AP Physics 2: Practice Exam 1

Multiple-Choice Questions

ANSWER SHEET

1 Ⓐ Ⓑ Ⓒ Ⓓ	18 Ⓐ Ⓑ Ⓒ Ⓓ	35 Ⓐ Ⓑ Ⓒ Ⓓ
2 Ⓐ Ⓑ Ⓒ Ⓓ	19 Ⓐ Ⓑ Ⓒ Ⓓ	36 Ⓐ Ⓑ Ⓒ Ⓓ
3 Ⓐ Ⓑ Ⓒ Ⓓ	20 Ⓐ Ⓑ Ⓒ Ⓓ	37 Ⓐ Ⓑ Ⓒ Ⓓ
4 Ⓐ Ⓑ Ⓒ Ⓓ	21 Ⓐ Ⓑ Ⓒ Ⓓ	38 Ⓐ Ⓑ Ⓒ Ⓓ
5 Ⓐ Ⓑ Ⓒ Ⓓ	22 Ⓐ Ⓑ Ⓒ Ⓓ	39 Ⓐ Ⓑ Ⓒ Ⓓ
6 Ⓐ Ⓑ Ⓒ Ⓓ	23 Ⓐ Ⓑ Ⓒ Ⓓ	40 Ⓐ Ⓑ Ⓒ Ⓓ
7 Ⓐ Ⓑ Ⓒ Ⓓ	24 Ⓐ Ⓑ Ⓒ Ⓓ	41 Ⓐ Ⓑ Ⓒ Ⓓ
8 Ⓐ Ⓑ Ⓒ Ⓓ	25 Ⓐ Ⓑ Ⓒ Ⓓ	42 Ⓐ Ⓑ Ⓒ Ⓓ
9 Ⓐ Ⓑ Ⓒ Ⓓ	26 Ⓐ Ⓑ Ⓒ Ⓓ	43 Ⓐ Ⓑ Ⓒ Ⓓ
10 Ⓐ Ⓑ Ⓒ Ⓓ	27 Ⓐ Ⓑ Ⓒ Ⓓ	44 Ⓐ Ⓑ Ⓒ Ⓓ
11 Ⓐ Ⓑ Ⓒ Ⓓ	28 Ⓐ Ⓑ Ⓒ Ⓓ	45 Ⓐ Ⓑ Ⓒ Ⓓ
12 Ⓐ Ⓑ Ⓒ Ⓓ	29 Ⓐ Ⓑ Ⓒ Ⓓ	46 Ⓐ Ⓑ Ⓒ Ⓓ
13 Ⓐ Ⓑ Ⓒ Ⓓ	30 Ⓐ Ⓑ Ⓒ Ⓓ	47 Ⓐ Ⓑ Ⓒ Ⓓ
14 Ⓐ Ⓑ Ⓒ Ⓓ	31 Ⓐ Ⓑ Ⓒ Ⓓ	48 Ⓐ Ⓑ Ⓒ Ⓓ
15 Ⓐ Ⓑ Ⓒ Ⓓ	32 Ⓐ Ⓑ Ⓒ Ⓓ	49 Ⓐ Ⓑ Ⓒ Ⓓ
16 Ⓐ Ⓑ Ⓒ Ⓓ	33 Ⓐ Ⓑ Ⓒ Ⓓ	50 Ⓐ Ⓑ Ⓒ Ⓓ
17 Ⓐ Ⓑ Ⓒ Ⓓ	34 Ⓐ Ⓑ Ⓒ Ⓓ	

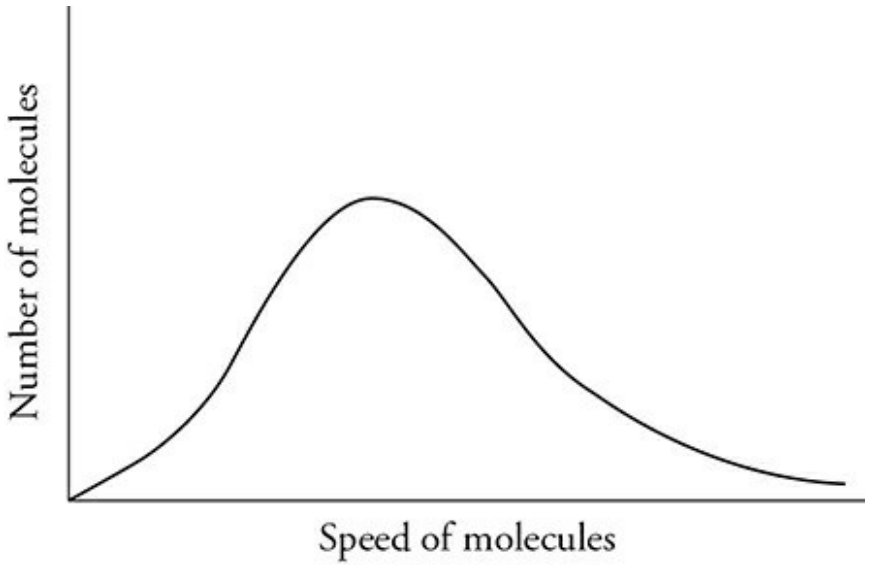
AP Physics 2: Practice Exam 1

Section 1 (Multiple Choice)

Directions: The multiple-choice section consists of 50 questions to be answered in 90 minutes. You may write scratch work in the test booklet itself, but only the answers on the answer sheet will be scored. You may use a calculator, the equation sheet, and the table of information. These can be found in the appendix or you can download the official ones from the College Board at: https://secure-media.collegeboard.org/digitalServices/pdf/ap/ap-physics-2-equations-table.pdf.

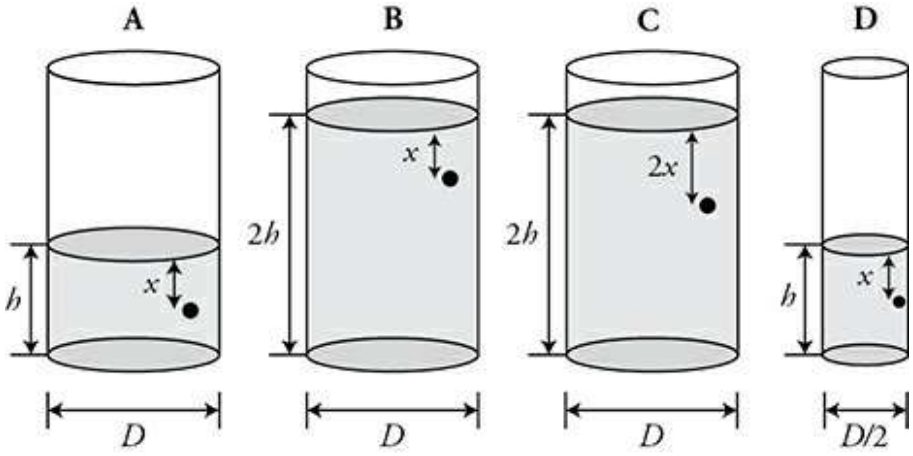
Questions 1–45: Single-Choice Items

Choose the single best answer from the choices provided, and mark the answer with a pencil on the answer sheet.



1. The graph shows the distribution of speeds for one mole of hydrogen at temperature T, pressure P, and volume V. How would the graph change if the sample was changed from one mole hydrogen to one mole of argon at the same temperature, pressure, and volume?

(A) The peak will shift to the left.
(B) The peak will shift upward and to the left.
(C) The peak will shift to the right.
(D) The peak will shift downward and to the right.



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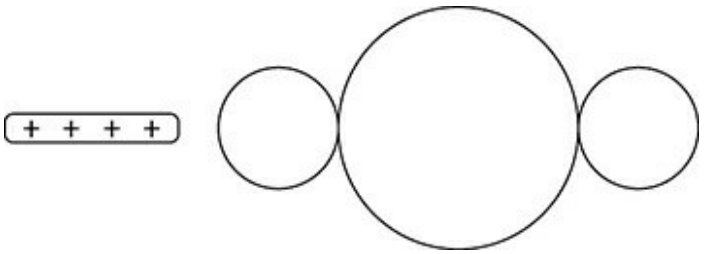
2. The figure shows four cylinders of various diameters filled to different heights with water. A hole in the side of each cylinder is plugged by a cork. All cylinders are open at the top. The corks are removed. Which of the following is the correct ranking of the velocity of the water (v) as it exits each cylinder?

(A) $v_A > v_D > v_C > v_B$
(B) $v_A = v_D > v_C > v_B$
(C) $v_B > v_C > v_A = v_D$
(D) $v_C > v_A = v_B = v_D$

3. An observer can hear sound from around a corner but cannot see light from around the same corner. Which of the following helps to explain this phenomenon?

(A) Sound is a longitudinal wave, and light is an electromagnetic wave.
(B) Sound is a mechanical wave, and light is a transverse wave.
(C) Light travels at a speed much faster than that of sound.
(D) Light has a much smaller wavelength than sound.



4. A positively charged rod is brought near to but not touching three metal spheres that are in contact with each other, as shown in the figure. Which is the best representation of the charge arrangement inside the three spheres?

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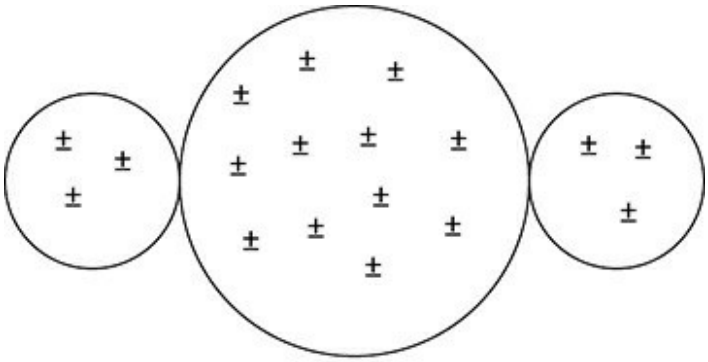
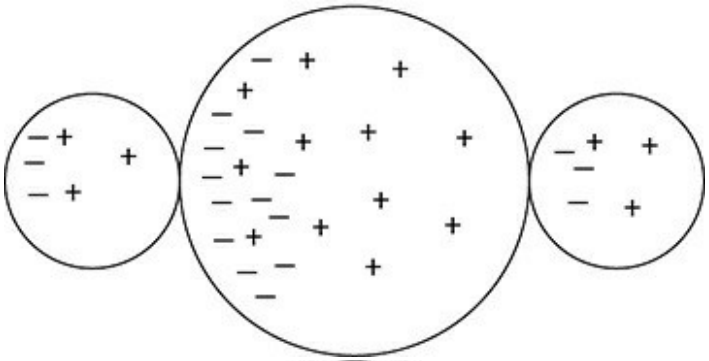
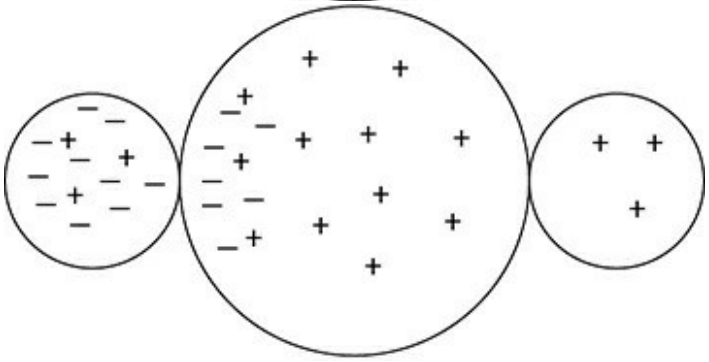
(A)



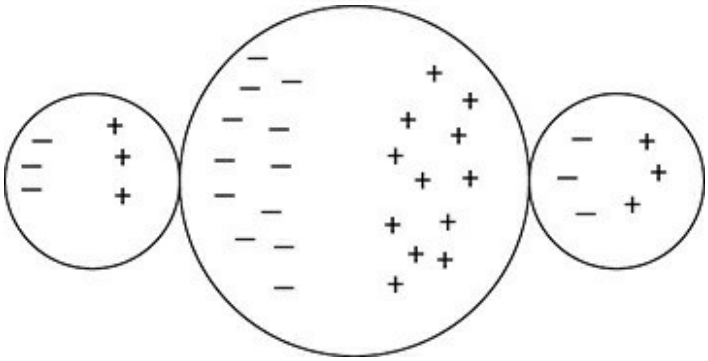
(B)



(C)



(D)



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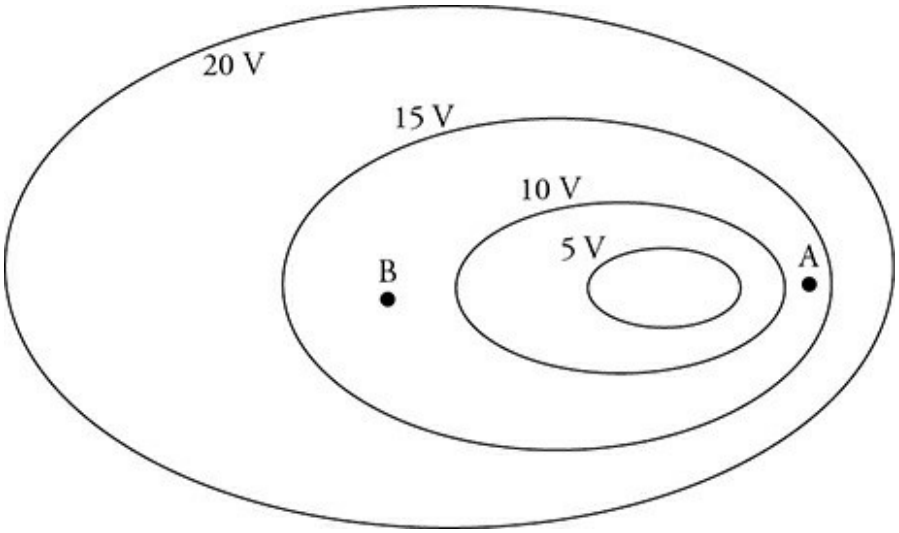


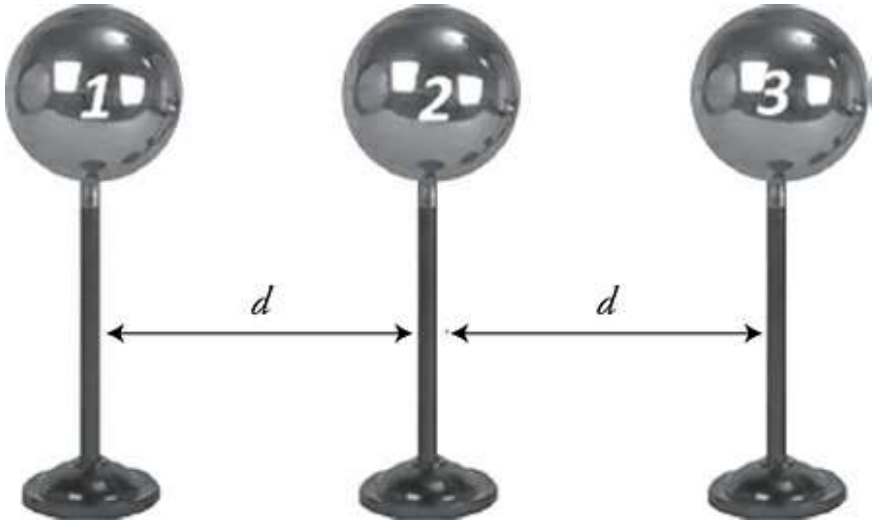
5. Isolines of equal electric potential in a region of space are shown in the figure. Points A and B are in the plane of the isolines. Which of the following correctly describes the relationship between the magnitudes and directions of the electric fields at points A and B?

(A) $E_A = E_B$ and is in the same direction.

(B) $E_A \neq E_B$ and is in the same direction.

(C) $E_A = E_B$ and is in the opposite direction.

(D) $E_A \neq E_B$ and is in the opposite direction.



6. The metal spheres on insulating stands 1, 2, and 3 are all identical and situated as shown in the figure. Spheres 1 and 2 have a charge of $-Q$,

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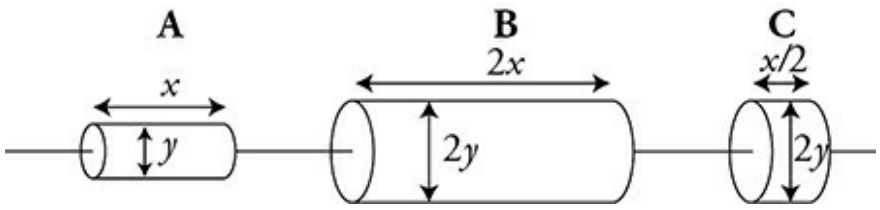
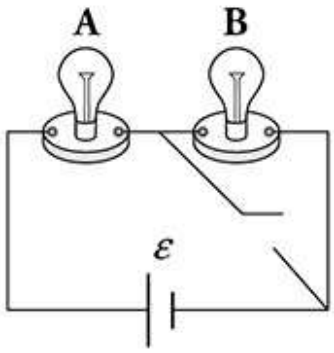
and sphere 3 has a charge of +2Q. The force of sphere 1 on sphere 2 is +F. What is the magnitude of the net force on sphere 3 in terms of F?

(A) 3/2 F
(B) 2 F
(C) 5/2 F
(D) 3 F



7. Three cylindrical resistors made of the same material but different dimensions are connected, as shown in the figure. A battery is connected to produce current through the resistors. Which is the correct ranking of the potential differences across the individual resistors?

(A) $V_A = V_B = V_C$
(B) $V_A > V_B > V_C$
(C) $V_A = V_B > V_C$
(D) $V_C > V_B > V_A$



8. The figure shows two bulbs connected to a battery in a circuit with a switch that is originally in the closed position. What happens to the brightness of the bulbs when the switch is opened?

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	Bulb A	Bulb B
(A)	Four times brighter	Goes out
(B)	Same brightness	Glows as brightly as bulb A
(C)	Half as bright	Glows as brightly as bulb A
(D)	Quarter as bright	Glows as brightly as bulb A

9. An astronaut in a rocket is passing by a space station at a velocity of 0.33 *c*. Looking out the window, the astronaut sees a scientist on the space station fire a laser at a target. The laser is pointed in the same direction that the astronaut is traveling. On which of the following observations will the astronaut and scientist agree?

(A) The length of the rocket
(B) The time it takes the laser to hit the target
(C) The speed of the laser beam
(D) The astronaut and scientist will not agree on any of these measurements.

10. A proton is moving toward the top of the page when it encounters a magnetic field that changes its direction of motion. After encountering the magnetic field, the proton's velocity vector is pointing out of the page. What is the direction of the magnetic field? Assume gravitational effects are negligible.

(A) Toward the bottom of the page
(B) To the right
(C) To the left
(D) Into the page

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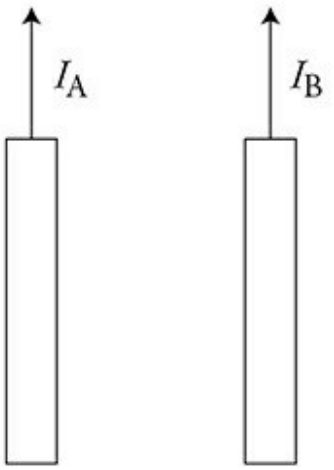

11. Two long parallel wires carry currents (I_A and I_B), as shown in the figure. Current I_A in the left wire is twice that of current I_B in the right wire. The magnetic force on the right wire is F. What is the magnetic force on the left wire in terms of F?

(A) F in the same direction
(B) F in the opposite direction
(C) $F/2$ in the same direction
(D) $F/2$ in the opposite direction

Questions 12 and 13

Four identical resistors of resistance R are connected to a battery, as shown in the figure. Ammeters A_1 and A_2 measure currents of 1.2 A and 0.4 A, respectively.

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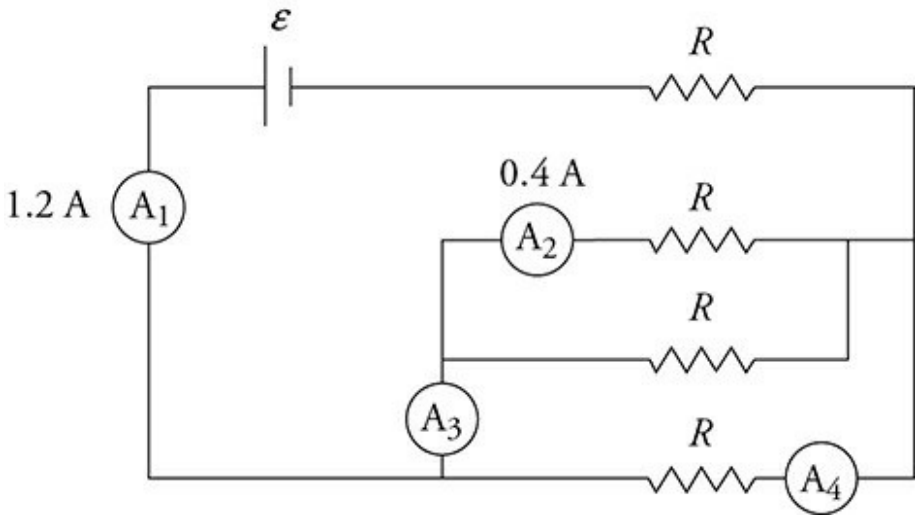

12. What are the currents measured by ammeters A_3 and A_4?

	A_3	A_4
(A)	0.4 A	0.4 A
(B)	0.8 A	0.4 A
(C)	0.4 A	1.2 A
(D)	0.8 A	1.2 A

13. What is the equivalent resistance of the circuit?

(A) ¼ *R*
(B) 4/3 *R*
(C) 5/2 *R*
(D) 4 *R*

Pressure ($\times 10^5$ Pa)	Volume ($\times 10^{-3}$ m^3)
1.0	25
1.5	17
1.8	14
2.2	11
2.6	9.6
3.3	7.6

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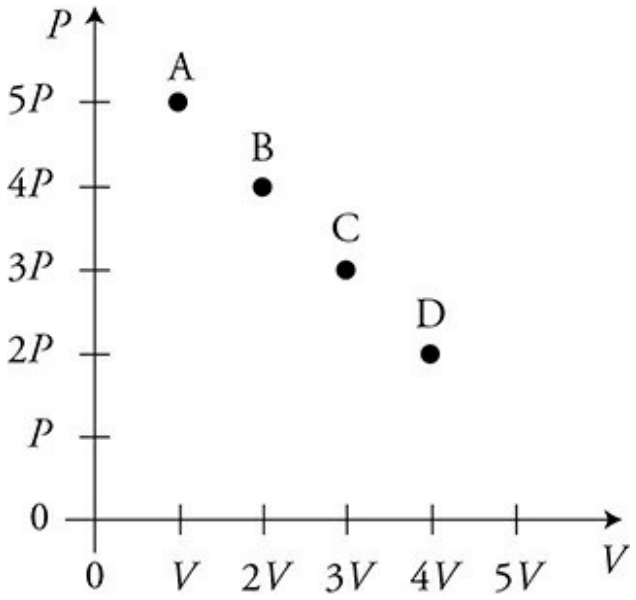
14. In an experiment, a gas is confined in a cylinder with a movable piston. Force is applied to the piston to increase the pressure and change the volume of the gas. Each time the gas is compressed, it is allowed to return to a room temperature of 20°C. The data gathered from the experiment is shown in the table. What should be plotted on the vertical and horizontal axes so the slope of the graph can be used to determine the number of moles of gas in the cylinder?

(A) P and V^2
(B) P and V
(C) P and $(V)^{1/2}$
(D) P and $1/V$



15. The figure shows the pressure and volume of a gas at four different states. Which of the following correctly ranks the temperature of the gas at the different states?

(A) $T_A > T_B > T_C > T_D$
(B) $T_B = T_C > T_A = T_D$
(C) $T_C > T_B = T_D > T_A$
(D) $T_D > T_C > T_B > T_A$

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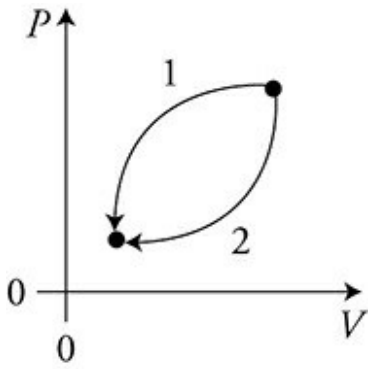
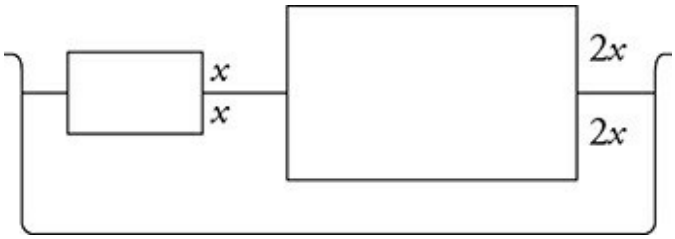


16. The figure shows the pressure and volume of three moles of gas being taken through two different processes. Which of the following is correct concerning the two processes shown in the figure?

(A) $\Delta U_1 = \Delta U_2$ and $W_1 = W_2$
(B) $\Delta U_1 = \Delta U_2$ and $W_1 > W_2$
(C) $\Delta U_1 > \Delta U_2$ and $W_1 = W_2$
(D) $\Delta U_1 > \Delta U_2$ and $W_1 > W_2$



17. Two blocks of different sizes and masses float in a tray of water. Each block is half submerged, as shown in the figure. Water has a density of 1,000 kg/m^3. What can be concluded about the densities of the two blocks?

(A) The two blocks have different densities, both of which are less than 1,000 kg/m^3.
(B) The two blocks have the same density of 500 kg/m^3.
(C) The two blocks have the same density, but the density cannot be determined with the information given.
(D) The larger block has a greater density than the smaller block, but the densities of the blocks cannot be determined with the

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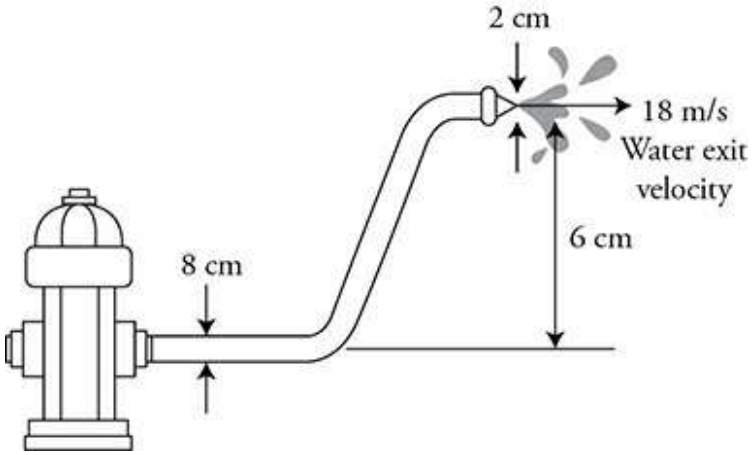
information given.



18. Firefighters use a hose with a 2 cm diameter exit nozzle connected to a hydrant with an 8 cm diameter opening to attack a fire on the second floor of a building 6 m above the hydrant, as shown in the figure. What pressure must be supplied at the hydrant to produce an exit velocity of 18 m/s? (Assume the density of water is 1,000 kg/m^3, and the exit pressure is 1×10^5 Pa.)

(A) 1.7×10^5 Pa
(B) 2.0×10^5 Pa
(C) 2.6×10^5 Pa
(D) 3.2×10^5 Pa

19. Two electrons exert an electrostatic repulsive force on each other. Is it possible to arrange the two electrons so the gravitational attraction between them is large enough to cancel out the electric repulsive force?

(A) No, the charge of the electrons squared is much larger than the mass of the electrons squared.
(B) No, there is no gravitational force between subatomic particles.
(C) Yes, reducing the radius between the electrons will increase the gravitational force as it is proportional to the inverse of the radius squared.
(D) Yes, increasing the distance between the electrons will reduce the electrostatic repulsion until it is equal to the gravitational force.

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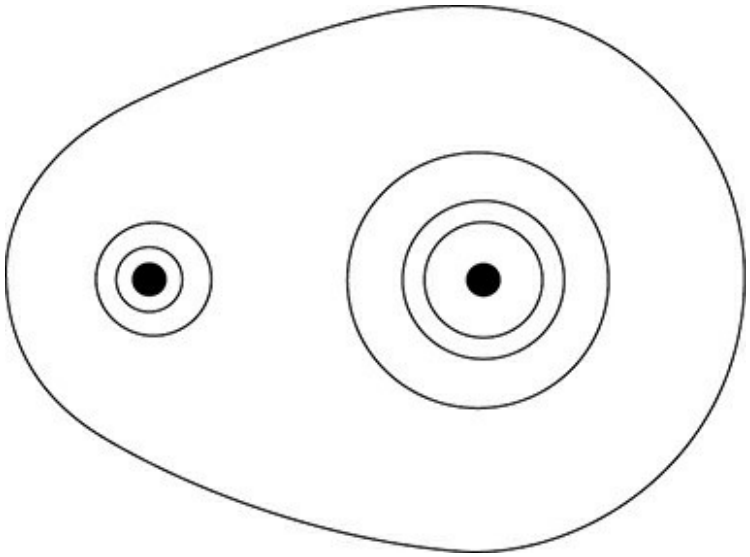
20. The news reports the discovery of two new particles by the research facility CERN in Geneva. The first particle, dubbed Alithísium, is large with a mass equivalence of 125 GeV ± 15 GeV and a net charge of -1.55×10^{-18} C ± 0.1×10^{-18}. The second particle, Psevdísium, has a mass of 5.4×10^{-4} u ± 0.1×10^{-4} u and a charge of 1.6×10^{-20} C ± 0.5×10^{-20}. Which of the following is most correct concerning the two new particles?

(A) Both particles appear reasonable.
(B) Alithísium appears reasonable, but Psevdísium does not.
(C) Psevdísium appears reasonable, but Alithísium does not.
(D) Neither particle appears reasonable.



21. The figure shows isolines of constant electric potential surrounding two charges. Which of the following correctly describes the two charges?

(A) The charges are the same magnitude and the same sign.
(B) The charges are the same magnitude but different signs.
(C) The charges are different magnitudes but the same sign.
(D) The charges are different magnitudes and different signs.

22. An iron magnet is broken in half at the midpoint between its north and south ends. What is the result?

(A) A separate north pole and south pole, each with the same magnetic

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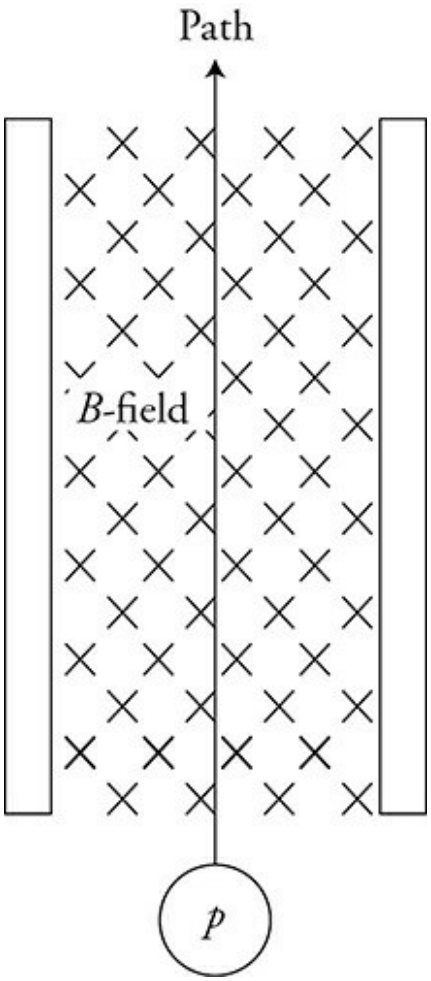
strength as the original magnet

(B) A separate north pole and south pole, each with half the magnetic strength of the original magnet

(C) Two separate north-south magnets, each with the same magnetic strength as the original magnet

(D) Two separate north-south magnets, each with half the magnetic strength of the original magnet



23. A magnetic field, directed into the page, is placed between two charged capacitor plates, as shown in the figure. The magnetic and electric fields are adjusted so a proton moving at a velocity of v will pass straight through the fields. The speed of the proton is doubled to $2v$. Which of the following force diagrams most accurately depicts all the forces acting on the proton when traveling at $2v$?

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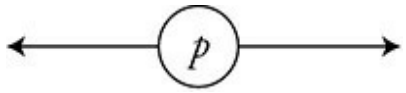
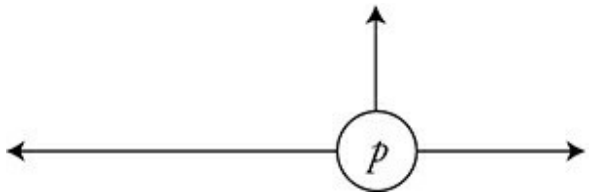
(A)



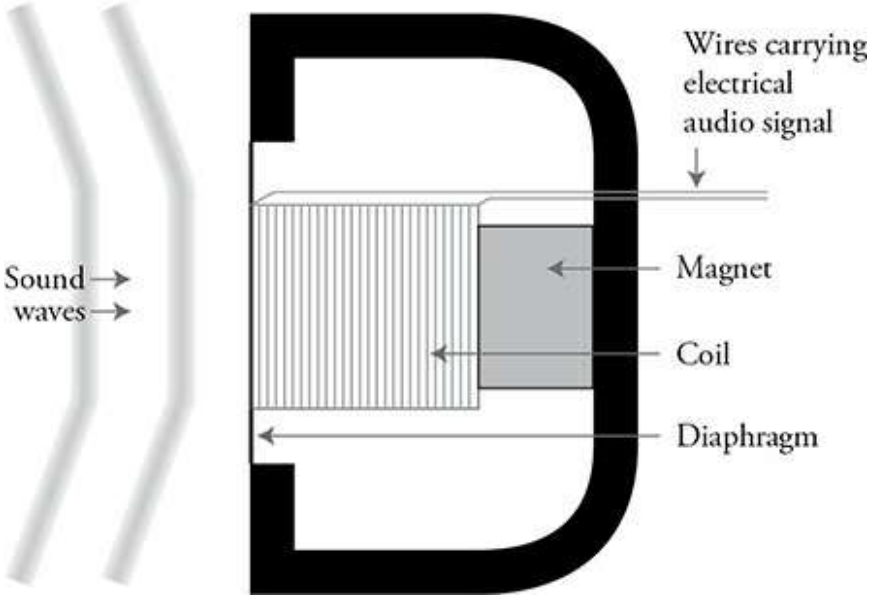
(B)

(C)

(D)



Cross-Section of Dynamic Microphone



24. A dynamic microphone contains a magnet and a coil of wire connected to a movable diaphragm, as shown in the figure. Sound waves directed at the diaphragm generate a current in the wires leading from the coil. Which of the following helps to explain why this occurs?

(A) The area of the coil changes.
(B) The magnitude of the magnetic field produced by the magnet changes.
(C) The angle between the plane of the coil and the magnetic field

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produced by the magnet change.

(D) The strength of the magnetic field in the plane of the coil changes.

25. A lens and a mirror both have a focal length of f in air. Both are submerged in water, and the focal length f_{water} is measured for both. How does the focal length under water compare to the focal length in air?

	Lens	Mirror
(A)	$f = f_{water}$	$f = f_{water}$
(B)	$f = f_{water}$	$f < f_{water}$
(C)	$f < f_{water}$	$f = f_{water}$
(D)	$f < f_{water}$	$f < f_{water}$

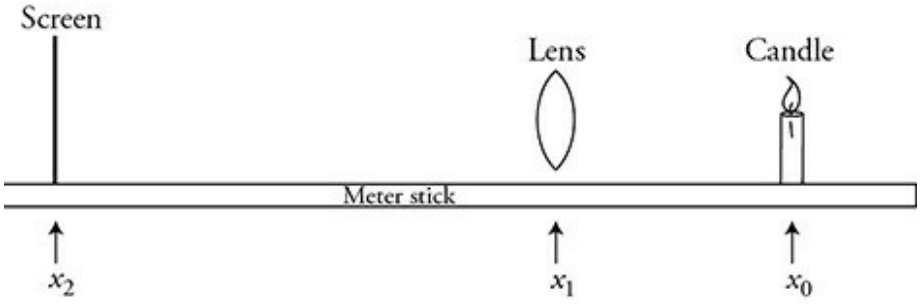
26. Which of the following correctly describes the motion of the electric and magnetic fields of a microwave transmitted by a cell phone?

(A) Both the electric and magnetic fields oscillate in the same plane and perpendicular to the direction of wave propagation.

(B) Both the electric and magnetic fields oscillate perpendicular to each other and to the direction of wave propagation.

(C) The electric field oscillates perpendicular to the direction of wave propagation. The magnetic field oscillates parallel to the direction of wave propagation.

(D) Both the electric and magnetic fields oscillate parallel to the direction of wave propagation.



27. An optics bench is set up on a meter stick, as shown in the figure. The light source is a candle placed at x_0. The lens is located at x_1. The screen

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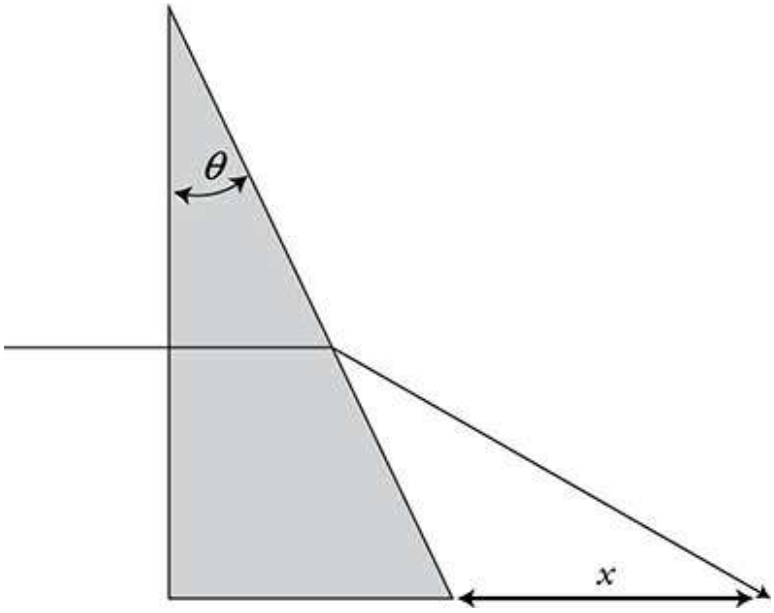
is moved until a sharp image appears at location x_2. The data is recorded in a table, the lens is moved to a new location (x_1), and the screen is adjusted until the image is sharp again. Which of the following procedures will allow a student to determine the focal length of the lens?

(A) Plot x_2 as a function of x_0. The focal length will be the vertical axis intercept.
(B) Plot $(x_2 - x_1)$ as a function of $(x_0 - x_1)$. The focal length will be the vertical axis intercept.
(C) Plot $1/x_2$ as a function of $1/x_0$. The focal length will be the inverse of the vertical axis intercept.
(D) Plot $1/(x_2 - x_1)$ as a function of $1/(x_0 - x_1)$. The focal length will be the inverse of the vertical axis intercept.



28. A laser beam passes through a prism and produces a bright dot of light a distance of x from the prism, as shown in the figure. Which of the following correctly explains the change in distance x as the angle (θ) of the prism is decreased?

(A) The distance x increases because the angle on incidence increases.
(B) The distance x increases because the angle of incidence decreases.
(C) The distance x decreases because the angle on incidence increases.

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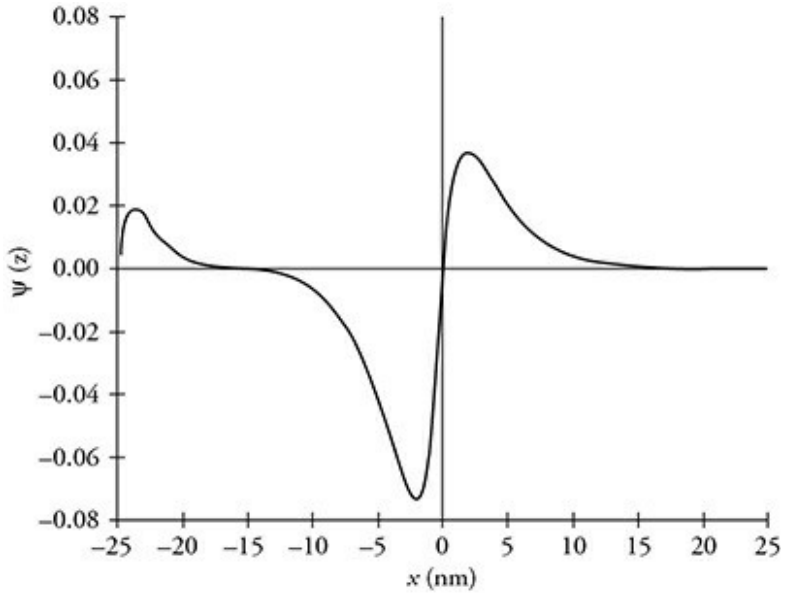
(D) The distance x decreases because the angle of incidence decreases.



29. The graph shows the wave function of a particle as a function of x in the region between $-25 \text{ nm} < x < +25 \text{ nm}$. At which of the following positions is the probability of finding the particle greatest?

(A) –24 nm
(B) –15 nm and 0.0 nm
(C) –2 nm
(D) 2 nm

30. A nucleus of ${}^{237}_{93}\text{Np}$ goes through a sequence of decays during which it emits four beta particles and some alpha particles to finally end up as a stable ${}^{250}_{81}\text{Tl}$ nucleus. How many alpha particles have been emitted in this process?

(A) 32
(B) 26
(C) 8
(D) 4

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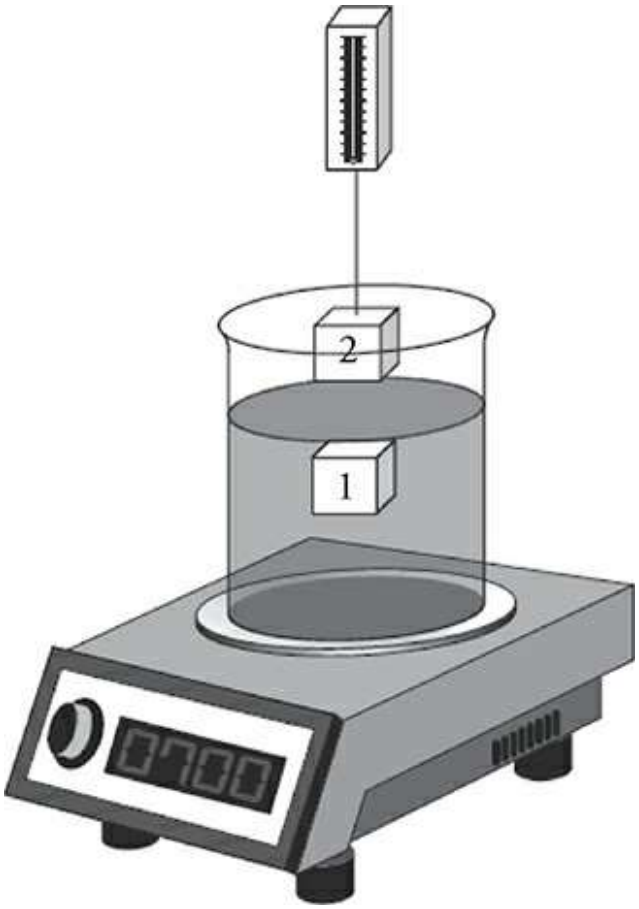

31. A beaker of water sits on a balance. A metal block with a mass of 190 g is held suspended in the water by a spring scale in position 1, as shown in the figure. In this position, the reading on the balance is 1,260 g, and the spring scale reads 120 g. When the block is lifted from the water to position 2, what are the readings on the balance and spring scale?

	Balance reading	Spring scale reading
(A)	1,190 g	120 g
(B)	1,190 g	190 g
(C)	1,260 g	190 g
(D)	1,330 g	120 g

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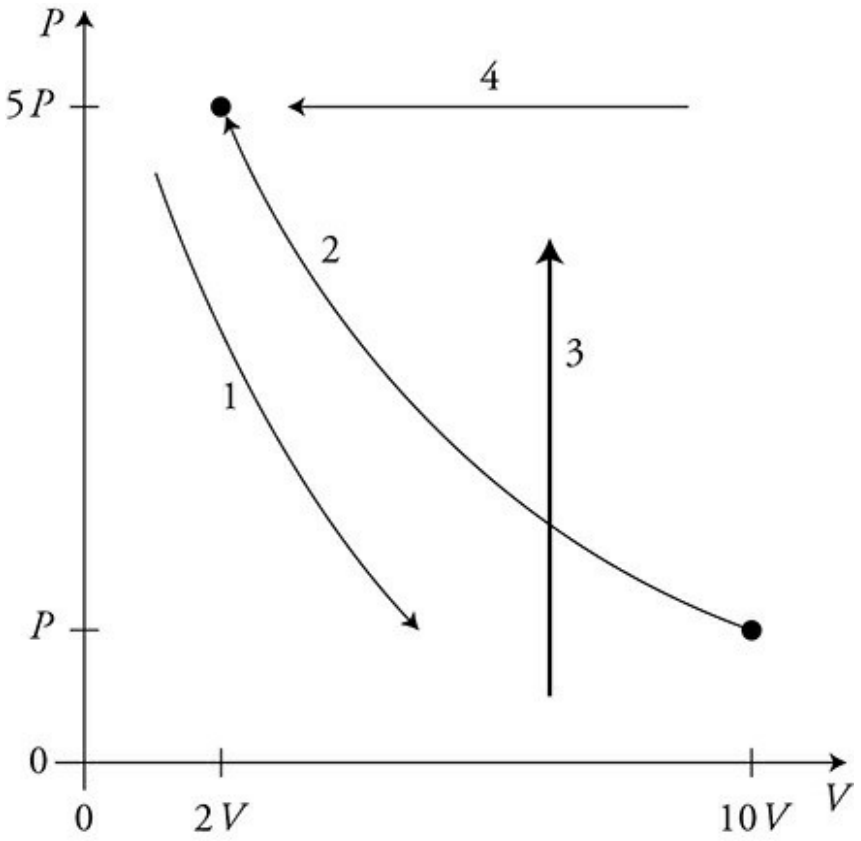

32. The figure shows four samples of gas being taken through four different processes. Process 1 is adiabatic. In which process is heat being transferred to the gas sample from the environment?

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

33. Two sealed cylinders holding different gases are placed one on top of the other so heat can flow between them. Cylinder A is filled with hydrogen. Cylinder B is filled with helium moving with an average speed that is half that of the hydrogen atoms. Helium atoms have four times the mass of hydrogen atoms. Which of the following best describes the transfer of heat between the two containers by conduction?

(A) Net heat flows from cylinder A to cylinder B, because heat flows from higher kinetic energy atoms to lower kinetic energy atoms.

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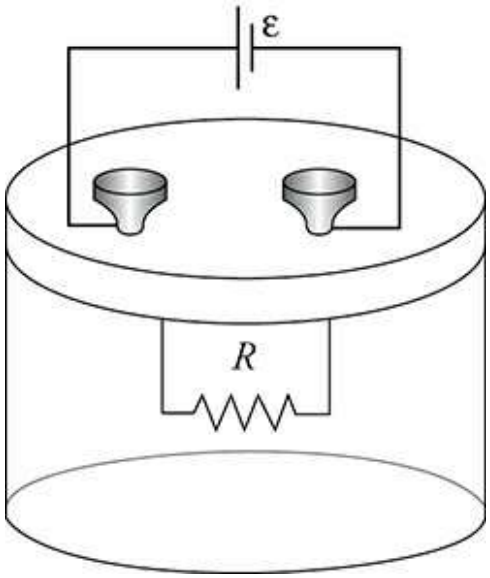
(B) Net heat flows from cylinder B to cylinder A, because heat flows from higher kinetic energy atoms to lower kinetic energy atoms.

(C) There is no net heat transfer between the two cylinders, because both gases have the same average atomic kinetic energy.

(D) There is no net heat transfer between the two cylinders, because heat conduction requires the movement of atoms between the cylinder, and the cylinders are sealed.



34. A resistor of resistance (R) is sealed in a closed container with n moles of gas inside. A battery of emf (ε) is connected to the resistor. Which of the following graphs shows the correct relationship between the gas atoms' average velocity (v_{avg}) and electrical energy (E) supplied to the resistor?

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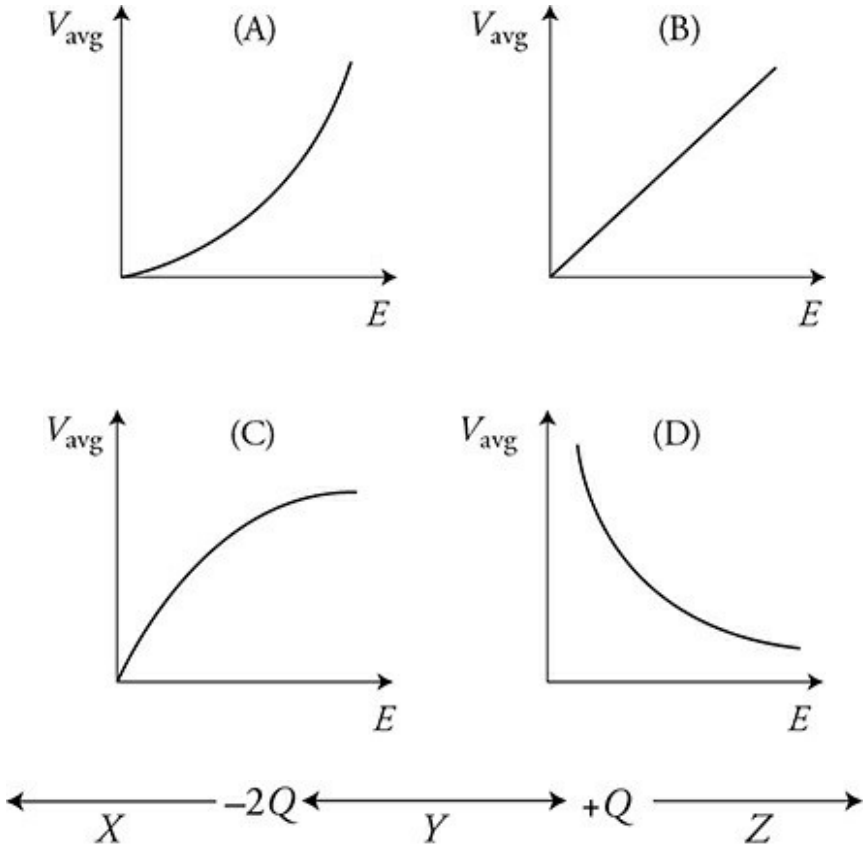

35. Two charges ($-2Q$ and $+Q$) are located as shown in the figure. Three regions are designated in the figure: X is to the left of $-2Q$; Y is between the two charges; and Z is to the right of $+Q$. Which of the following correctly ranks the magnitude of electric field in the three regions?

(A) $E_X > E_Y > E_Z$

(B) $E_Y > E_X > E_Z$

(C) $E_Y > E_X = E_Z$

(D) It is not possible to rank the magnitudes of the electric fields without more information.

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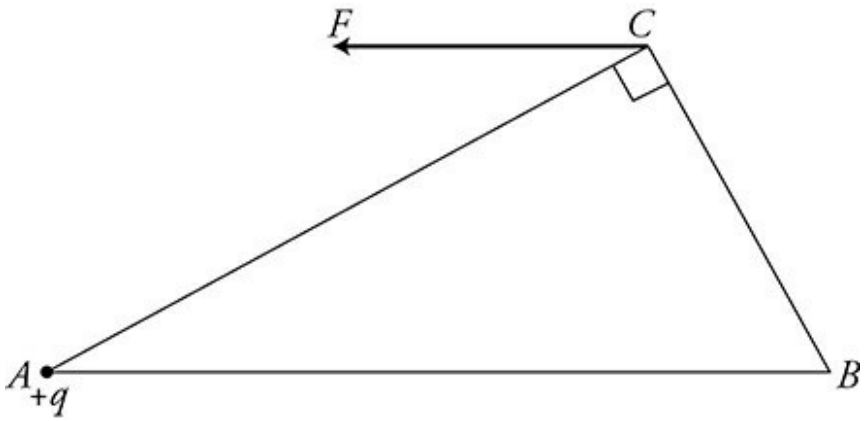


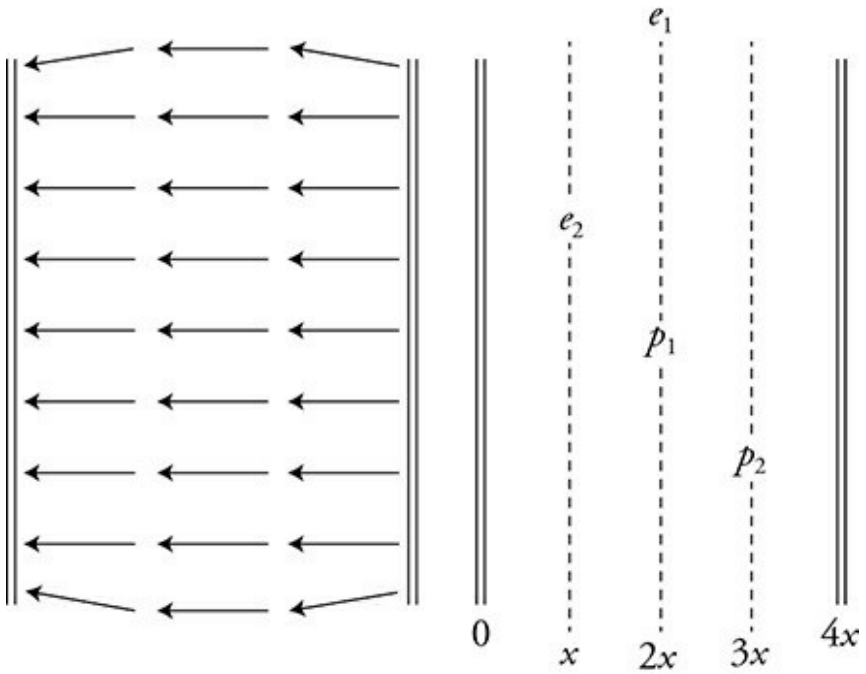
36. A positive charge ($+q$) is placed at vertex A of a triangle, as shown in the diagram. What charge must be placed at vertex B to cause an electron placed at vertex C to receive a force as shown?

(A) Positive and smaller than $|+q|$

(B) Positive and larger than $|+q|$

(C) Negative and smaller than $|+q|$

(D) Negative and larger than $|+q|$



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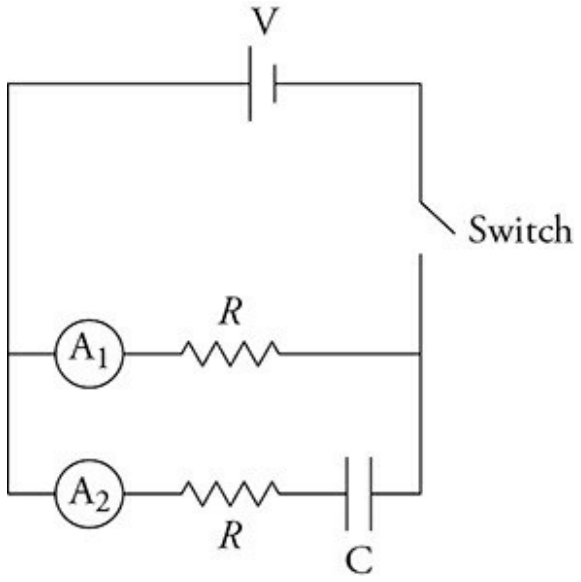
37. The left figure shows a capacitor with a horizontal electric field. The distance between the plates is $4x$. The right figure shows two electrons, e_1 and e_2, and two protons, p_1 and p_2, which are placed between the plates at the locations shown. Which of the following is a correct statement about the forces on the charges?

(A) The forces on e_1 and e_2 are not the same in magnitude but are the same in direction.
(B) All four particles receive the same magnitude of force but not all in the same direction.
(C) The force on p_1 is the largest in magnitude because it is in the middle of the capacitor where the electric field is strongest.
(D) The forces on e_2 and p_2 are the largest in magnitude because they are closer to the charged plates.



38. The circuit shown in the figure has two resistors, an uncharged capacitor, a battery, two ammeters, and a switch initially in the open position. What will happen to the current measured in the ammeters from the instant the switch is closed to a long time after the switch is closed?

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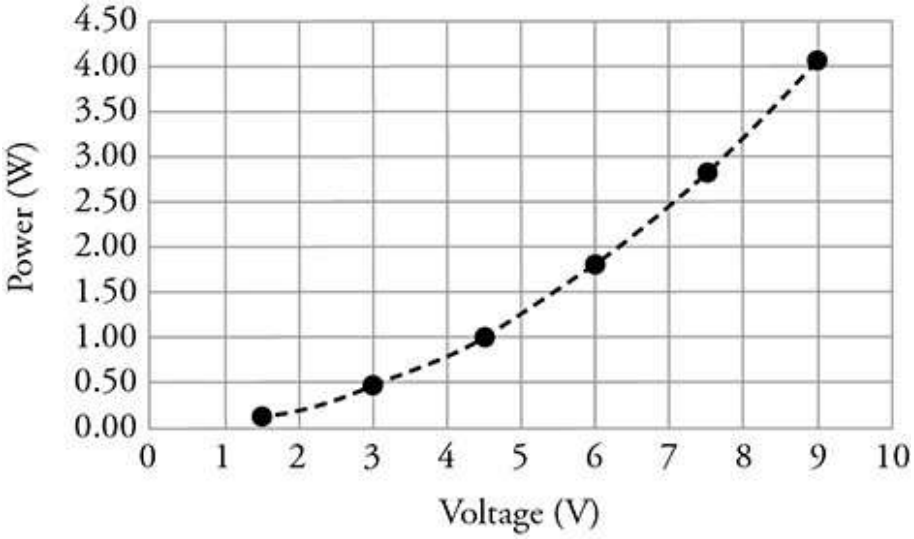
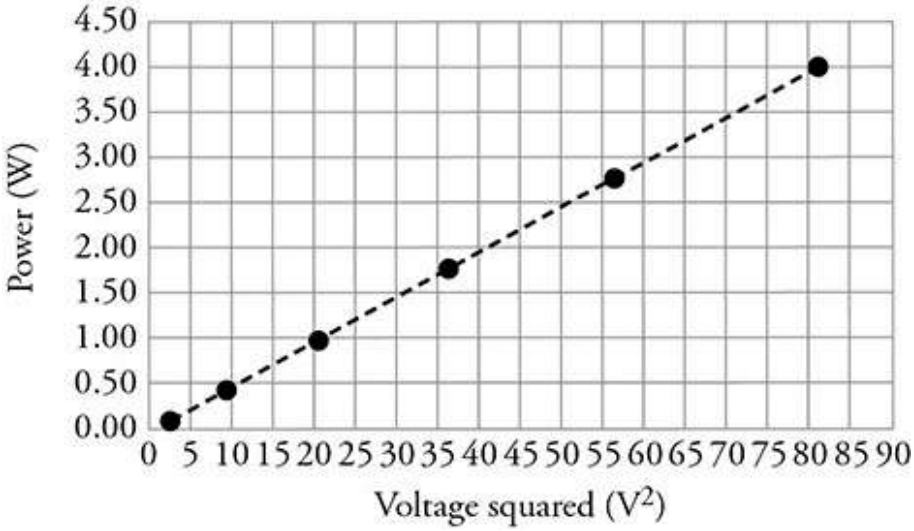
	Ammeter 1	Ammeter 2
(A)	Reading remains constant	Reading remains constant
(B)	Reading remains constant	Reading will change
(C)	Reading will change	Reading remains constant
(D)	Reading will change	Reading will change





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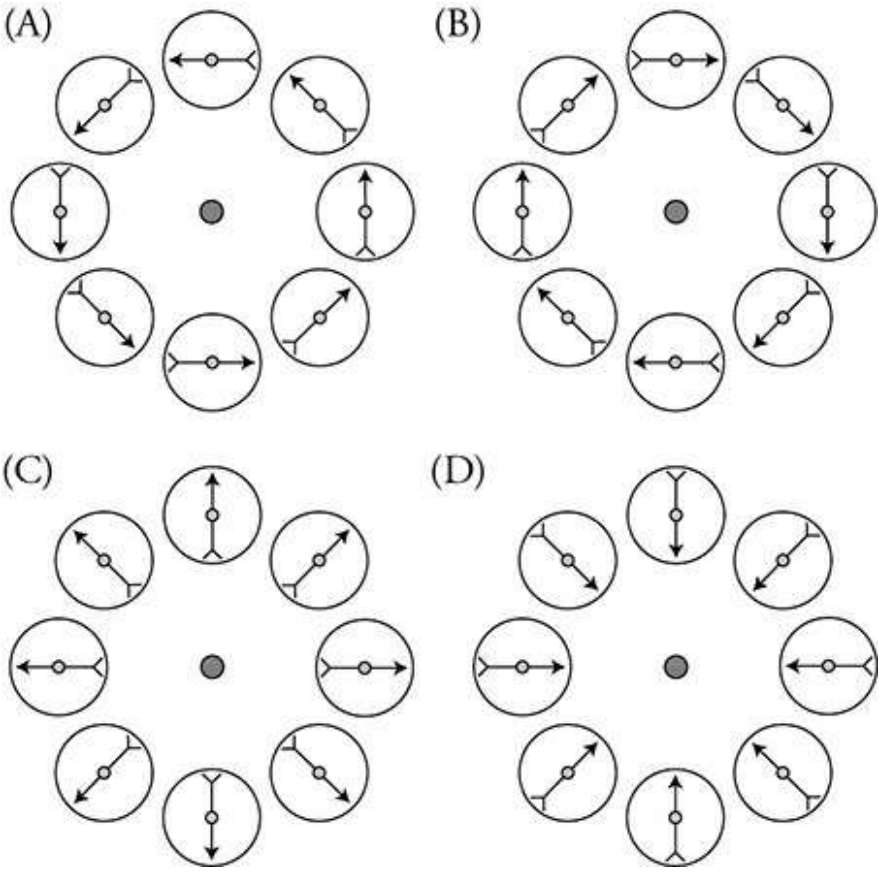
39. A single resistor is connected to a voltage source that consists of batteries with the same voltage connected in series. The power dissipated by the resistor for various voltages is shown in the two graphs. What is the resistance of the resistor?

(A) 0.05 Ω
(B) 0.22 Ω
(C) 4.5 Ω
(D) 20 Ω

40. Compasses are arranged in a tight circle around a long wire that is perpendicular to the plane of the compasses. The wire is represented in the figures by a dot. The wire carries a large current directly into the page. Which of the following best depicts the orientation of the compass needles?



41. A mirror produces an upright image one-half the height of the object when the object is 12 cm from the mirror's surface. What is the focal

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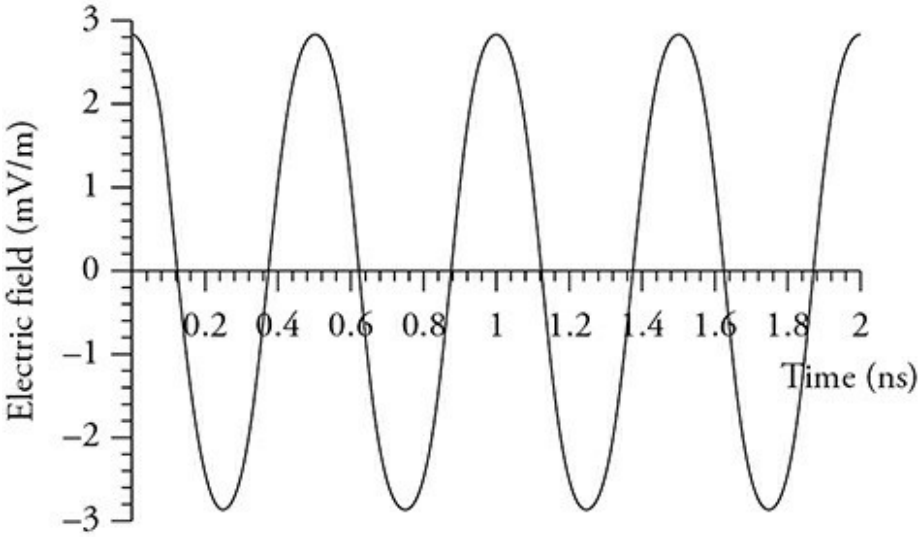
length of the mirror?

(A) –12 cm
(B) –4 cm
(C) 4 cm
(D) 6 cm



42. Which of the following best represents the electric field (E) measured in mV/m as a function of time measured in nanoseconds (ns)?

(A) $E = 6\cos(25.1t)$
(B) $E = 6\cos(12.6t)$
(C) $E = 3\cos(12.6t)$
(D) $E = 3\cos(25.1t)$

43. A light ray with a wavelength of λ_w and a frequency of f_w in water (n = 1.33) is incident on glass (n = 1.61). In the glass, the wavelength and frequency of the light is λ_g and f_g. How do the values of wavelength and frequency of the ray of light in water compare to those in glass?

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	Wavelength	Frequency
(A)	$\lambda_w > \lambda_g$	$f_w = f_g$
(B)	$\lambda_w > \lambda_g$	$f_w > f_g$
(C)	$\lambda_w < \lambda_g$	$f_w = f_g$
(D)	$\lambda_w < \lambda_g$	$f_w < f_g$

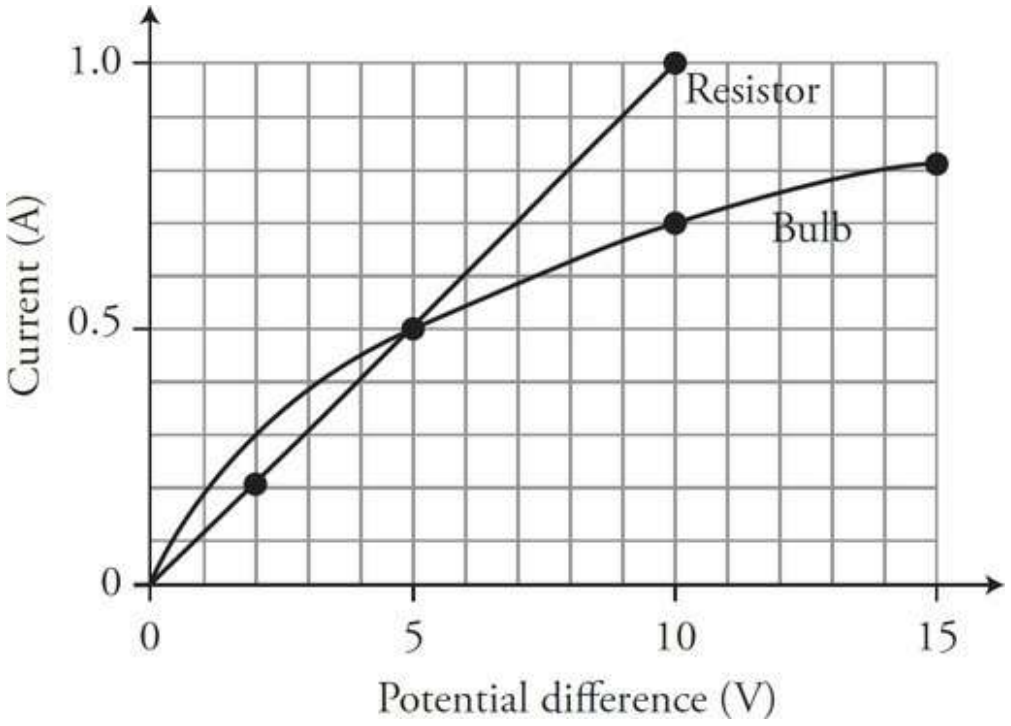
44. Which of the following explains why the nucleus of a stable atom is bound together?

(A) The gravitational force between the neutrons and protons is greater than the repulsive electric force between the protons.

(B) The neutrons polarize and create an attractive electric force that cancels the repulsive electrostatic force of the protons.

(C) The orbit of electrons creates a magnetic force on the protons that is greater than the repulsive electric force.

(D) The strong force between nucleons is greater than the repulsive electric force of the protons.



45. The figure shows current as a function of electric potential difference for a resistor and bulb. Are the devices ohmic?

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	Resistor	Bulb
(A)	Ohmic	Ohmic
(B)	Ohmic	Non-ohmic
(C)	Non-ohmic	Ohmic
(D)	Non-ohmic	Non-ohmic

Questions 46–50: Multiple-Correct Items

Directions: Identify exactly two of the four answer choices as correct, and mark the answers with a pencil on the answer sheet. No partial credit is awarded; both of the correct choices, and none of the incorrect choices, must be marked to receive credit.

46. Four identical capacitors with a plate area of A, a distance between the plates of d, and a dielectric constant k are connected to a battery, a resistor, and a switch in series. The switch is closed for a long time. The total energy stored in the set of four capacitors is U. The four capacitors in series are to be replaced with a single capacitor that will store the same energy as the four-capacitor set. Which capacitor geometry will accomplish this? **(Select two answers.)**

	Dielectric constant	Plate area	Distance between plates
(A)	2κ	$2A$	d
(B)	κ	$2A$	$2d$
(C)	$\frac{1}{2}\kappa$	$\frac{1}{2}A$	d
(D)	κ	A	$4d$

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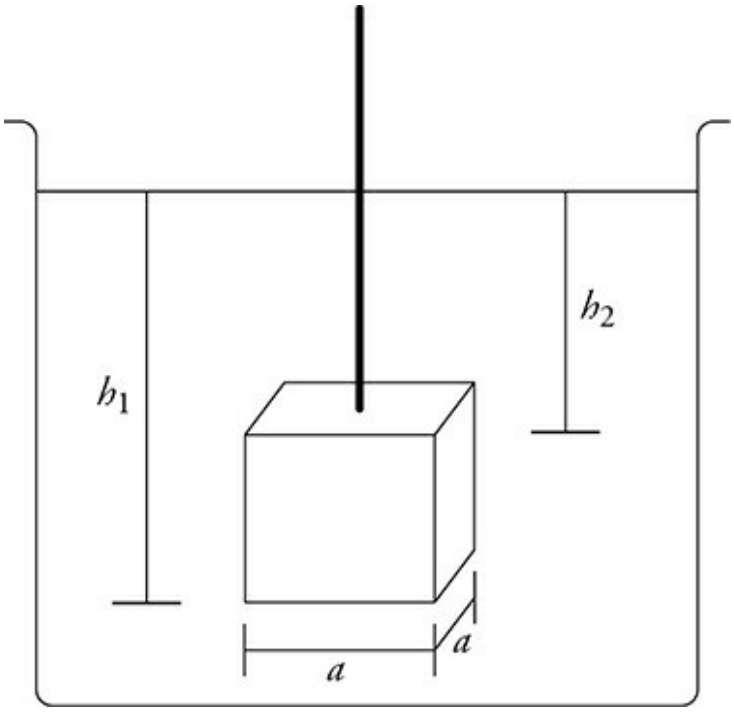

47. A mass (m) is suspended in a fluid of density (ρ) by a thin string, as shown in the figure. The tension in the string is T. Which of the following is an appropriate equation for the buoyancy force? **(Select two answers.)**

(A) $F_b = mg$
(B) $F_b = mg - T$
(C) $F_b = a^2 \rho g h_1$
(D) $F_b = a^2 \rho g (h_1 - h_2)$

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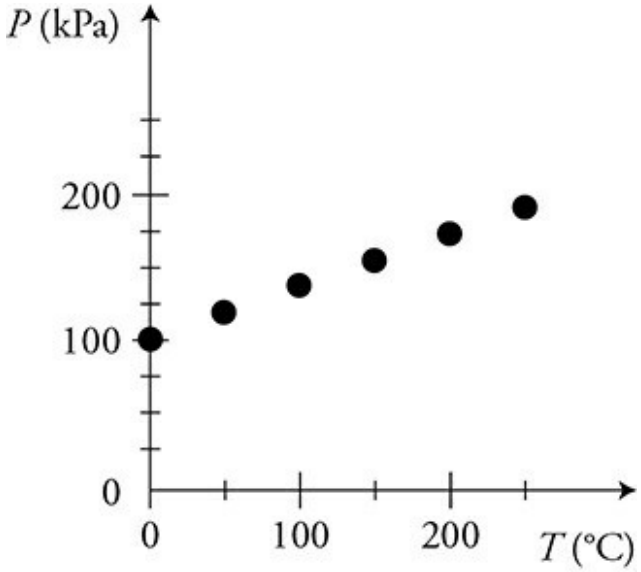
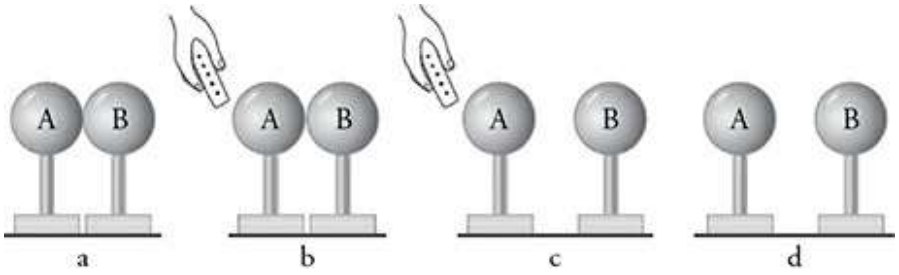


48. In an experiment, a sealed container with a volume of 100 ml is filled with hydrogen gas. The container is heated to a variety of temperatures, and the pressure is measured. The data from the experiment is plotted in the figure. Which of the following methods can be used to determine additional information regarding the gas? **(Select two answers.)**

(A) The slope can be used to calculate the number of atoms in the gas.
(B) The area under the graph can be used to calculate the work done by the gas.
(C) The vertical axis can be used to calculate the force the gas exerts on the container.
(D) The x-intercept can be used to estimate the value of absolute zero.



49. Two neutral metal spheres on insulating stands are placed so they touch, as shown in figure a. A positive rod is brought close to sphere A, as shown in figure b. Sphere B is moved to the right, as shown in figure c.

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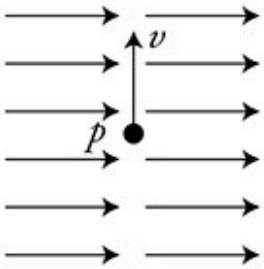
The positive rod is then removed, as shown in figure d. Which of the following correctly describes the situation after the rod is removed? **(Select two answers.)**

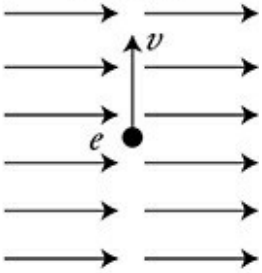
(A) The net charge of the system that includes both spheres remains neutral.
(B) The net charge of sphere B is negative.
(C) Spheres A and B attract each other.
(D) The electric field between the spheres points to the right.

50. In each of the answer choices below, either a proton or an electron is moving toward the top of the page through either an electric or a magnetic field. In which case does the charged particle experience a force to the right? **(Select two answers.)**

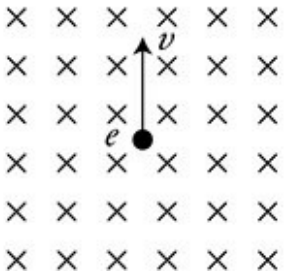
(A) *E*-field



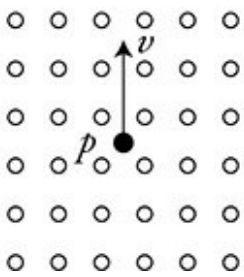
(B) *B*-field



(C) *E*-field



(D) *B*-field



AP Physics 2: Practice Exam 1

Section 2 (Free Response)

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Directions: The free-response section consists of four questions to be answered in 90 minutes. Questions 1 and 4 are longer free-response questions that require about 25 minutes each to answer and are worth 12 points each. Questions 2 and 3 are shorter free-response questions that should take about 20 minutes each to answer and are worth 10 points each. Show all your work to earn partial credit. On an actual exam, you will answer the questions in the space provided. For this practice exam, write your answers on a separate sheet of paper.

1. (12 points—suggested time 25 minutes)

An air bubble is formed at the bottom of a swimming pool and then released. The air bubble ascends toward the surface of the pool.

(A) In a clear, coherent, paragraph-length response, describe any changes in the bubble size and describe the motion of the bubble as it ascends to the surface. Explain the factors that affect the size of the bubble and the bubble's motion. Include a description of any forces acting on the bubble from the time it is at the bottom of the pool until the bubble is just below the surface of the pool.

(B) On the figure, draw a vector for each force acting on the bubble. Make sure all vectors are drawn in correct proportion to each other.

(C) The bubble does not collapse under the pressure of the water. Explain how the behavior of the gas atoms keeps the bubble from collapsing.

(D) The bubble begins at a depth of D below the surface of the water where the bubble has an initial volume of V_D. The atmospheric pressure at the surface of the pool is P_S. The density of the water in the pool is ρ. Assume that the air temperature in the bubble remains constant as it rises to the surface. Derive an expression for the volume (V_S) of the bubble when it reaches the surface of the pool.

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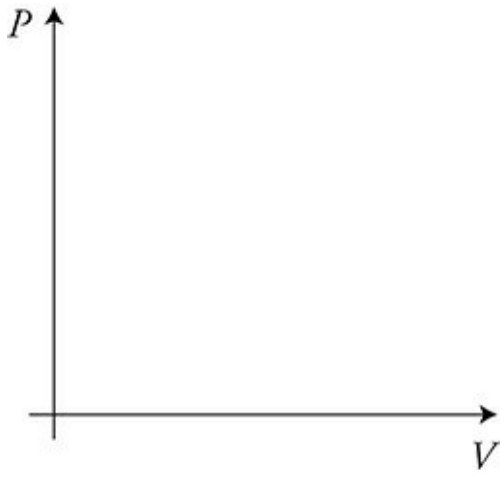

(E) In part (D) it was assumed that the temperature of the bubble remains constant. Now assume that the air temperature in the bubble can change but that the bubble rises so quickly to the surface that there is negligible thermal energy transfer between the bubble and the swimming pool water. Base your answers on this assumption.

i. Sketch the process on the PV diagram. Indicate on the axis the initial and final pressures and volumes.

ii. How does the value $P_S V_S$ compare to the value $P_D V_D$?

__Greater than $P_D V_D$ __Equal to $P_D V_D$ __Less than $P_D V_D$

Justify your answer.

2. (10 points—suggested time 20 minutes)

Some students are investigating how the geometry of the cylindrical shaft of graphite in a wooden pencil influences the resistance of the graphite. The students use a 9 V battery as an emf source. In the first part of the investigation, the students choose to investigate the influence of length on the resistance of the graphite conductive pathway.

(A) i. Besides the graphite and battery, what additional equipment would you need to gather the data needed to determine the influence of length on the resistance of the graphite conductive pathway?

ii. Using standard symbols for circuit elements, draw a schematic diagram of the circuit the students could use to determine the

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influence of length on the resistance of the conductive pathway. Include the appropriate locations and electrical connection of all equipment including any measuring devices. Clearly label your diagram.

iii. Describe the procedure you would use with your circuit to gather enough data to determine the influence of length on the resistance of the conductive pathway. Make sure your procedure is detailed enough that another student could perform the experiment.

iv. The 9 V battery used in the experiment has a sizable internal resistance. Would you need to change your procedure in part iii? Justify your answer.

Next the students investigate how the geometry of Play-Doh influences the resistance of cylindrical lengths of Play-Doh used as a conductive pathway. The investigation results in the data in the table.

Trial	Diameter (m)	Length (m)	Current (A)	Voltage across Play-Doh (V)
1	0.002	0.1	0.003	9.0
2	0.002	0.2	0.001	9.0
3	0.002	0.3	0.001	9.0
4	0.002	0.4	0.001	9.0
5	0.002	0.5	0.001	9.0
6	0.003	0.1	0.006	9.0
7	0.003	0.2	0.003	9.0
8	0.003	0.3	0.002	9.0
9	0.004	0.1	0.011	9.0
10	0.004	0.2	0.006	9.0
11	0.006	0.1	0.025	8.9
12	0.008	0.1	0.045	8.9
13	0.010	0.1	0.069	8.8

(B) i. Which subset of data would be most useful in creating a graph to determine the relationship between the resistance and diameter of the Play-Doh? If the data chosen are incomplete, fill in the needed data in the extra columns provided in the table.

ii. Plot the subset of data you chose on the axis, being sure to label the axis. Draw a line or curve that best represents the relationship

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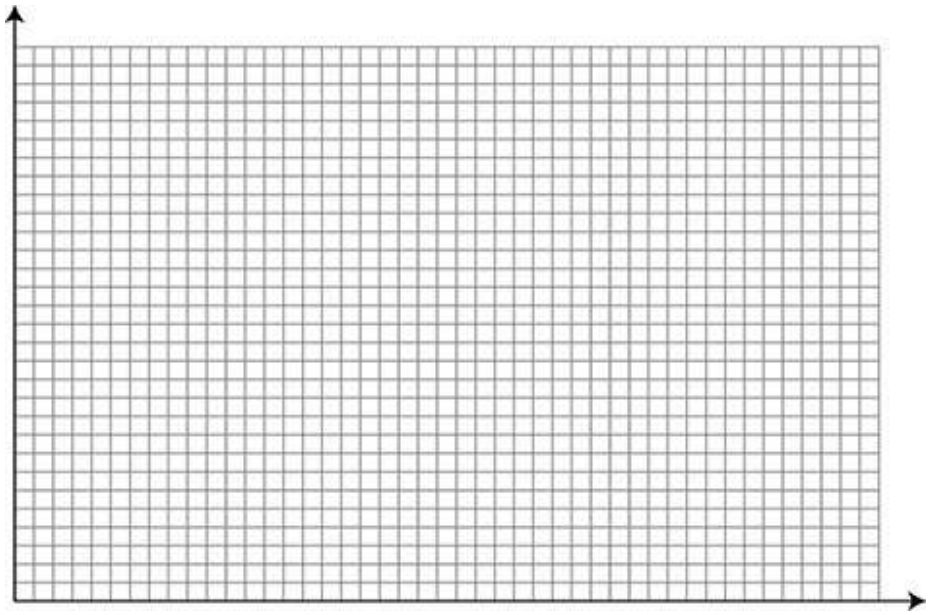
between the variables.



iii. What can you conclude from your line or curve about the relationship between the resistance and diameter of the conductive pathway?

iv. How can you prove that the relationship you suspect between resistance and diameter is correct?

v. The students who produced this data set said, “It took a long time to measure these data, and the Play-Doh was noticeably drier by the end of the lab.” Will this influence the validity of the relationship you concluded in part iii?

Justify your answer.

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3. (10 points—suggested time 20 minutes)

A gas with a ground state of –8.0 eV is illuminated by a broad ultraviolet spectrum of light and is found to absorb 248 nm of light. When the ultraviolet light is turned off, the gas sample emits three different

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wavelengths of light: 248 nm, 400 nm, and 650 nm.

(A) On the axis provided, construct and label an energy level diagram that displays the process of both the absorption and emissions by the gas. Show your supporting calculations below.

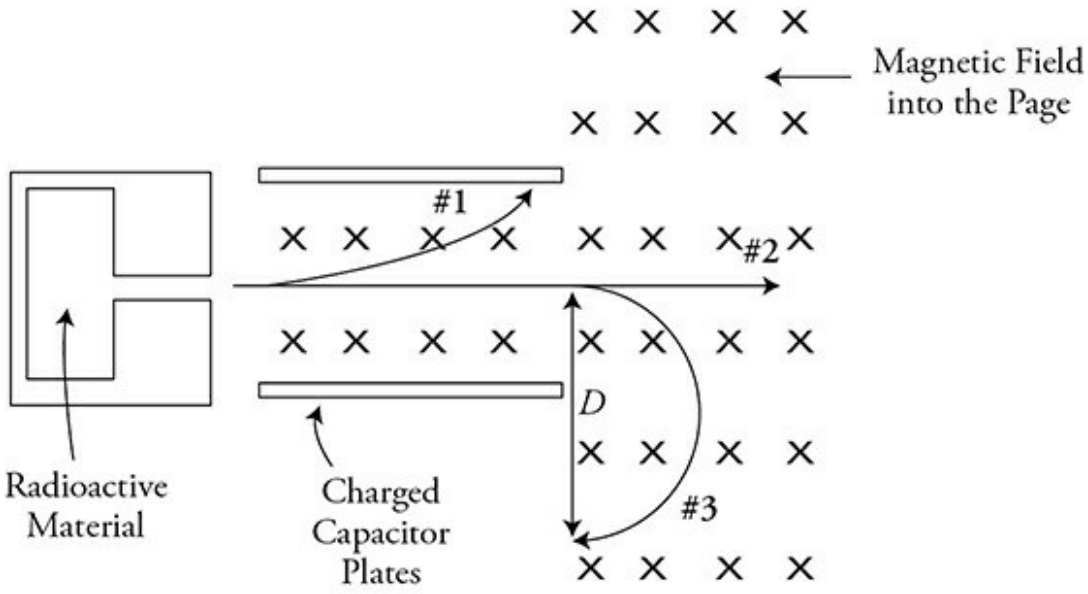
(B) The light emitted by the gas is directed toward a sample of tin. It is found that the 248-nm emission from the gas causes electrons to be ejected from the tin, but that the 400-nm emission does not. Will the 650-nm emission eject electrons from the tin? If so, explain how it could be accomplished. If not, explain why it is not possible.

(C) The light from the gas is now directed at a sample of potassium that subsequently ejects electrons with a maximum energy of 2.71 eV.

i. Calculate the de Broglie wavelength of the maximum energy electrons.

ii. These electrons are directed at two small openings spaced 2 nm apart. Will this result in the formation of an interference pattern? Justify your answer using appropriate physics principles.

4. (12 points—suggested time 25 minutes)



A sample of radioactive sources is enclosed within a lead-shielded container with a narrow exit aperture that ensures that any ejected

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particles will exit the container directly to the right. The ejected particles pass between charged parallel conductive plates and a region of magnetic field that is directed into the page. Three particles exit the container and follow paths as shown in the figure. Students observing the particles make these statements:

Student A: Both particles 2 and 3 pass through the capacitor region undeflected so there is no net force on them. They both must be neutral particles.

Student B: The path of particle 3 implies it has a negative charge. Therefore, the bottom plate of the capacitor must be negatively charged.

Student C: Particle 1 is positive because it curves upward.

(A) List all parts of the students' statements that are correct. Explain your reasoning for each.

(B) List all parts of the students' statements that are incorrect. Explain your reasoning for each.

(C) On the figure, sketch the electric field vectors between the capacitor plates that are consistent with the motion of the particles.

(D) Particle 3 is detected at distance D from its exit point from the capacitor plates. Using this information, derive an expression for the charge to mass ratio (q/m) of particle 3 in terms of D, E (the electric field between the capacitor plates), and B (the magnetic field).

(E) Using the equation derived in (D), a charge to mass ratio (q/m) of 1.76×10^{11} C/kg was calculated. Explain how this number could be used to determine the set of possible masses of particle 3.

(F) One of the radioactive sources enclosed in the shielded container is fermium-257, which has 100 protons and a half-life of 100.5 days. Fermium transmutes into Californium (Cf) by emitting an alpha particle with a velocity of 2.0×10^7 m/s.

(i) Write the complete nuclear equation of this decay reaction.

(ii) Write, but do not solve, a symbolic expression that could be used to calculate the mass released to energy in one single fermium–257 decay.

(iii) Assuming the fermium–257 is isolated and stationary, calculate the velocity of the Californium nucleus after the alpha particle is

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ejected.

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