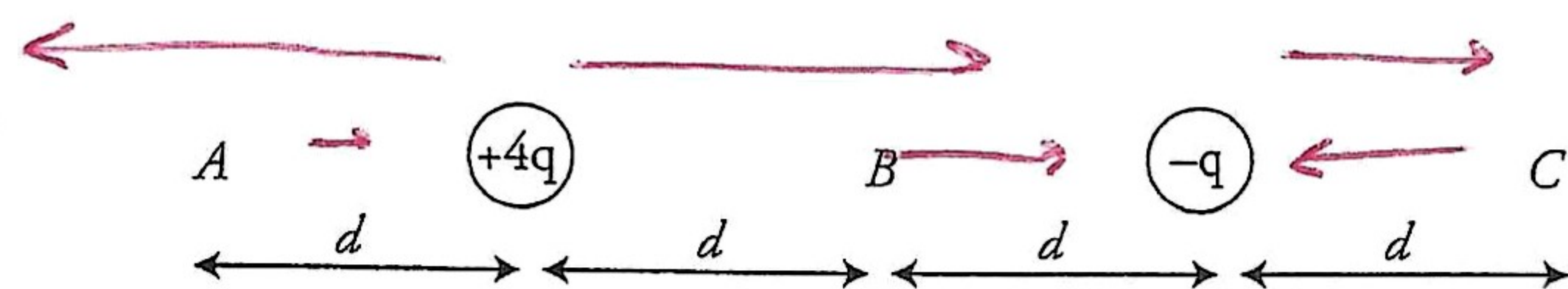


+ higher potential

25. In a region of space, there is an electric potential field with isolines as shown in the figure. Which of the following is the most accurate description of the electric field in the region?

- (A) An electric field is directed to the left with a uniform strength of 3 V/m.
- (B) An electric field is directed to the left with a uniform strength of 75 V/m.
- (C) An electric field is directed to the left that increases in strength from left to right with an average value of 75 V/m.
- (D) An electric field is directed to the right that increases in strength from right to left with an average value of -75 V/m.

$V = Ed$   
 $E = \frac{\Delta V}{d}$   
 $\frac{3V}{0.04m}$

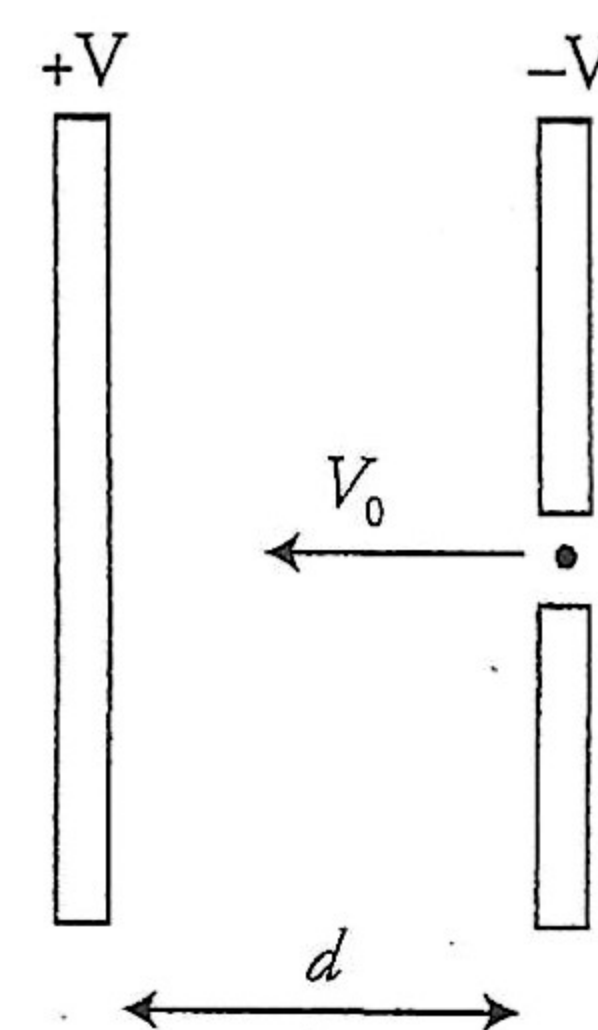


26. Which of the following correctly represents the relationship between the electric field strengths at locations A, B, and C?

- (A)  $E_A > E_B > E_C$
- (B)  $E_A = E_B > E_C$
- (C)  $E_B > E_A > E_C$
- (D)  $E_B > E_A = E_C$

B - add together  
 C - cancel  
 A - subtract

open:  $R_T = 3R$   
 $I = \frac{V}{3R} = \frac{1}{3}I$   
 closed: by pass  $R_2$   
 $R_T = 2R$   
 $I = \frac{V}{2R} = \frac{1}{2}I$

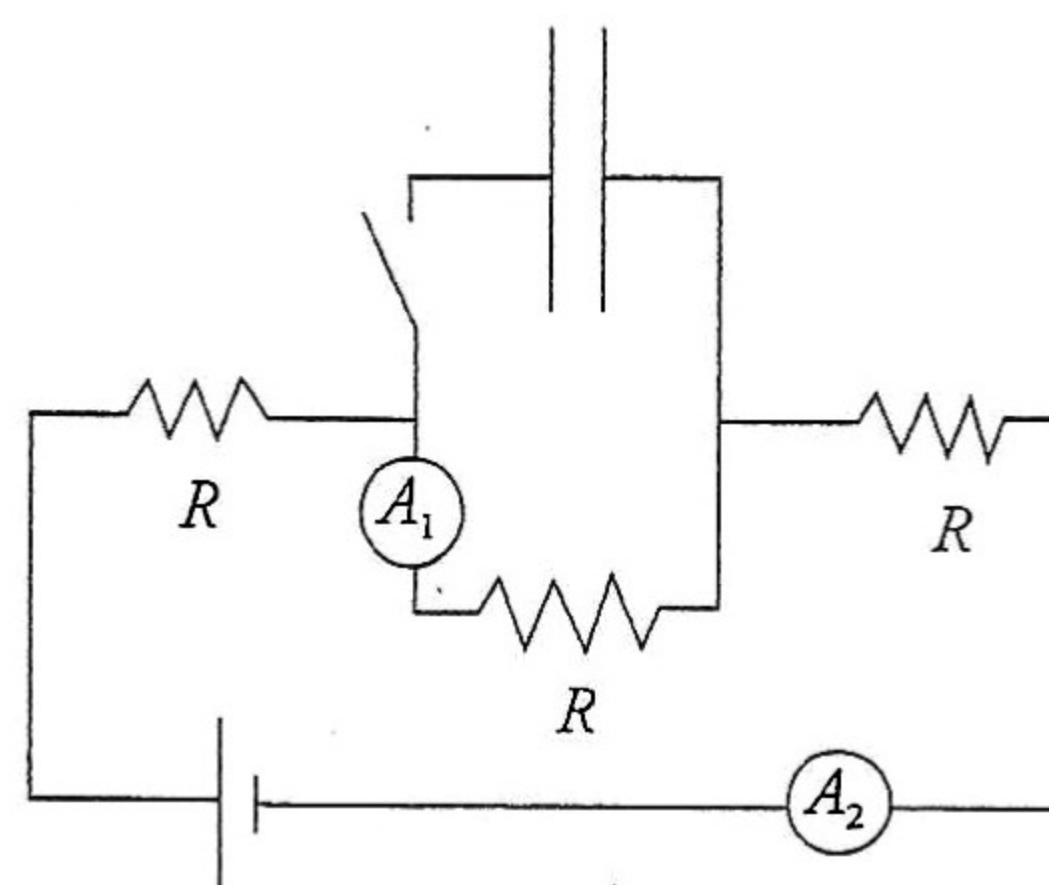


27. An electron of charge  $-e$  and mass  $m$  is launched with a velocity of  $v_0$  through a small hole in the right plate of a parallel plate capacitor toward the opposite plate a distance  $d$  away. The electric potential of both plates are equal in magnitude, but opposite in sign  $\pm V$  as shown in the figure. What is the kinetic energy of the electron as it reaches the left plate?

- (A)  $\frac{1}{2}mv_0 - 2Ve$
- (B)  $\frac{1}{2}mv_0$
- (C)  $\frac{1}{2}mv_0 + Ve$
- (D)  $\frac{1}{2}mv_0 + 2Ve$

$E_f = E_0$   
 $K = K + U_e$   
 ~~$K = \frac{1}{2}mv_0^2$~~   
 $K = \frac{1}{2}mv_0^2 + q\Delta V$   
 $= \frac{1}{2}mv_0^2 + e(2V)$

$\Delta V = +V - -V = 2V$



28. The circuit shown in the figure consists of three identical resistors, two ammeters, a battery, a capacitor, and a switch. The capacitor is initially uncharged and the switch is open.

What happens to the readings of the ammeters immediately after the switch is closed?

- |                   |               |
|-------------------|---------------|
| $A_1$             | $A_2$         |
| (A) decrease      | decrease      |
| (B) decrease      | stay the same |
| (C) decrease      | increase      |
| (D) stay the same | stay the same |

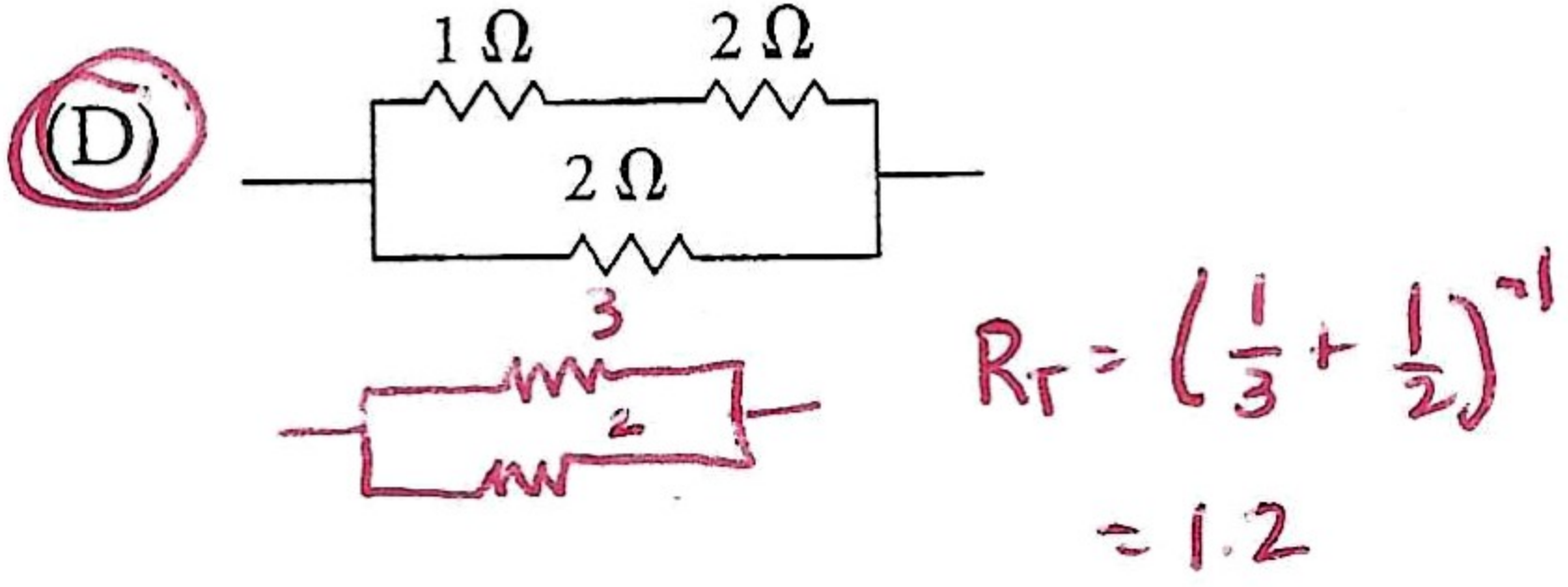
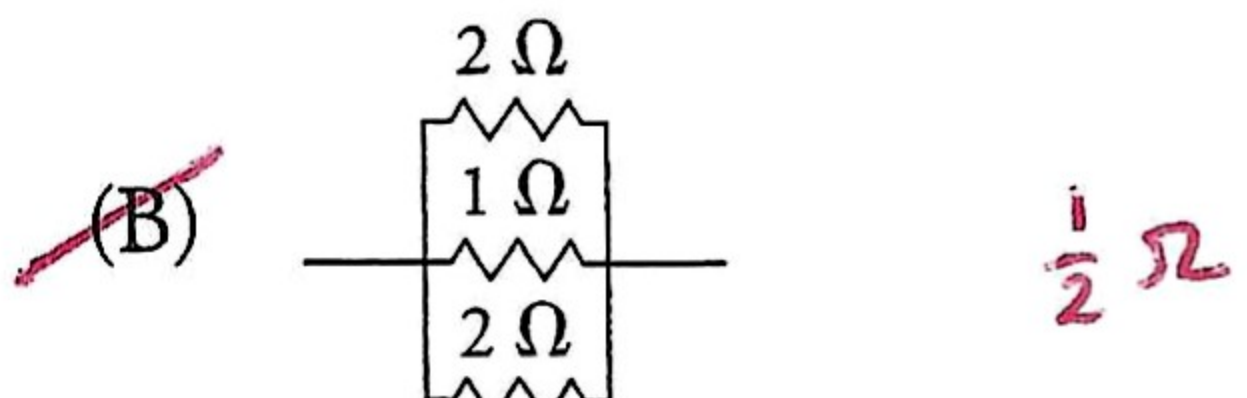
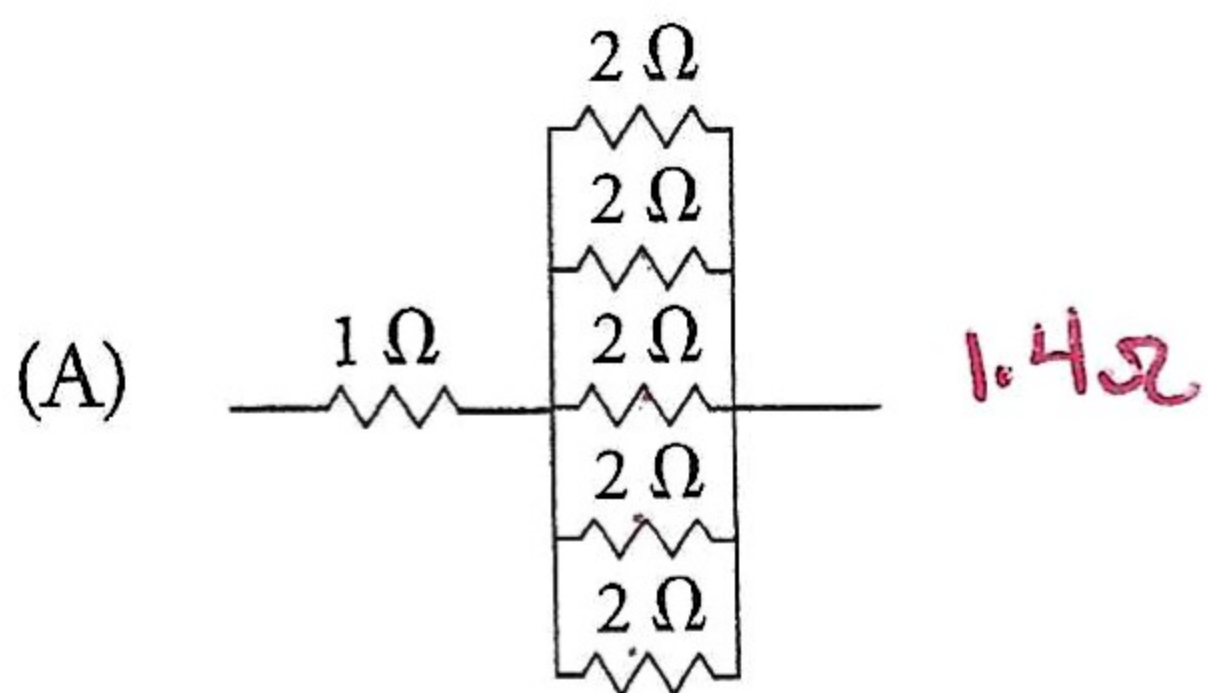
Number of Resistors Connected to the Battery	Power Delivered to the Resistors (W)
1	5.00
2	2.50
3	1.67
4	1.25
5	1.00

29. A student connects a single resistor to a 10-V battery and takes measurements to find the power delivered by the battery to the resistor. The student then adds another resistor to the circuit and measures the power delivered to both resistors. This process is repeated, adding one resistor at a time, until the battery is connected to five resistors. The data from the experiment is given. Which of the following can be concluded from the data?

- (A) The resistors are all identical and are connected in parallel.
- (B) The resistors are all identical and are connected in series.
- (C) The resistors are not identical, but they must be connected in series.
- (D) The resistors are nonohmic and how they are connected cannot be determined.

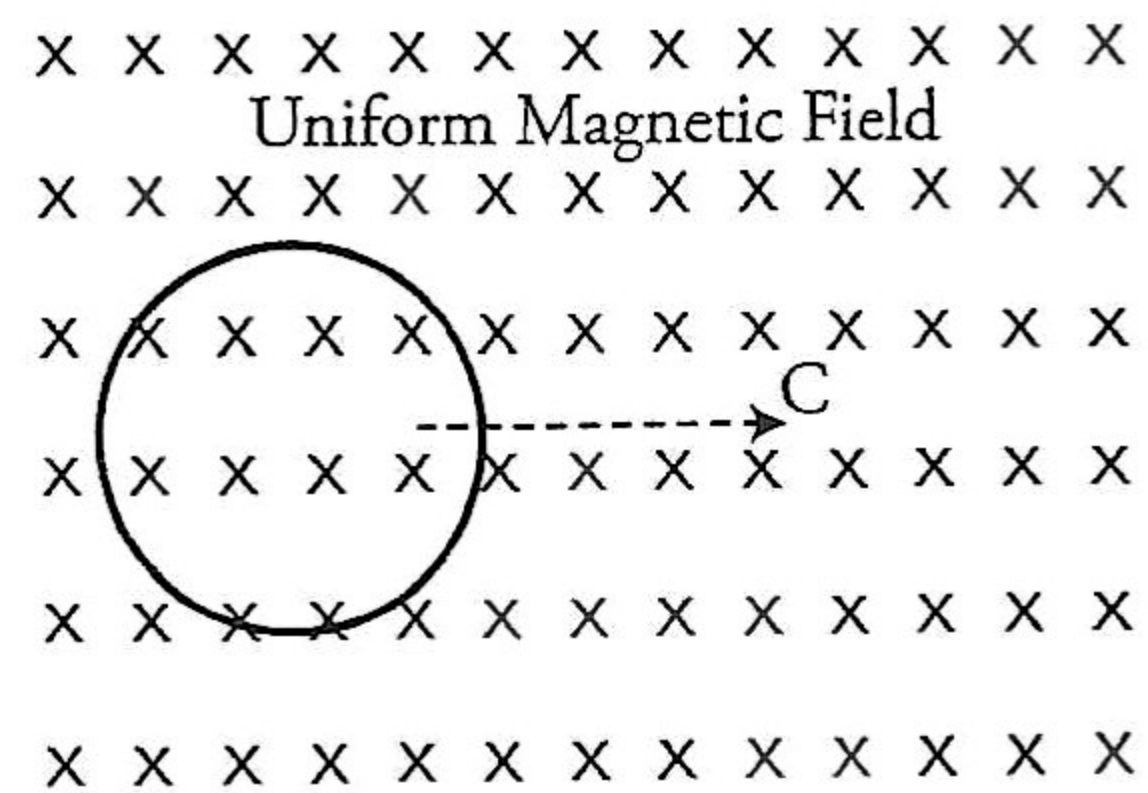
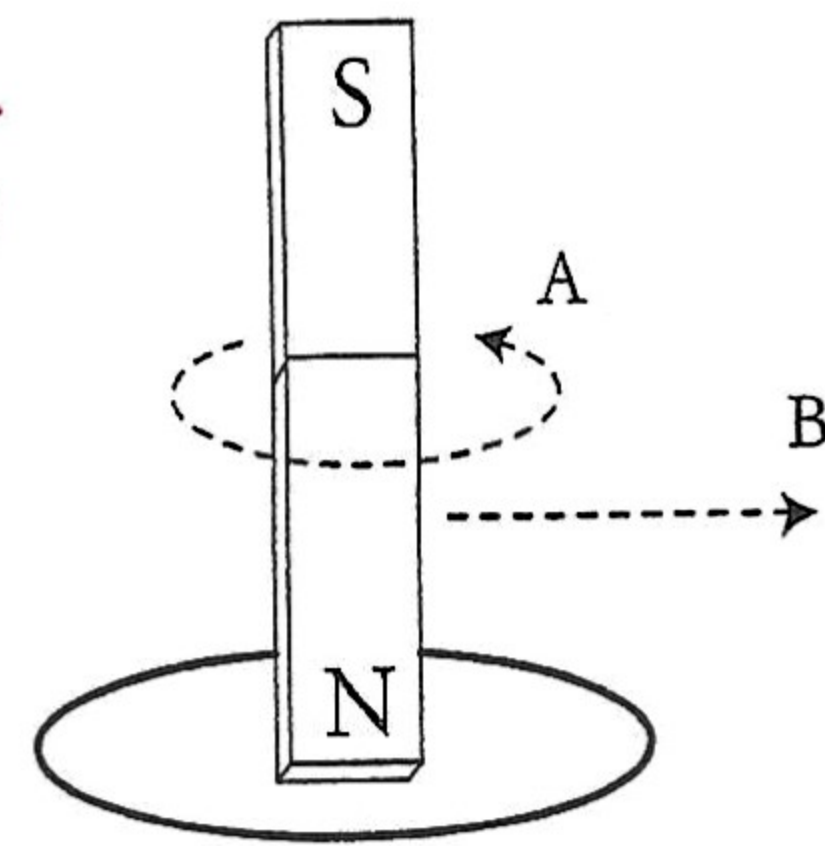
*Handwritten notes:*  
 $P = IV = IR = \frac{V^2}{R}$   
 $\uparrow R \downarrow P$   
 Series  
 $P = \frac{V^2}{R}$   
 $1R = \frac{V^2}{R} = \frac{(10)^2}{R} = 20$   
 $2R = \frac{V^2}{R} = \frac{(10)^2}{2.5} = 40$   
 $3R = \frac{V^2}{R} = \frac{(10)^2}{1.67} = 60$

30. An electronics manufacturer needs a 1.2-Ω resistor for a phone it is designing. The company has calculated that it is less expensive to build the 1.2-Ω resistor from cheaper 1-Ω and 2-Ω resistors than to purchase the 1.2-Ω resistor from a supplier. Which of the following resistor arrangements is equivalent to 1.2 Ω and is the most effective method to construct the 1.2-Ω resistor?

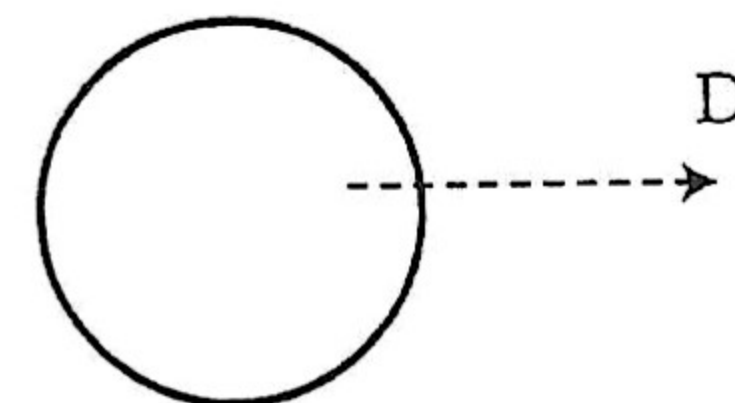


31. Which of the following shown in the figure will cause current flow in the wire loop?

*Handwritten note:* Change B or A



Long Current Carrying Wire



*Handwritten note:*  $\Phi = \Delta BA$

- (A) rotating a magnet along its vertical axis above a loop of wire as indicated with arrow A
- (B) moving a magnet from above a loop of wire to the right as indicated with arrow B
- (C) moving a loop of wire to the right in a uniform magnetic field as indicated by arrow C
- (D) moving a loop of wire to the right along a long current-carrying wire as indicated by arrow D

*Handwritten note:* decreases B

32. Under which of the following conditions would it be appropriate to neglect the gravitational force on a charge in a magnetic field?

- (A)  $G \ll \mu_0$
- (B)  $g \ll B$
- (C)  $mg \ll qvB$
- (D)  $v = 0$

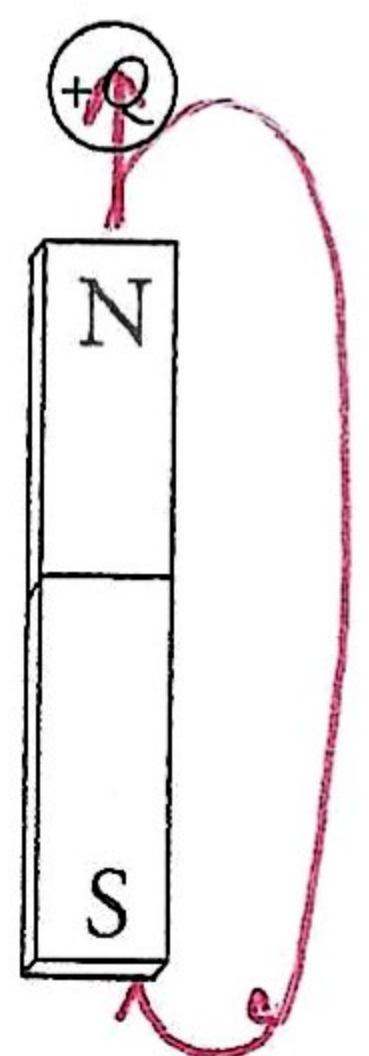
*Handwritten note:* when weight is much less than  $F_B$



33. A child playing with two magnets places them close together and holds them in place to keep them from moving, as shown in the figure. Magnet A has a larger magnetic field and a larger mass than magnet B. What will happen when the magnets are released and free to move?

- (A) Magnet A will not move, while magnet B will accelerate away because magnet B is smaller.
- (B) Magnet A will accelerate away more slowly than magnet B because magnet B exerts a smaller force on magnet A.
- (C) Magnet A will accelerate away more slowly than magnet B because magnet A has a larger mass.
- (D) Both magnets will accelerate away at the same rate because the force between them will be the same magnitude.

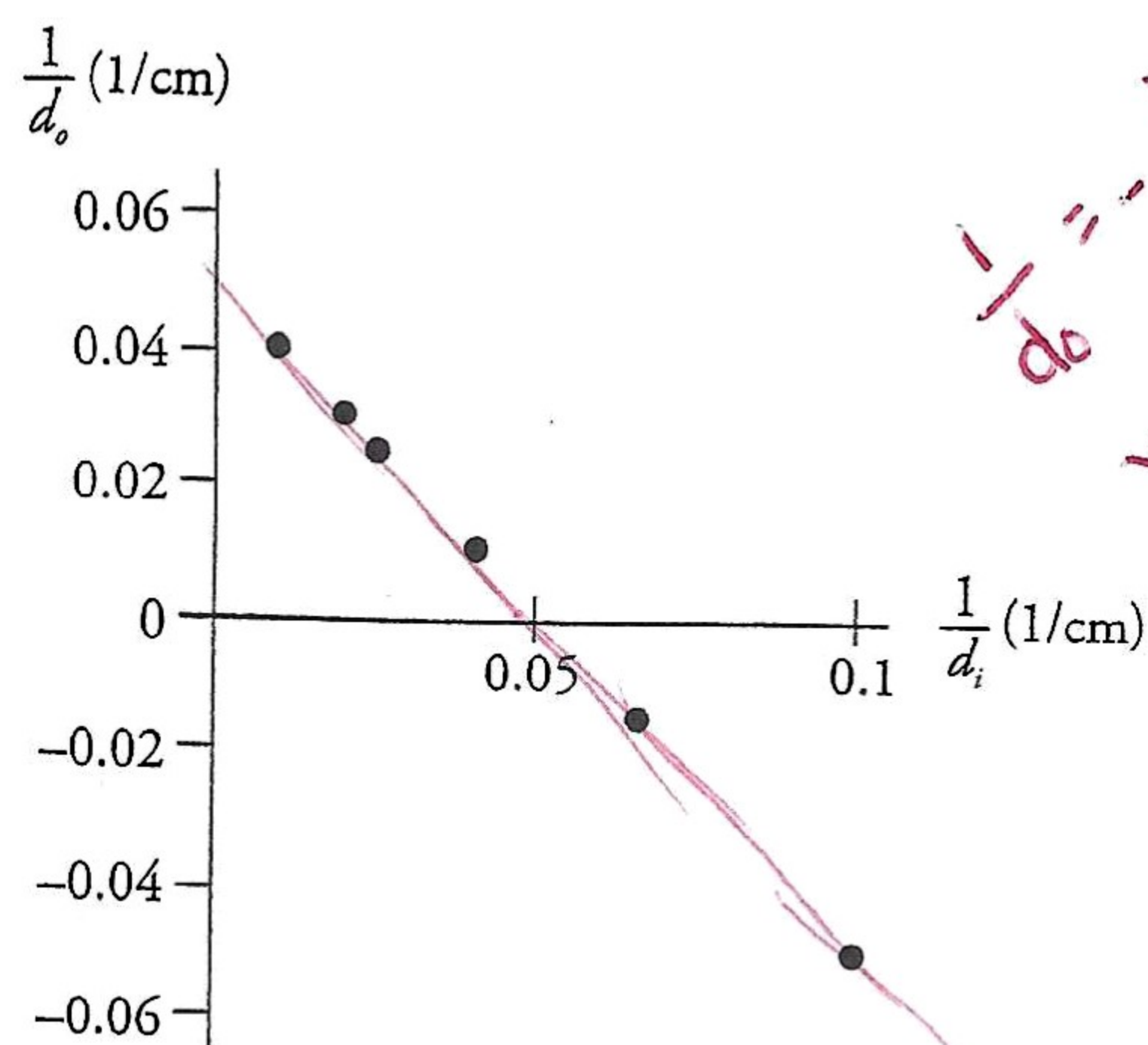
$a = \frac{F_{net}}{m}$



$\vec{v} \times \vec{B}$   
 $F$   
 right hand rule

34. A charge  $+Q$  is positioned close to a bar magnet as shown in the figure. If the charge is experiencing a force into the page, which way must the charge be moving?

- (A) to the right
- (B) to the left
- (C) toward the top of the page
- (D) out of the page

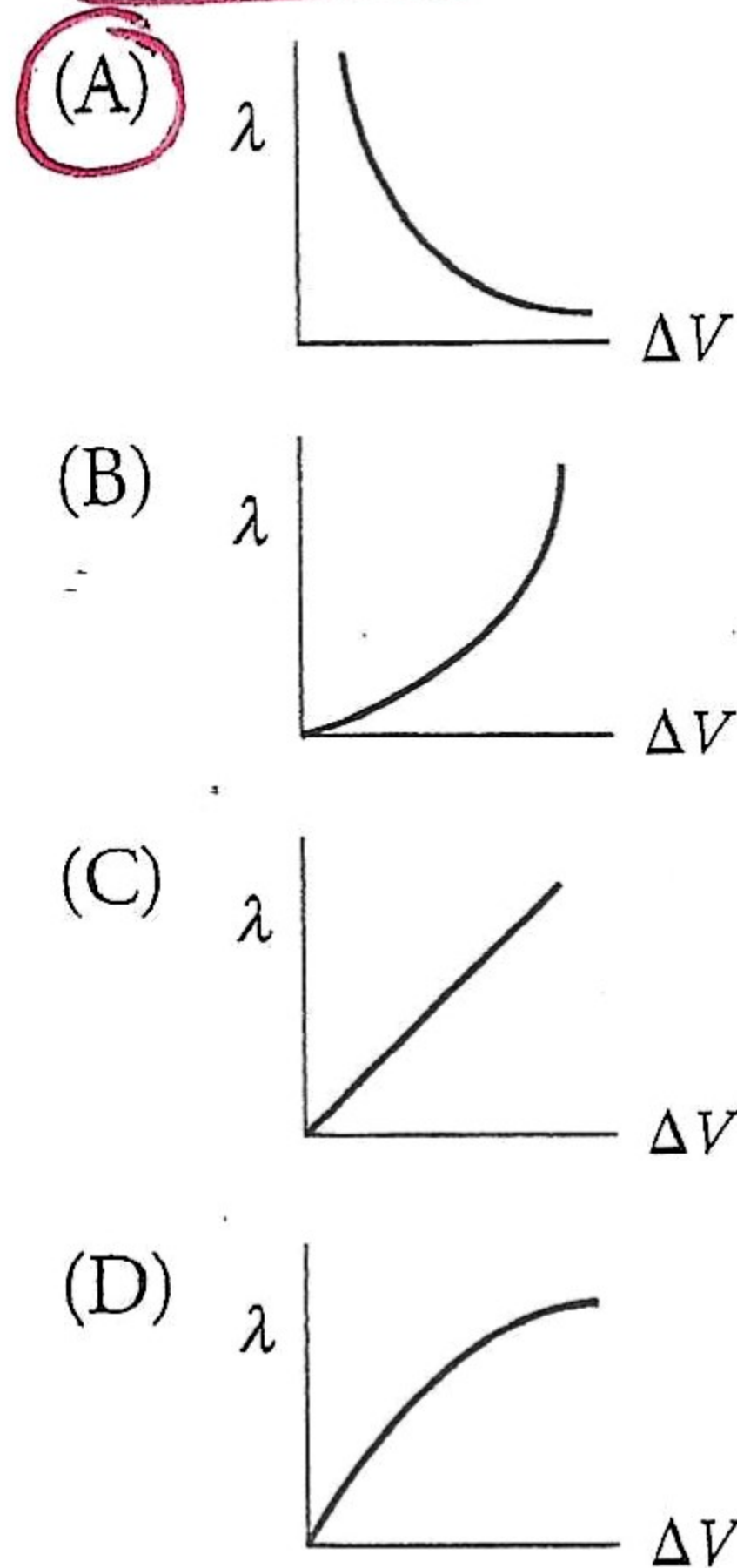


$\frac{1}{d_o} = -\frac{1}{d_i} + \frac{1}{f}$   
 $y = mx + b$   
 $b = \frac{1}{f}$   
 $f = \frac{1}{b}$

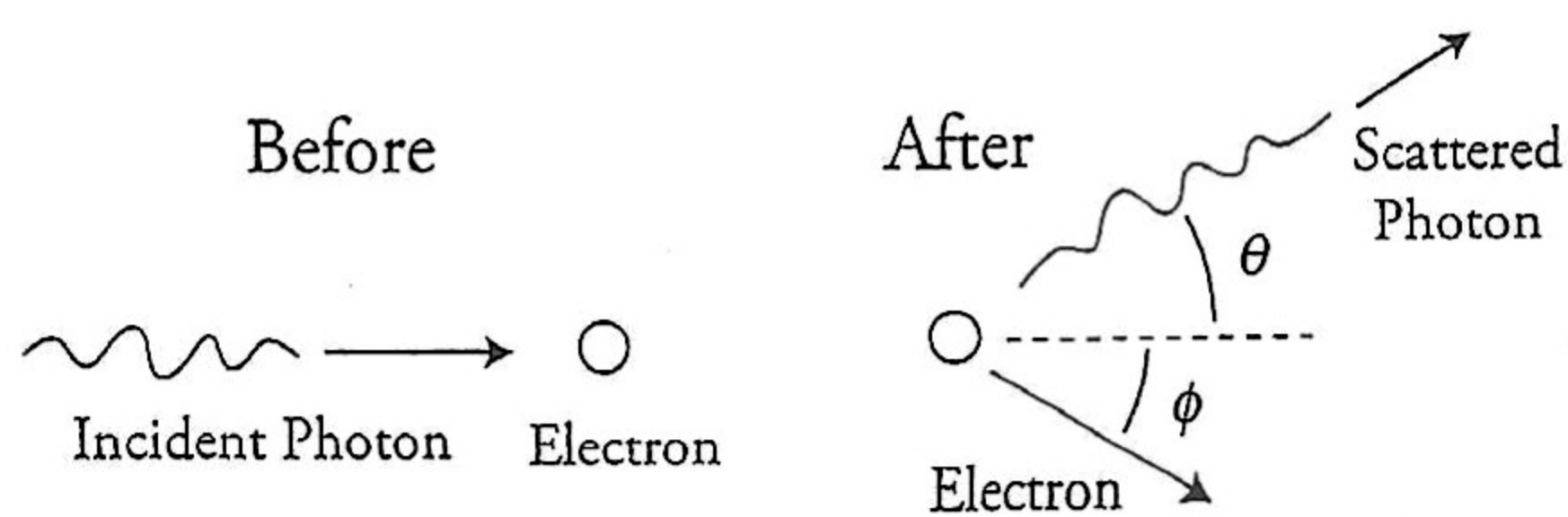
35. You were absent when your AP Physics 2 class performed a lens lab. When you return to school, the teacher says to get the data from a friend and complete the assignment of calculating the focal length of the lens used in the lab. Your friend hands you the graph shown in the figure where  $d_o$  and  $d_i$  are the object and image distances. Which of the following is equal to the focal length of the lens?

- (A) the  $y$ -intercept of the best-fit line
- (B) the inverse of the  $y$ -intercept of the best-fit line
- (C) the slope of the best-fit line
- (D) the inverse of the slope of the best-fit line

36. A scientist is using an electron microscope to study the structure of viruses ranging in size from 20 to 300 nm. The scientist must adjust the accelerating potential of the microscope to create an electron of the proper speed and wavelength to produce a detailed image of the virus. Which of the following graphs best depicts the relationship between accelerating voltage and the wavelength of the electrons?



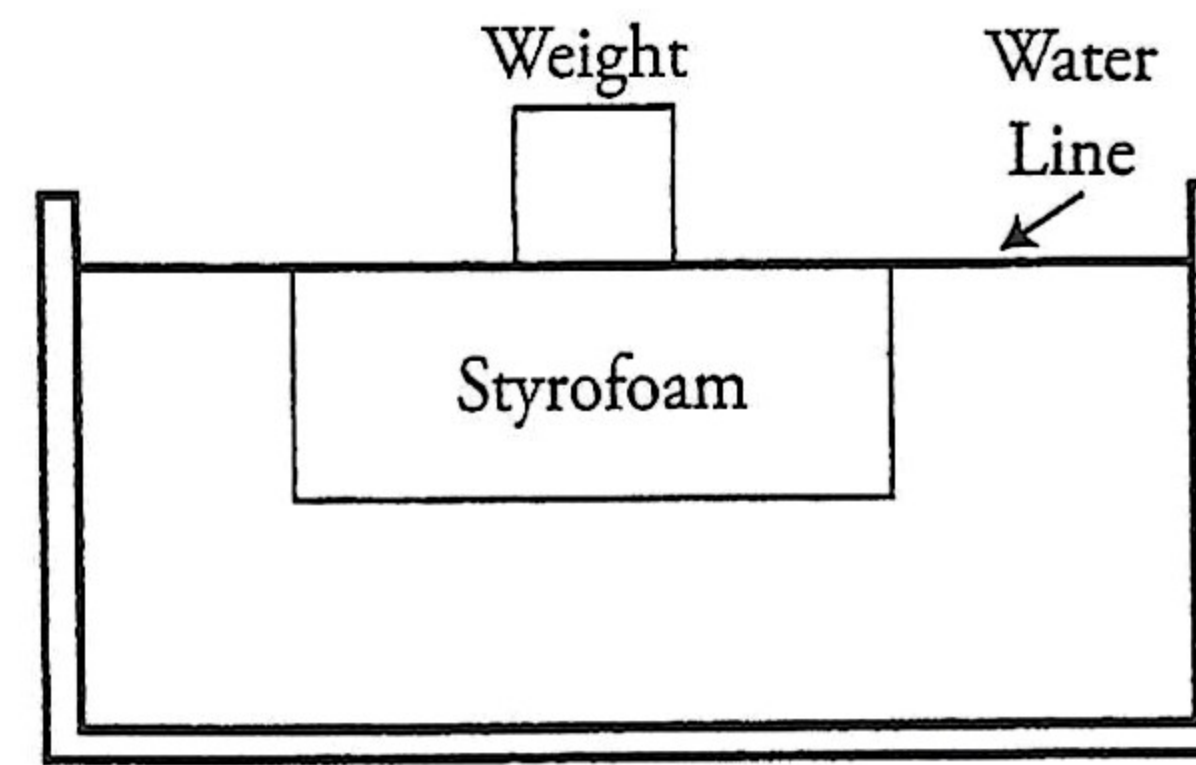
$\lambda = \frac{h}{p} = \frac{h}{mv}$   
 ↑ v ↓ λ  
 ↑ ΔV ↑ λ



37. A photon of wavelength λ collides with a stationary electron glancing off at an angle of θ, while the electron moves off with an angle of φ measured from the original path of the photon as shown in the figure. Which of the following statements correctly states the effect on the wavelength of the scattered photon and why?

$E = \frac{hc}{\lambda}$   
 ↓ E ↑ λ

- (A) The wavelength of the scattered photon decreases because the photon transfers energy to the electron in the interaction.
- (B) The wavelength of the scattered photon decreases because the photon transfers momentum to the electron in the interaction.
- (C) The wavelength of the scattered photon remains the same because the photon is acting as a particle during the collision.
- (D) The wavelength of the scattered photon increases because the photon transfers energy to the electron in the interaction.

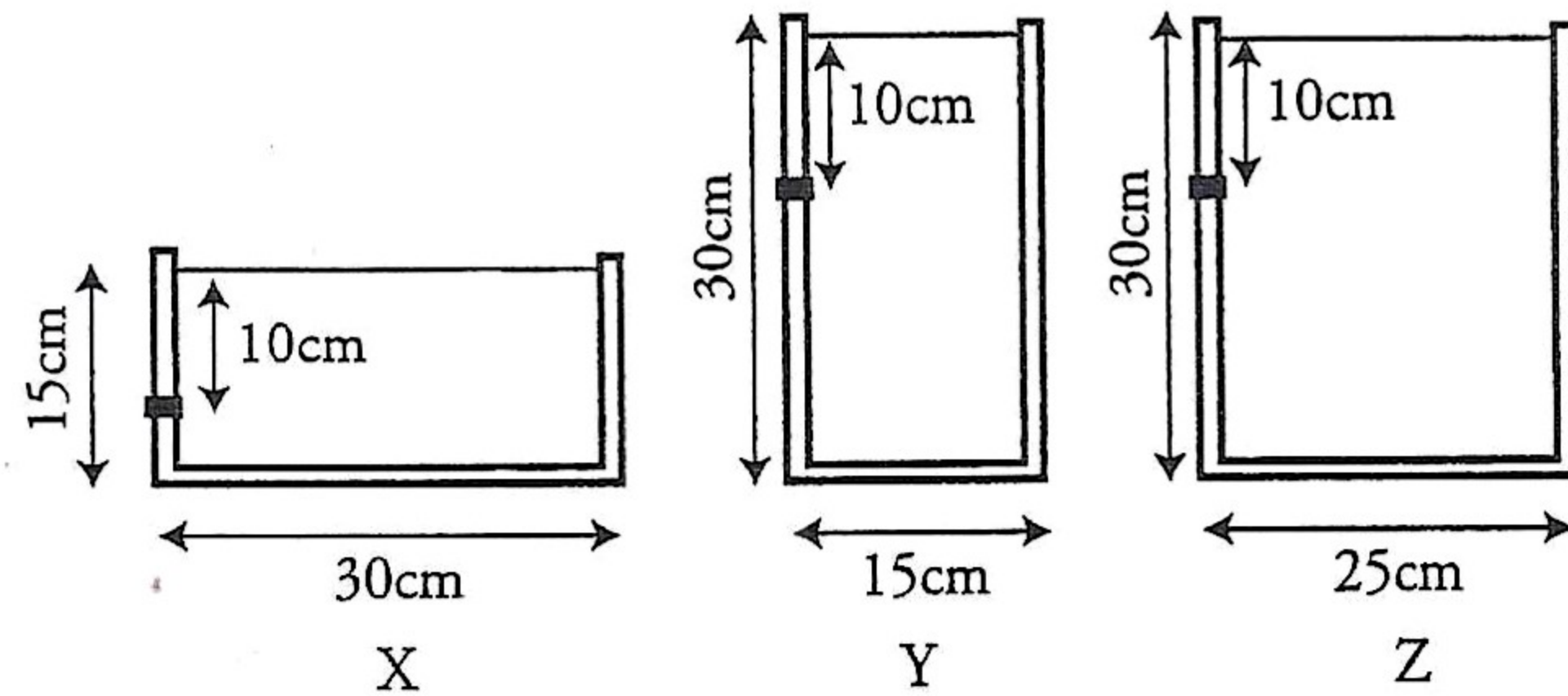


$F_B = \rho g V$

38. A mass is fixed to the top of a Styrofoam block that floats in a container of water. The mass is large enough to make the water line flush with the top of the Styrofoam as shown in the figure. What will happen if the Styrofoam is inverted so that the mass is now suspended under the block?

displace water equal to weight  
 block displaces some, so not all styrofoam needed

- (A) The whole contraption sinks.
- (B) The contraption floats with the waterline still flush with the top of the Styrofoam.
- (C) The contraption floats with the waterline below the top of the Styrofoam.
- (D) It is impossible to determine without knowing the density of the mass and Styrofoam.



39. Three beakers of different sizes are filled with water as shown. Each beaker has a rubber stopper of the identical size and shape fitted to a drain hole in the side. Which correctly ranks the force applied to the stoppers by the water?

- (A)  $X = Y = Z$
- (B)  $X > Y = Z$
- (C)  $X > Z > Y$
- (D)  $Z > Y = X$

$F = PA$

$P = P_0 + \rho gh$

Same height,  
 Same P,  
 Same F

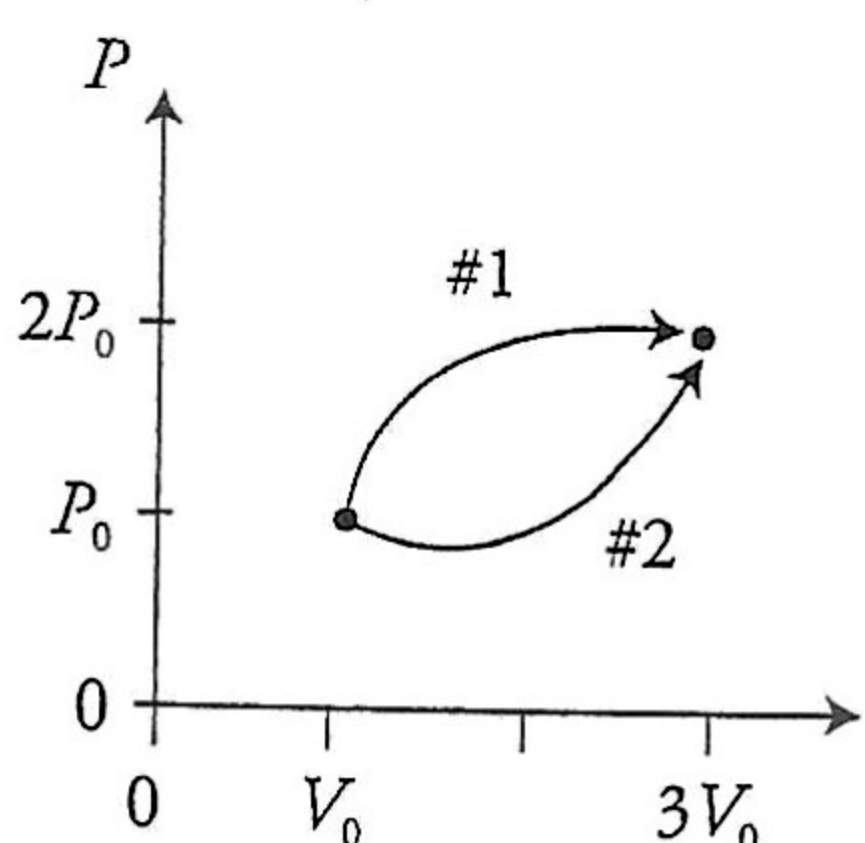
*hand more → bigger diff  
Air*

40. A person can stand outside on a cold day for hours without ill effect, but falling into a cold lake can kill a person in a matter of minutes. Which of the following is the primary reason for this phenomenon?

*Also true for air*

- (A) The molecules of the person are, on average, moving faster than those of the surroundings.
- (B) Thermal energy moves from high concentration areas (hot) to low concentration areas (cold).
- (C) As heat flows out of the person and warms the fluid surrounding the person, the warmer fluid rises, allowing fresh cool fluid to come in contact with the person and increasing the rate of heat transfer.
- (D) Water has more molecules per volume than air, increasing molecular contact with the person.

*True but not reason  
True but not reason  
True but not reason*



41. A sample of gas can be taken from an initial pressure  $P_0$  and volume  $V_0$  to a final pressure and volume along either path 1 or 2 as shown in the figure. Your lab partner states: "Moving along either path won't make any difference because both paths start and end at the same places. So, everything about the gases during both processes 1 and 2 will be the same." Which of the following is a proper analysis of your lab partner's statement?

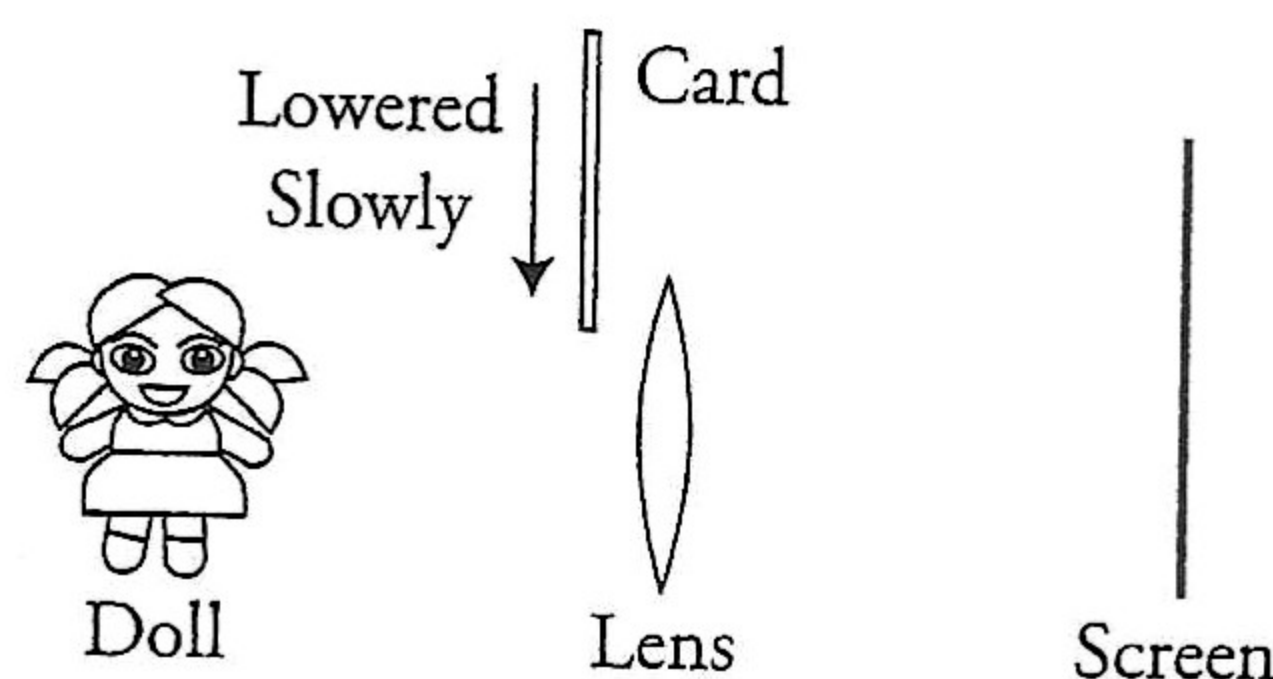
- ~~(A) The change in temperature is the same, but the change in internal energies will be different.~~
- (B) The change in internal energies will be the same, but the thermal energy transferred to the gas will be different.
- (C) The thermal energy transferred to the gas will be the same, but the work done by the gas will be different.
- (D) The work done by the gas will be the same, but the change in temperature will be different.

*ΔU same W = area under curve  
#1 more work,*

42. A glass lens of focal length  $f = 80$  cm in air is submerged in oil. How will submerging the lens in oil affect the focal length of the lens and why?

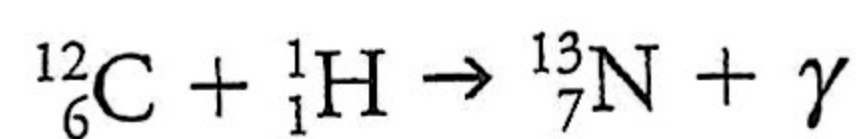
*oil bends less  
less diff in n*

- (A)  $f > 80$  cm because there is now a smaller change in velocity as light passes from oil into the glass.
- (B)  $f = 80$  cm because the index of refraction of glass has remained unchanged by placing the lens into the oil.
- (C)  ~~$f = 80$  cm~~ because the shape of the lens has remained unchanged by placing the lens into the oil.
- (D)  $f < 80$  cm because light travels slower in oil.



43. A lens is placed between a doll and a white sheet of paper in such a way as to produce an image on the paper. On the side of the lens facing the doll, a dark card is slowly lowered to cover the lens as shown in the figure. Which of the following correctly explains what will happen to the image of the doll?

- ~~(A) As the descending card blocks more and more of the lens, the focal point of the lens shifts. This causes the image to become increasingly blurry until the image disappears from the screen.~~
- ~~(B) The image remains clear, but the head of the doll in the image disappears first, followed by the feet, as the light from the top of the object is blocked before the light from the feet.~~
- ~~(C) The image remains clear, but since the doll projects an inverted real image on the screen, the doll's feet will disappear from view first, followed by the head last, as light from the object is blocked.~~
- (D) As the card blocks light from the object, the image remains clear but becomes increasingly dim until the image disappears.



44. Which of the following expressions correctly relates the masses of the constituent particles involved in the nuclear reaction shown?

(A)  $m_C + m_H - m_N = 0$

(B)  $m_C + m_H - m_N - \frac{hf_\gamma}{c^2} < 0$

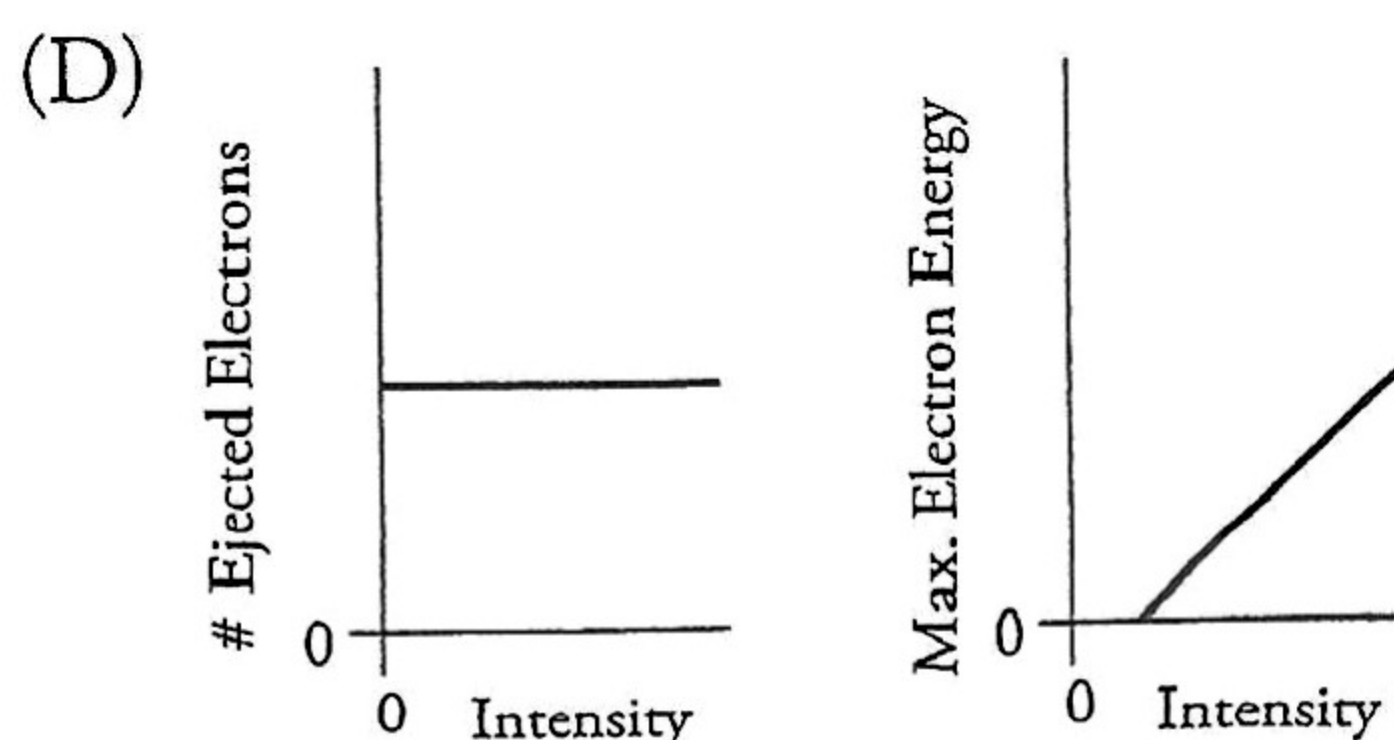
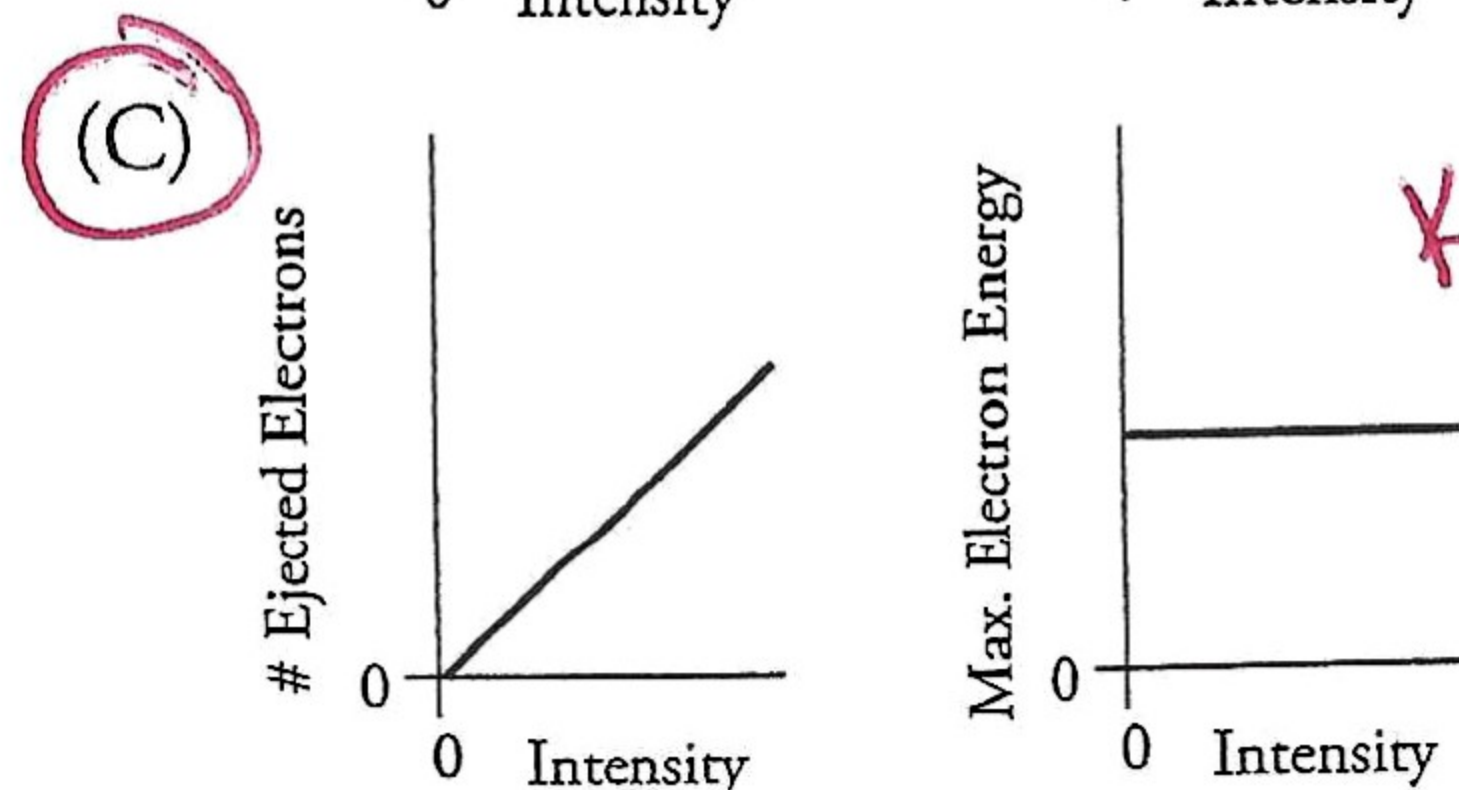
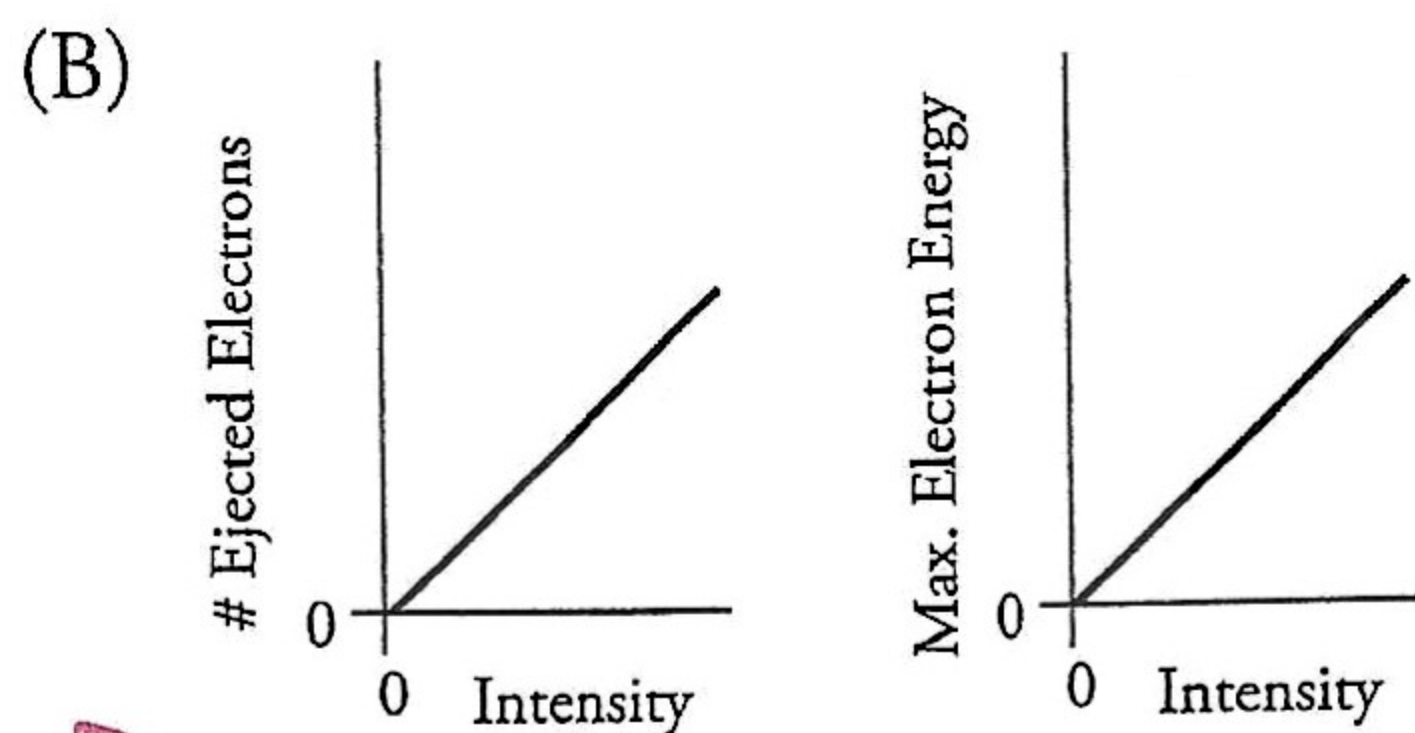
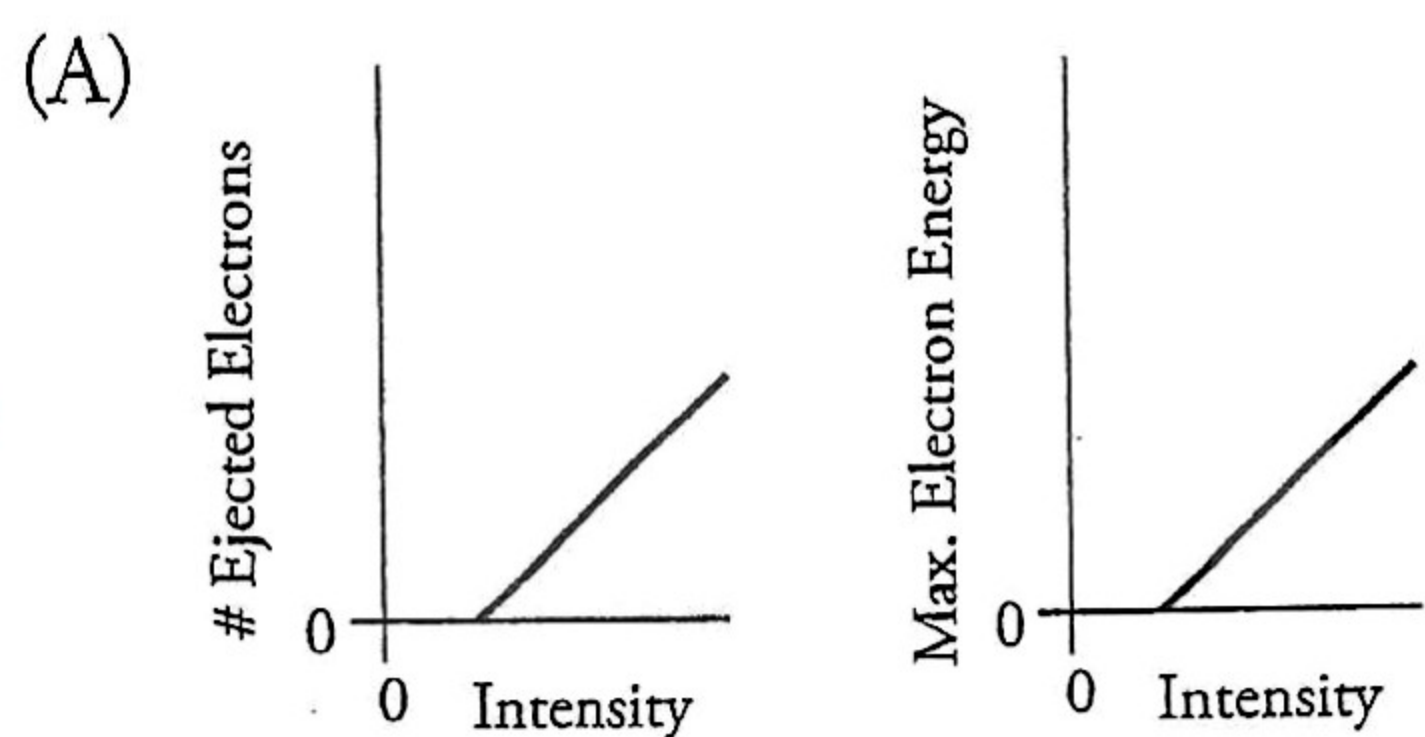
(C)  $m_C + m_H - m_N - \frac{hf_\gamma}{c^2} = 0$

(D)  $m_C + m_H - m_N - \frac{hf_\gamma}{c^2} > 0$

*energy*  
*mass + energy are conserved*

45. In an experiment, monochromatic violet light shines on a photosensitive metal, which causes electrons to be ejected from the metal. Which of the following graphs best depicts the number of ejected electrons and the maximum energy of the ejected electrons versus the intensity of the violet light shining on the metal?

*E = hf*  
*same f*  
*same E*  
*use some to ionize,*  
*rest is e- energy*



*K<sub>max</sub> = hf - φ*

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.

Volume (cm <sup>3</sup> )	5.0	5.0	5.0	5.0
Pressure (kPa)	200	210	220	230
Temperature (°C)	0	20	40	60

46. A technician is experimenting with a sample of gas in a closed container and produces this set of data. What can be concluded from this data? (Select two answers.)

- (A) Pressure is inversely proportional to the volume.
- (B) Volume is directly proportional to the temperature.
- (C) Pressure is directly proportional to the temperature.
- (D) The number of molecules of gas in the container is  $4.4 \times 10^{-4}$  moles.

*Volume constant*

47. In which of the following cases would it be appropriate to ignore the gravitational force? (Select two answers.)

- (A) A teacher charges a balloon with her hair and demonstrates how the balloon can be stuck to the ceiling by the electrostatic force.
- (B) A scientist suspends a charged droplet of oil between two charged horizontal capacitor plates.
- (C) Electrons move through a wire in an electrical circuit.
- (D) A physics student is asked to calculate the force between the proton and electron in a hydrogen atom.

*F<sub>g</sub> = F<sub>e</sub>*

*F<sub>e</sub> >> F<sub>g</sub> for subatomic particles*

*+ charged*  
*Tilts more same charge*

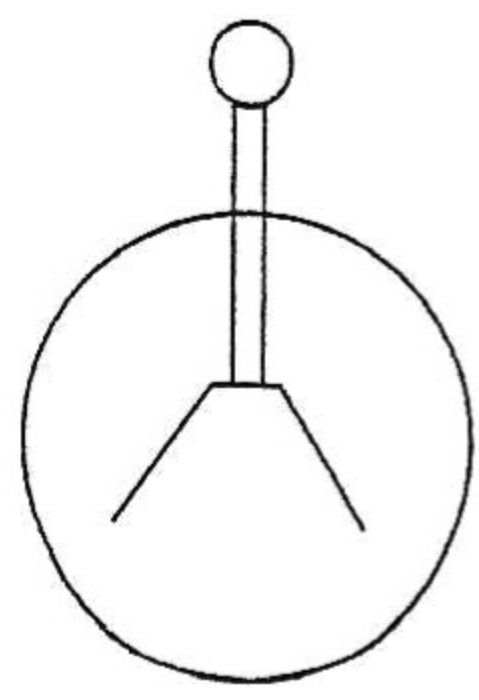


Figure 1

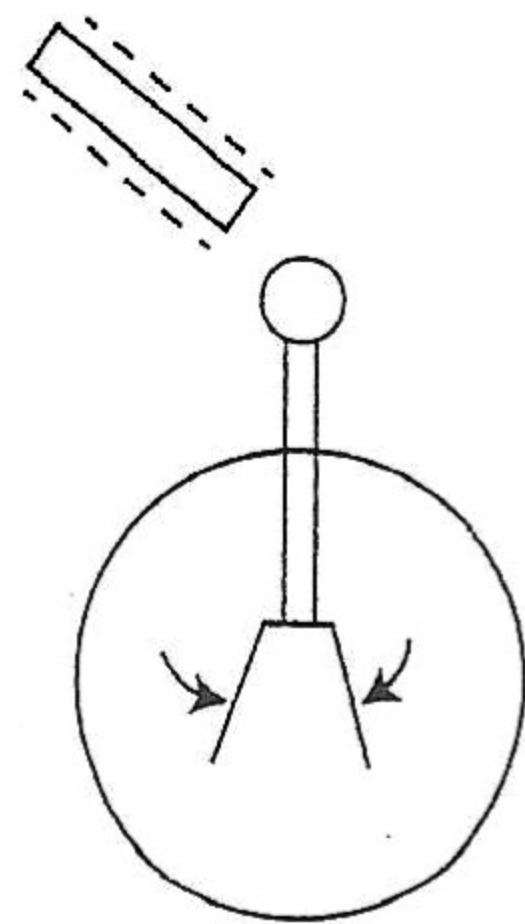


Figure 2

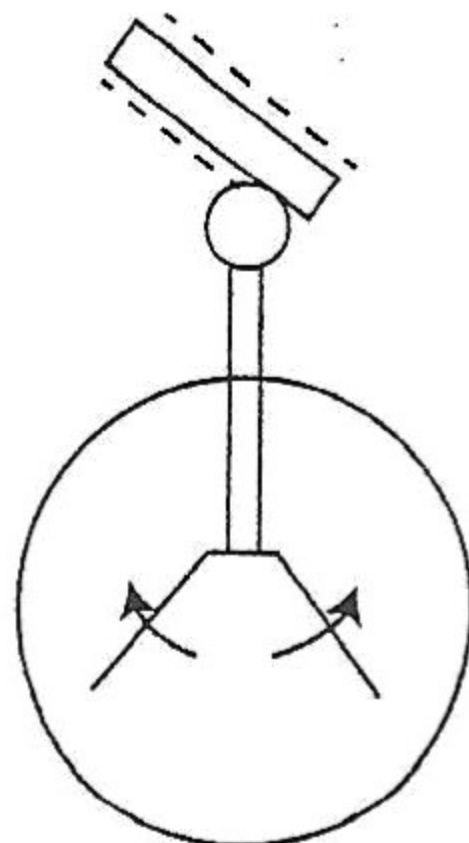
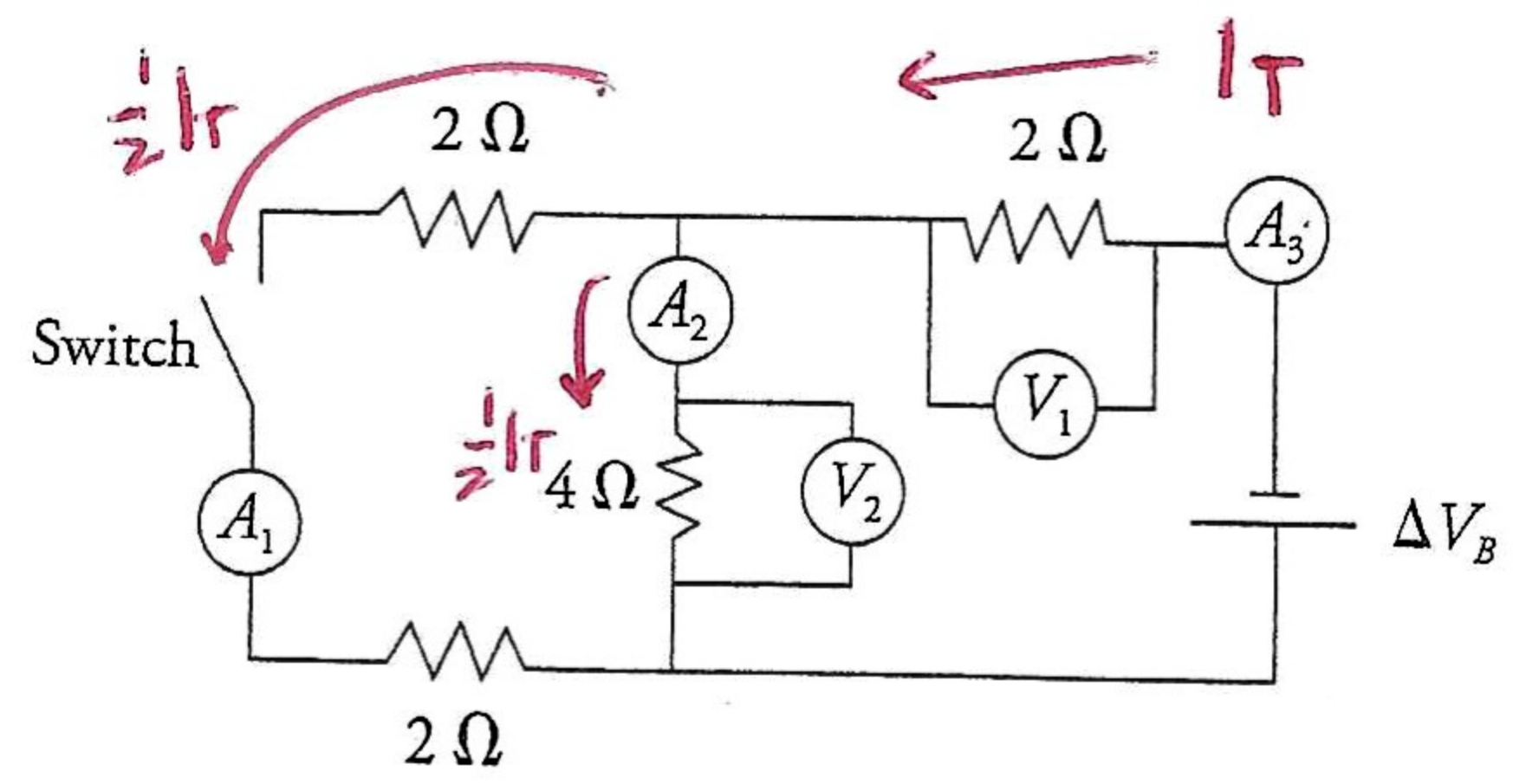


Figure 3

48. An electroscopes is shown with its movable metal leaves in a sequence of events. Originally the electroscopes is in a position with the leaves at an outward angle as shown in Figure 1. A negatively charged rod is brought close to the electroscopes and the leaves swing downward as shown in Figure 2. Finally, the rod touches the electroscopes and the leaves spring outward as shown in Figure 3. Which of the following statements correctly describe this behavior? (Select two answers.)

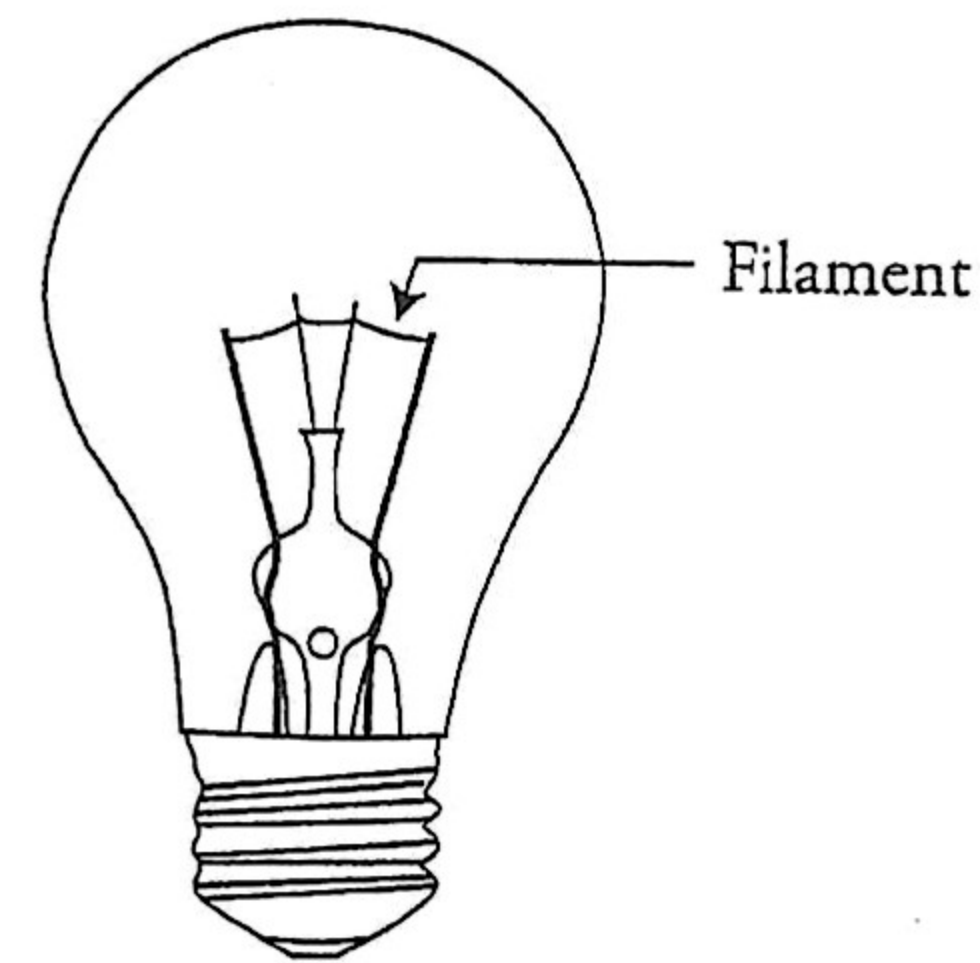
- (A) In Figure 1, the electroscopes has a net positive charge.
- (B) In Figure 2, the leaves move closer together because the rod discharges the electroscopes.
- (C) In Figure 2, negative charges are pushed toward the leaves at the bottom of the electroscopes.
- (D) In Figure 3, positive charges from the electroscopes migrate onto the rod, leaving the electroscopes negatively charged.



49. The circuit shown has a battery of negligible internal resistance, resistors, and a switch. There are voltmeters, which measure the potential differences  $V_1$ , and  $V_2$ , and ammeters  $A_1$ ,  $A_2$ ,  $A_3$ , which measure the currents  $I_1$ ,  $I_2$ , and  $I_3$ . The switch is initially in the closed position. With the switch still closed, which of the following relationships are true? (Select two answers.)

- (A)  $I_1 + I_2 - I_3 = 0$
- (B)  $\Delta V_B - V_1 - V_2 = 0$
- (C)  $V_1 > V_2$
- (D)  $I_2 = I_3$

*$V_1 + V_2 = \Delta V_B$*   
 *$V_1 = V_2$  b/c  $R_1 = 2R$*   
 *$R_{II} = 2R$*



50. An incandescent bulb is shown in the figure. When connected to the same power source, which of the following would make this bulb brighter? (Select two answers.)

- (A) increase the length of the filament *↑R*
- (B) increase the thickness of the filament *↓R*
- (C) connect two of the existing filaments in series  *$R_T = 2R$*
- (D) connect two of the existing filaments in parallel  *$R_T = \frac{1}{2}R$*

*$R = \frac{\rho L}{A}$*  *↑L ↑R*  
*↑A ↓R*

