(B) 5.0 newtons
(C) 20 newtons
(D) 50 newtons
(E) 500 newtons
15. Energy may be expressed with the unit
- (A) kilowatt.
(B) newton-meter.
(C) kilogram-meter/second².
(D) joule/second.
(E) kilogram-meter/second.
16. A constant net force of 5.0 newtons acts on a 20 kilogram object which was initially at rest. The object is displaced 10 meters. What is the increase in the kinetic energy of the object?
- (A) 50 joules
(B) 100 joules
(C) 250 joules
(D) 500 joules
(E) 1000 joules
17. A constant net force F acts on an object and moves the object through a distance d parallel to the direction of the force in a time interval t . The calculation $(F \cdot d)/t$ leads to a quantity called
- (A) energy.
(B) impulse.
(C) momentum.
(D) power.
(E) work.

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18. Two identical cars are traveling along a level road. One car has twice the speed of the other. The brakes of both cars exert equal and constant braking forces. If the slower car travels 20 meters to stop, what distance would be needed to stop the faster car?
- (A) 20 meters
(B) 40 meters
(C) 60 meters
(D) 80 meters
(E) 400 meters
19. A force of 20 newtons acts on an object with a mass of 3.0 kilograms for 10 seconds. The magnitude of the change of momentum caused by this force is
- (A) 30 kilogram · meters/second.
(B) 60 kilogram · meters/second.
(C) 67 kilogram · meters/second.
(D) 200 kilogram · meters/second.
(E) 600 kilogram · meters/second.
20. A 100-gram ball moving at 2.0 meters/second approaches a rigid wall perpendicular to the surface. If the collision with the wall is elastic, what is the approximate change in the momentum of the ball?
- (A) zero
(B) 0.20 kilogram · meter/second
(C) 0.40 kilogram · meter/second
(D) 1.0 kilogram · meters/second
(E) 2.0 kilogram · meters/second
21. After the springs have been released the momentum imparted to the *left* sphere is
- (A) the same in all three cases.
(B) largest in case I.
(C) largest in case II.
(D) largest in case III.
(E) the same in cases II and III, but not in case I.
22. After the springs have been released the kinetic energy imparted to the *left* sphere is
- (A) the same in all three cases.
(B) largest in case I.
(C) largest in case II.
(D) largest in case III.
(E) the same in cases II and III, but not in case I.
23. Ball I with an initial speed V , makes a head-on elastic collision with an identical ball II which is initially at rest. Assuming the balls rest on a frictionless plane, it can be concluded that after the collision ball I
- (A) continues forward with the same speed V .
(B) and ball II stick together.
(C) rebounds with the same speed V .
(D) comes to rest.
(E) and ball II move away from each other at a right angle.
24. The speed of an object moving with simple harmonic motion is largest when the
- (A) object has zero acceleration.
(B) object is at the endpoints of its path.
(C) magnitude of object's acceleration has its largest value.
(D) object reverses the direction of its motion.
(E) acceleration is positive.

DIAGRAM FOR QUESTIONS 21 AND 22

In the diagram below, three identical springs are compressed the same amount and placed between three pairs of spheres as shown. The relative mass of each sphere is indicated in the diagram. Assume the only force acting on the spheres is due to the spring.

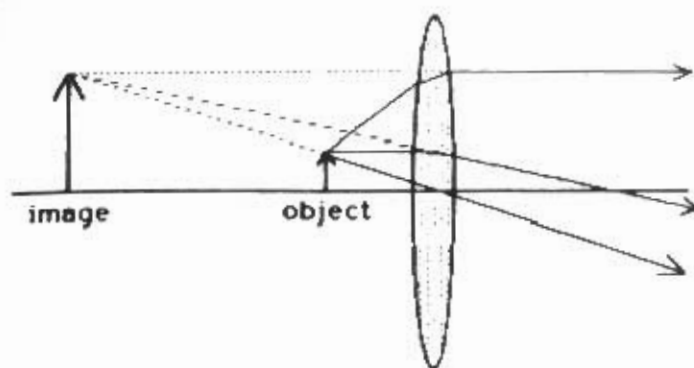


END OF SECTION A

Part I - SECTION B

Waves, Optics, and Sound

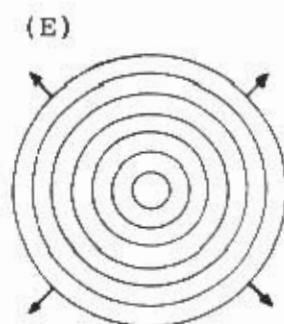
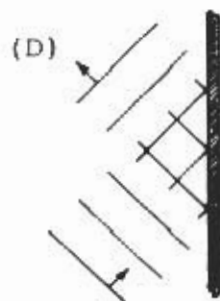
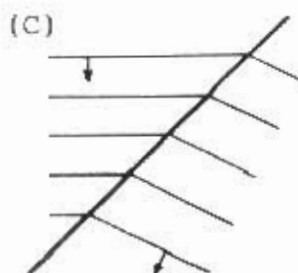
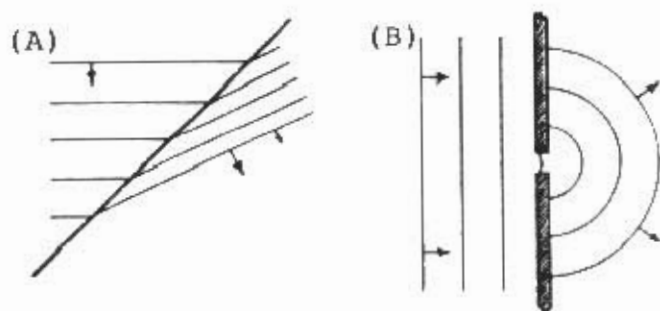
DIAGRAM FOR QUESTION 25



25. The ray drawing above represents the basic ray drawing for a
- (A) camera.
 - (B) human eye.
 - (C) magnifying glass.
 - (D) slide projector.
 - (E) telescope.
26. The frequency of a wave is 50 hertz and its wavelength is 2.0 meters. What is the speed of the wave?
- (A) 0.040 meter/second
 - (B) 25 meters/second
 - (C) 100 meters/second
 - (D) 200 meters/second
 - (E) 340 meters/second

DIAGRAM FOR QUESTIONS 27 AND 28

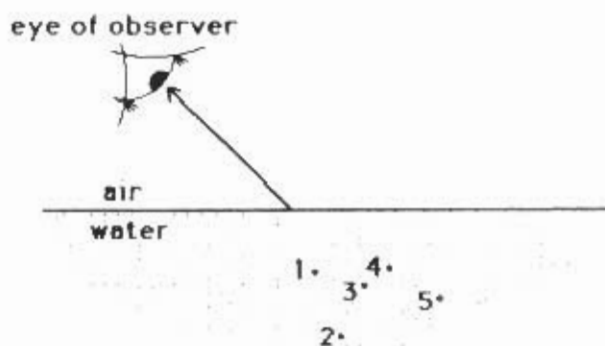
Arrows show direction the wave crest is moving



27. Which drawing represents refraction of waves as they enter a medium of increased wave speed?
- (A) A
 - (B) B
 - (C) C
 - (D) D
 - (E) E
28. Which drawing represents diffraction of waves?
- (A) A
 - (B) B
 - (C) C
 - (D) D
 - (E) E
29. Plane periodic waves meet a barrier in a ripple tank. What happens to the wavelength, frequency, and speed of these waves upon reflection?
- | | WAVELENGTH | FREQUENCY | SPEED |
|-----|------------|-----------|-----------|
| (A) | changed | changed | unchanged |
| (B) | changed | unchanged | changed |
| (C) | unchanged | changed | changed |
| (D) | changed | changed | changed |
| (E) | unchanged | unchanged | unchanged |

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DIAGRAM FOR QUESTION 30



30. In the diagram above, an observer sees a small fish in a tank of water. The ray of light in the drawing comes from the fish to the observer. At which position(s) could the fish be located?

(A) 1 or 2 only
 (B) 3 only
 (C) 4 or 5 only
 (D) 1 or 4 only
 (E) 2 or 5 only

31. The image of an object formed by a single plane mirror is always

(A) real.
 (B) the same distance as the object from the reflecting surface of the mirror
 (C) smaller than the object.
 (D) located at the reflecting surface of the mirror.
 (E) larger than the object

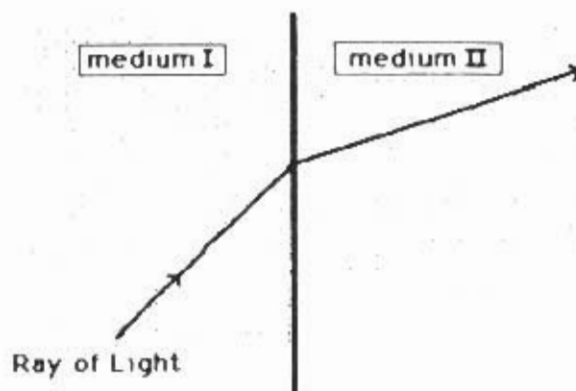
32. Four kinds of electromagnetic radiation are:

1. blue light
 2. microwaves
 3. radio waves
 4. ultraviolet light

Which of the lists places these radiations in order of increasing wavelength?

(A) 4, 1, 2, 3
 (B) 3, 2, 1, 4
 (C) 1, 4, 2, 3
 (D) 3, 2, 4, 1
 (E) none of the above

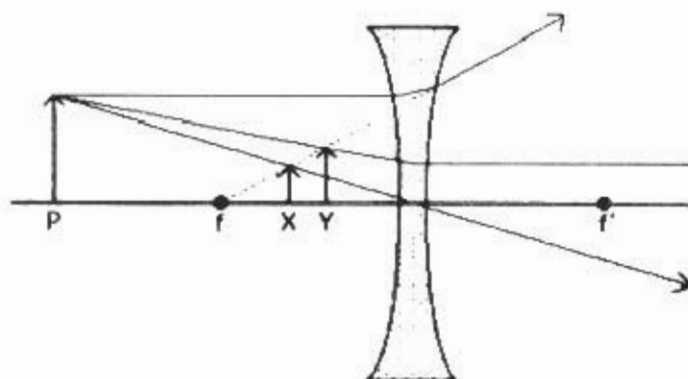
DIAGRAM FOR QUESTION 33



33. In the diagram above, light follows the path shown. Compared with medium I, the light in medium II has

(A) larger frequency.
 (B) larger wavelength.
 (C) larger intensity.
 (D) larger speed.
 (E) none of the above.

DIAGRAM FOR QUESTION 34

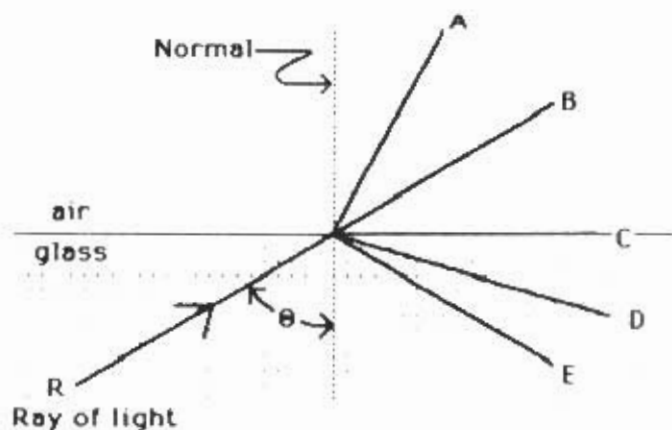


THIN DIVERGING LENS

34. In the diagram above, three rays from the tip of an object at position P are shown passing through a thin diverging lens. Which statement about the image of the object is true?

(A) Only one virtual image is located at position X.
 (B) Only one real image is located at position X.
 (C) Only one virtual image is located at position Y.
 (D) Only one real image is located at position Y.
 (E) There are two images, one at position X and another at position Y.

DIAGRAM FOR QUESTION 35



35. In the diagram above, a ray of light R strikes the air-water boundary at an angle θ that is greater than the critical angle. The light ray R will continue as the ray labeled

(A) A
(B) B
(C) C
(D) D
(E) E

36. As a ray of light passes an opaque barrier some of the light is bent around the barrier. This phenomenon is called

(A) diffraction.
(B) dispersion.
(C) interference.
(D) polarization.
(E) refraction.

37. Which of these phenomena best illustrates the wave nature of light?

(A) absorption
(B) interference
(C) photoemission
(D) reflection
(E) transmission

38. Which is true of a light beam traveling *in water* compared with the same light beam traveling in air?

	WAVELENGTH	FREQUENCY	SPEED
(A)	the same	the same	the same
(B)	the same	greater	smaller
(C)	the same	greater	greater
(D)	greater	the same	smaller
(E)	smaller	the same	smaller

39. A student standing in front of a high wall claps his hands regularly at a rate of three times a second. The student hears the echo of one clap just as he makes the next one. What is the approximate distance to the wall?

(A) 55 meters
(B) 110 meters
(C) 220 meters
(D) 495 meters
(E) 990 meters

40. When viewed from different angles, an oil film on a surface of water shows bands of color. These colors are primarily produced because

(A) only certain colors are reflected from an oil surface.
(B) light is refracted when it enters the oil.
(C) light reflected from the two surfaces of the oil film produce interference effects.
(D) certain colors are absorbed by oil.
(E) the index of refraction of oil is less than the index of refraction of water.

END OF SECTION B

END OF PART I

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Part II - SECTION C

Heat and Kinetic Theory

41. The molecules in a tank of hydrogen gas have the same average speed as the molecules in a tank of oxygen gas. What can be concluded concerning these two gases?
 - (A) Both gases have the same temperature.
 - (B) The hydrogen gas has the higher pressure.
 - (C) The molecules of both gases have the same average translational kinetic energy.
 - (D) Hydrogen gas has the lower temperature.
 - (E) None of the above can be concluded.
42. An ideal gas is enclosed in a cylinder with a movable piston. The pressure is constant and the temperature of the gas is 27° Celsius. The gas is now heated until its volume is doubled. What is the final temperature of the gas?
 - (A) 54° Celsius
 - (B) 150° Celsius
 - (C) 300° Celsius
 - (D) 327° Celsius
 - (E) 600° Celsius
43. A piece of lead with a mass of 5.0 kilograms is dropped from rest onto a concrete platform from a height of 8.0 meters. Assume the collision is perfectly inelastic. How many calories of heat are generated?
 - (A) less than 20
 - (B) between 20 and 50
 - (C) between 50 and 80
 - (D) between 80 and 110
 - (E) more than 110
44. If 100 milliliters of water at 35° Celsius are mixed with 50 milliliters of water at 50° Celsius, what is the final temperature of the mixture? Assume that the liquids are mixed in a container such that a negligible amount of heat is transferred to the surroundings.
 - (A) less than 38° Celsius
 - (B) more than 38° Celsius and less than 41° Celsius
 - (C) more than 41° Celsius and less than 44° Celsius
 - (D) more than 44° Celsius and less than 47° Celsius
 - (E) more than 47° Celsius
45. How many of the following can be used as the temperature sensitive quantity in thermometers?

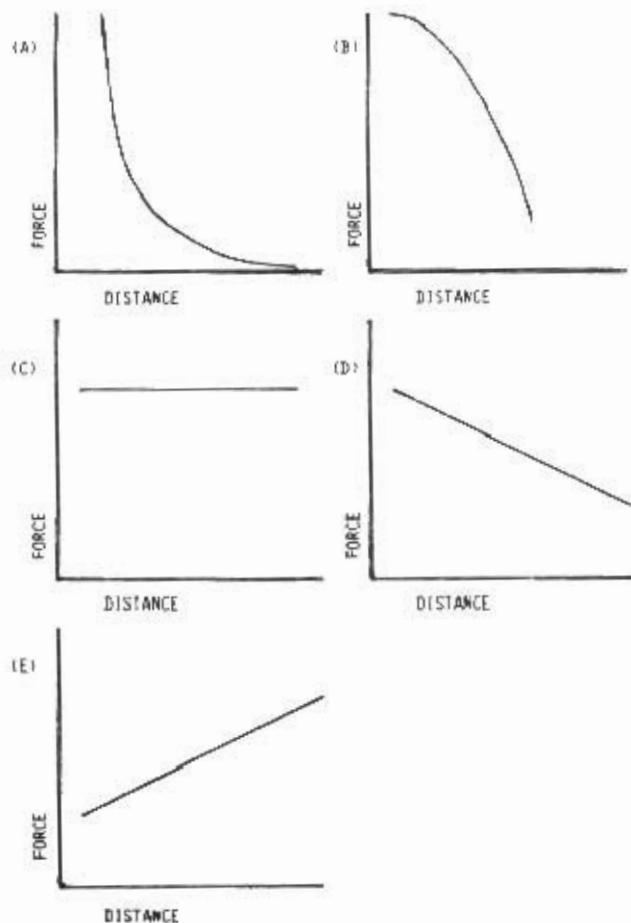
Gas volume
Gas pressure
Liquid volume
Electrical resistance

 - (A) none
 - (B) only one
 - (C) only two
 - (D) only three
 - (E) all four
46. A fixed amount of an ideal gas is in a container whose volume may be varied. Assume the temperature is held constant, and the pressure is increased by a factor of five. If the original volume was 2.0 liters, what is the final volume?
 - (A) 0.40 liter
 - (B) 0.50 liter
 - (C) 2.0 liters
 - (D) 2.5 liters
 - (E) 10 liters
47. The absolute temperature of an ideal gas is directly proportional to the
 - (A) average momentum of the molecules of the gas.
 - (B) average translational kinetic energy of the molecules of the gas.
 - (C) relative increase in volume of the gas for a temperature increase of one Celsius degree.
 - (D) amount of heat required to raise the temperature of the gas by one Celsius degree.
 - (E) number of moles of gas molecules.
48. The walls of a thermos bottle are coated with silver in order to reduce heat transfer by
 - (A) conduction.
 - (B) convection.
 - (C) evaporation.
 - (D) radiation.
 - (E) sublimation.

END OF SECTION C

Part II - SECTION D
Electricity and Magnetism

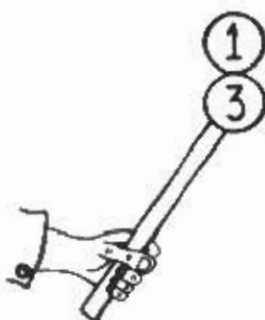
DIAGRAM FOR QUESTION 49



49. In the diagram above, which of the graphs best illustrates the magnitude of the electrostatic force between two charged spheres versus the distance between the spheres? Assume the distance between the spheres is large compared to the size of the spheres.

(A) A
 (B) B
 (C) C
 (D) D
 (E) E

DIAGRAM FOR QUESTION 50



2

50. In the diagram above, two identical conducting spheres 1 and 2 carry equal charges. They are separated by a distance that is very large compared to their diameters and they repel each other with an electrical force F . A third identical but uncharged sphere 3 on an insulating handle is touched first to sphere 1, then to sphere 2 and finally removed. What is the force between spheres 1 and 2 now?

(A) $F/16$
 (B) $F/4$
 (C) $3F/8$
 (D) $F/2$
 (E) $3F/4$

51. Which is true for a positive charge moving freely from a point of high potential to a point of low potential?

(A) potential energy remains the same
 (B) potential energy decreases
 (C) kinetic energy remains the same
 (D) kinetic energy decreases
 (E) none of the above is true

52. An object with a positive charge of 0.10 coulomb moves freely from a potential of 100 volts to a potential of 20 volts. What is the change of this object's kinetic energy?

(A) gains 2.0 joules
 (B) loses 2.0 joules
 (C) gains 10.0 joules
 (D) loses 10.0 joules
 (E) none of the above

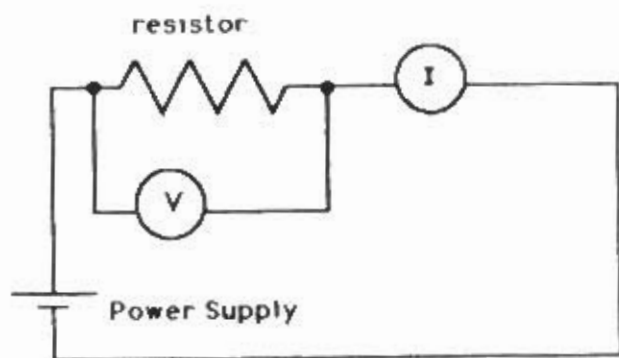
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DIAGRAM FOR QUESTIONS 53 AND 54



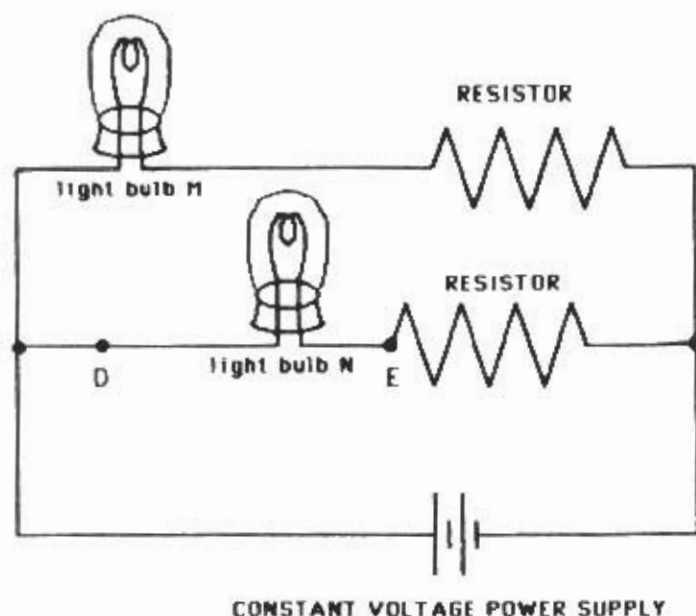
53. In the diagram above, electrically charged spheres are placed at R and S. Another charged sphere is placed at P and the total electrostatic force on this sphere is zero. Which statement must be true?
- (A) Charge R is positive and charge S is negative.
 (B) Charge R is negative and charge S is positive.
 (C) Charge R and S must be positive.
 (D) Charge R and S must be negative.
 (E) Charge R is the same sign as charge S.
54. What is the magnitude of charge R compared to the magnitude of charge S?
- (A) one-fourth as great
 (B) one-half as great
 (C) equal
 (D) twice as great
 (E) four times as great

DIAGRAM FOR QUESTION 55



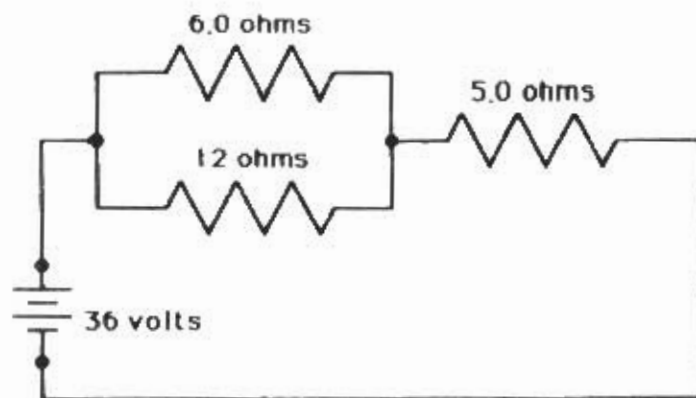
55. The diagram above shows a circuit for determining the resistance of a resistor by measuring the current (I), measuring the voltage (V) and then using the formula $R = V/I$. In order to produce a more accurate answer one should
- (A) reverse the positions of the ammeter and the voltmeter
 (B) use a voltmeter with a lower resistance
 (C) use a voltmeter with a higher resistance
 (D) take voltage reading first.
 (E) take current reading first.

DIAGRAM FOR QUESTION 56



56. In the diagram above, the constant voltage power supply has an emf and negligible internal resistance. Initially both light bulbs M and N light. If bulb N is taken out of its socket, then
- (A) bulb M will increase in brightness.
 (B) the voltage between D and E becomes zero.
 (C) the voltage between D and E does not change.
 (D) the voltage between D and E increases.
 (E) the current through the power supply will increase

DIAGRAM FOR QUESTION 57



57. In the diagram above, what is the equivalent resistance of the two resistors connected in parallel?
- (A) 0.45 ohm
 (B) 2.7 ohms
 (C) 3.5 ohms
 (D) 4.0 ohms
 (E) 18 ohms

58. A twelve-volt car battery supplies an average current of 50 amperes to a starter motor. How much charge passes through the starter in 0.10 minute?

(A) 5.0 coulombs
(B) 25 coulombs
(C) 100 coulombs
(D) 300 coulombs
(E) 500 coulombs

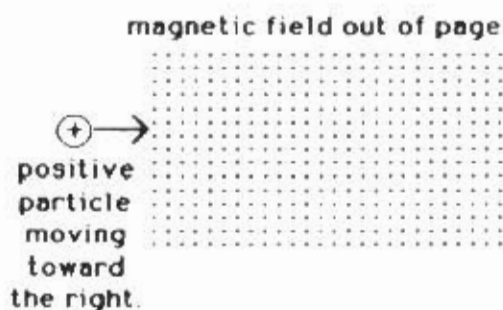
59. Two identical dry cells are connected in series and have a total emf of 3.0 volts. When a resistor of 5.8 ohms is connected to the dry cells, the current is 0.50 ampere. What is the internal resistance of *each* cell?

(A) 0.050 ohm
(B) 0.20 ohm
(C) 0.10 ohm
(D) 2.0 ohms
(E) 2.9 ohms

60. What is the equivalent unit for the watt-second?

(A) newton
(B) newton/meter
(C) ohm
(D) volt-coulomb
(E) volt-ampere

DIAGRAM FOR QUESTION 61



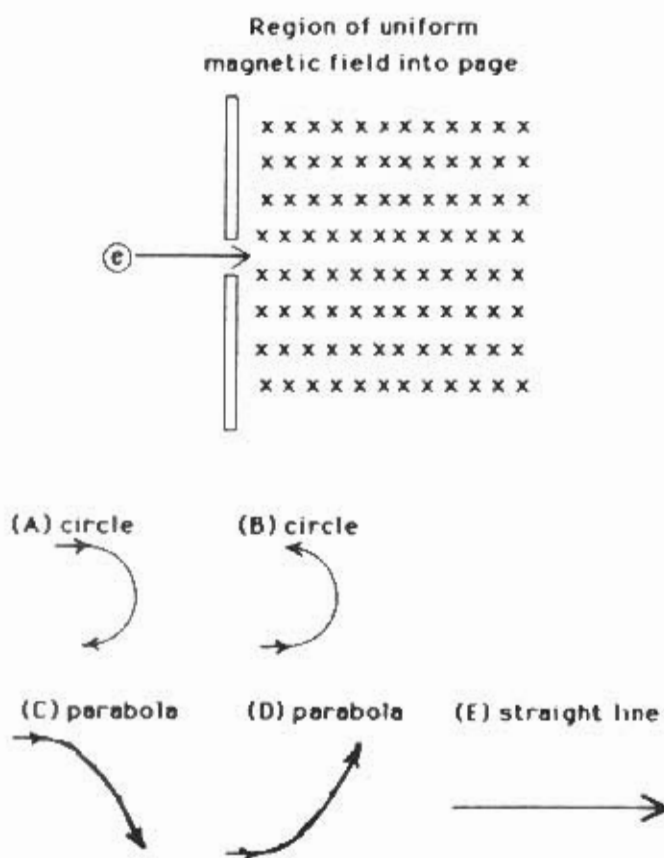
61. In the diagram above, the initial magnetic force on a positive particle upon entering the magnetic field B is

(A) toward the top of the page.
(B) toward the bottom of the page.
(C) into the page.
(D) out of the page.
(E) to the left of the page.

62. A device used to measure electric current directly is the

(A) ammeter.
(B) electroscope.
(C) ohmmeter.
(D) potentiometer.
(E) Wheatstone bridge.

DIAGRAM FOR QUESTION 63

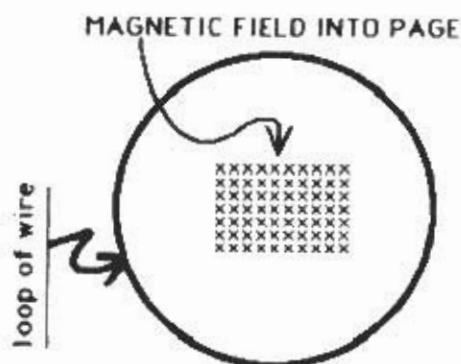


63. As shown in the diagram above, an electron enters a region containing a uniform magnetic field. Initially the electron moves perpendicular to the magnetic field which is directed into the page. Which diagram best represents the motion of the electron when it is in the magnetic field?

(A) A
(B) B
(C) C
(D) D
(E) E

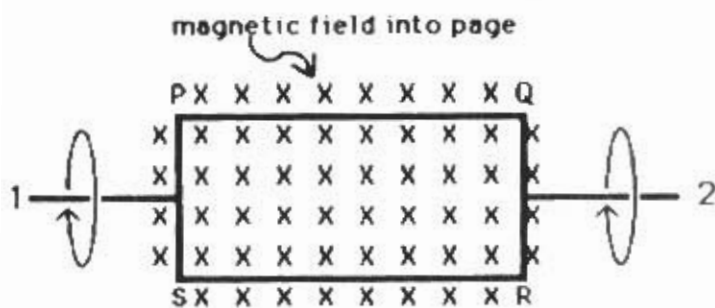
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DIAGRAM FOR QUESTION 64



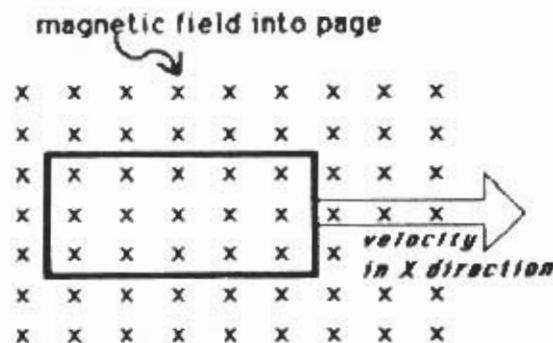
64. In the diagram above, an electromagnet produces a constant magnetic field inside a loop of wire. At the instant shown, the magnetic field is directed into the page. Which of the following is true?
- (A) There is no current in the loop.
 (B) There is a constant clockwise current in the loop.
 (C) There is a constant counterclockwise current in the loop.
 (D) There is an increasing current in the loop.
 (E) There is a decreasing current in the loop.
65. At the North magnetic pole of the earth, a magnetic needle free to point in *any* direction would
- (A) point South.
 (B) be parallel to the ground.
 (C) be perpendicular to the ground.
 (D) spin in a horizontal circle.
 (E) point East.

DIAGRAM FOR QUESTION 66



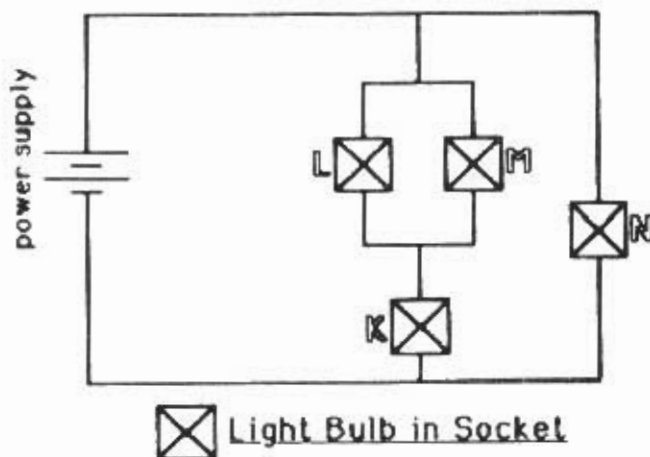
66. In the diagram above, the loop PQRS is rotating at a constant angular velocity about the line connecting points 1 and 2. At the instant shown the loop is in the plane of the paper. The maximum induced emf is produced when the loop has rotated an additional
- (A) 0 degrees.
 (B) 30 degrees.
 (C) 45 degrees.
 (D) 60 degrees.
 (E) 90 degrees.

DIAGRAM FOR QUESTION 67



67. In the diagram above consider only electromagnetic forces. The force necessary to keep the rectangular loop moving in the X-direction at a constant velocity within the uniform magnetic field is
- (A) zero.
 (B) toward the right.
 (C) toward the left.
 (D) upward.
 (E) downward.

DIAGRAM FOR QUESTION 68



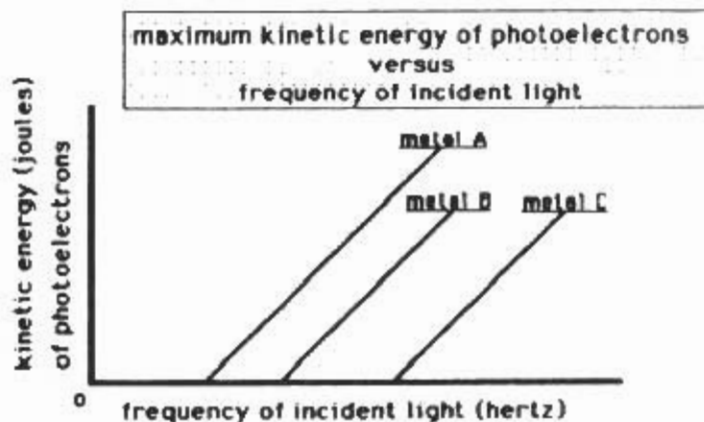
68. In the circuit shown above, which light bulbs should be removed from their sockets so that the current through the power supply will be zero?
- (A) K and L only
 (B) K and N only
 (C) L and M only
 (D) L and N only
 (E) K, L, and M only

END OF SECTION D

Part II - SECTION E

Modern Physics

DIAGRAM FOR QUESTION 69



69. In the graph above, what does the intercept of each line with the horizontal axis represent?
- energy of the light which corresponds to a given frequency
 - threshold frequency of light for the emission of photoelectrons in each metal
 - relative energy of the light incident upon each metal
 - total kinetic energy of all the electrons emitted by each metal
 - frequency of electron emission
70. Which phenomenon can best be explained by assuming an electron has wave characteristics?
- Frank-Hertz effect
 - interference patterns
 - photoelectric effect
 - radioactivity
 - static electricity
71. It is possible to explain the fact that electrons occupy discrete energy states in atoms by applying the
- Doppler effect.
 - fact the speed of light is finite.
 - ideal gas law.
 - theory of relativity.
 - wave nature of matter.
72. Einstein's theory of the photoelectric effect explains that for a given metallic surface, the maximum kinetic energy of the ejected electrons depends upon the
- angle of incidence of the incident light.
 - duration of exposure of the metal surface.
 - frequency of the incident light.
 - intensity of the incident light.
 - the number of ejected electrons per second.
73. When an electric current is passed through a hydrogen-filled gas discharge tube, a line emission spectrum is observed. This observation supports
- Bohr's theory of atomic structure.
 - Compton scattering.
 - Einstein's photoelectric theory.
 - Faraday's law of electromagnetic induction.
 - the second law of thermodynamics.
74. Which has the greatest rest mass?
- alpha particle
 - electron
 - neutron
 - photon of visible light
 - proton
75. After 2 hours, $1/8$ of the initial amount of a radioactive isotope is left. What is the half-life of this isotope?
- 15 minutes
 - 30 minutes
 - 40 minutes
 - 60 minutes
 - more than 60 minutes
76. Rutherford's early scattering experiments provided convincing evidence for the existence of the
- atom.
 - atomic nucleus.
 - electron.
 - neutron.
 - proton.
77. An object approaches you with a speed of $0.8c$ (c represents the speed of light). This object has a light source which directs a beam of light toward you. If you measure the speed of the light in the beam as it passes you, what will you find for its speed?
- $0.2c$
 - $0.8c$
 - $1.0c$
 - $1.8c$
 - $2.0c$

Go on to next page

78. Which postulates are from the Bohr atomic theory?
- I. An atomic system can exist in any one of a number of states such that no emission of radiation takes place.
 - II. Emission or absorption of radiation corresponds to atomic transitions between energy states.
 - III. We are unable to measure both the position and momentum of an electron with unlimited precision.
 - IV. Wave-particle dualism is a general property, for radiation and matter.
- (A) I and II only
(B) I and III only
(C) II and III only
(D) II and IV only
(E) III and IV only
79. What is the mass number of the resulting nucleus after uranium-238 has undergone alpha decay?
- (A) 234
(B) 236
(C) 238
(D) 239
(E) 242
80. What is the number of neutrons in the nucleus of an atom of the aluminum isotope $^{27}_{13}\text{Al}$?
- (A) 12
(B) 13
(C) 14
(D) 27
(E) 40

END OF SECTION E

END OF EXAMINATION