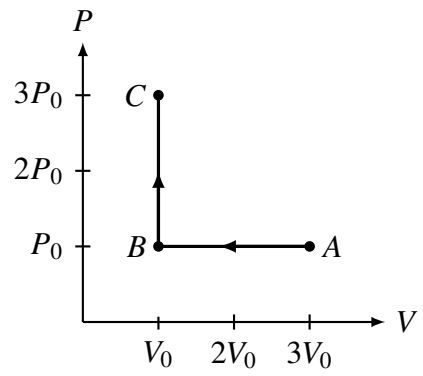
AP & IBHL PHYSICS PRACTICE TEST #2
PART 1: MULTIPLE-CHOICE QUESTIONS

Questions 1–2: A sealed cylinder with a moveable piston contains N molecules of an ideal gas. The gas is initially in state A shown on the above PV diagram, where P is pressure and V is volume. The gas is then taken through the two processes shown.



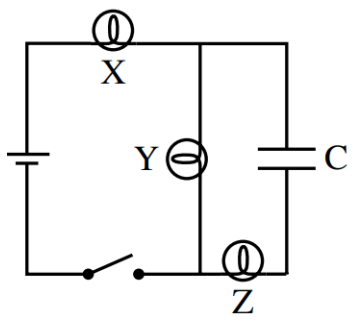
1. Which of the following correctly ranks the average speed v of the molecules in states A, B, and C?
   (A) $(v_B = v_C) > v_A$
   (B) $v_C > v_B > v_A$
   (C) $(v_A = v_C) > v_B$
   (D) $v_B > (v_C = v_A)$

2. Which of the following correctly ranks the magnitude of the force F the gas exerts on the piston in states A, B, and C?
   (A) $F_A > F_C > F_B$
   (B) $F_C > F_B > F_A$
   (C) $(F_B = F_C) > F_A$
   (D) $F_C > (F_A = F_B)$

3. A sample of ideal gas in a tank of contant volume. The sample absorbs heat energy so that its temperature changes from 300 K to 600 K. If v_1 is the average speed of the gas molecules before the absorption of heat and v_2 is their average speed after the absorption of heat, what is the ratio v_2/v_1?
   (A) $\frac{1}{2}$
   (B) 1
   (C) $\sqrt{2}$
   (D) 2
   (E) 4

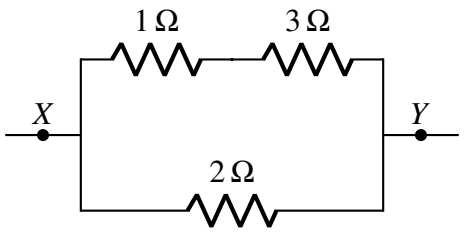
4. A cylindrical resistor is connected to a battery with an emf of 15.0 V, resulting in a current of 3.0 A in the circuit. The resistor is removed, and a new resistor of the same material with twice the radius and twice the length of the original resistor is connected to the battery. What is the new current in the circuit?
   (A) 1.5 A
   (B) 3.0 A
   (C) 6.0 A
   (D) 12.0 A

5. Water of density 1000 kg/m^3 is pumped through a straight, horizontal hose and out a nozzle that has an opening with a cross-sectional area 10 times smaller than that of the hose. The water exits the nozzle at a speed of 10.0 m/s. The difference between the pressure of the fluid when it is in the hose near the pump and as it exits the nozzle is
   (A) 4.5×10^3 Pa
   (B) 4.95×10^4 Pa
   (C) 9.9×10^4 Pa
   (D) 4.95×10^6 Pa



6. In the circuit shown above, bulbs X, Y, and Z are identical and capacitor C is initially uncharged. The switch is closed at time $t = 0$. Which of the following describes the brightness of bulbs Y and Z after the switch is closed?
   (A) Both bulbs light and remain lit.
   (B) Bulbs Y and Z are both initially lit, and bulb Y eventually goes out.
   (C) Bulbs Y and Z are both initially lit, and bulb Z eventually goes out.
   (D) Bulb Y is always lit and bulb Z is always out.

Questions 7–8 refer to the following diagram that shows part of a closed electrical circuit.

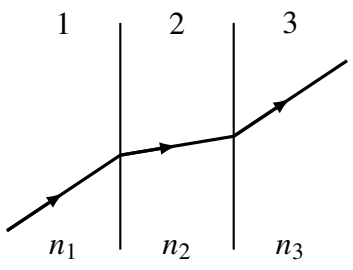


7. The electrical resistance of the part of the circuit shown between point X and point Y is:
   (A) $1\frac{1}{3}\Omega$
   (B) $2\,\Omega$
   (C) $2\frac{3}{4}\Omega$
   (D) $4\,\Omega$
   (E) $6\,\Omega$

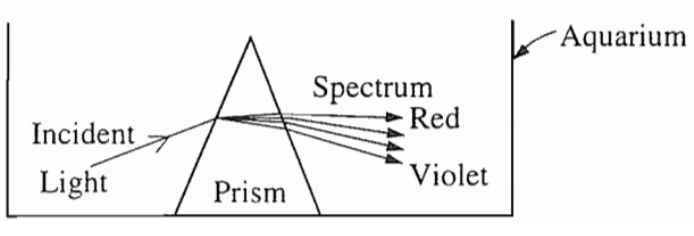
8. When there is a steady current in the circuit, the mount of charg passing a point per unit time is
   (A) the same everywhere in the circuit
   (B) greater at X than at point Y
   (C) greater in the $1\,\Omega$ than the $2\,\Omega$ resistor
   (D) greater in the $1\,\Omega$ than the $3\,\Omega$ resistor
   (E) greater in the $2\,\Omega$ than the $3\,\Omega$ resistor

9. A student in a classroom sees a tree outside that is far from the classroom window and uses a concave mirror to form an image of the tree on a screen. Which of the following best describes the image?
   (A) Real and near the center of curvature of the mirror
   (B) Real and near the focal point of the mirror
   (C) Virtual and near the center of curvature of the mirror
   (D) Virtual and near the focal point of the mirror

10. A concave mirror with a radius of curvature of 1.0 m is used to collect light from a distant star. The distance between the mirror and the image of the star is most nearly
    (A) 0.25 m
    (B) 0.50 m
    (C) 0.75 m
    (D) 1.0 m
    (E) 2.0 m



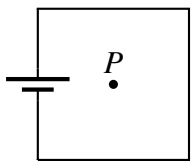
11. A light ray passes through substances 1, 2, and 3, as shown above. The indices of refraction for these three substances are n_1, n_2, and n_3, respectively. Ray segment in 1 and 3 are parallel. From the direction of the ray, one can conclude that
    (A) n_3 must be the same as n_1
    (B) n_2 must be the same as n_1
    (C) n_2 must be the same as n_3
    (D) n_1 must be equal to 1.00
    (E) all three indices must be the same



12. A beam of white light is incident on a triangular glass prism with an index of refraction of about 1.5 for visible light, producing a spectrum. Initially, the prism is in a glass aquarium filled with air, as shown above. If the squarium is filled with water with an index of refraction of 1.3, which of the following is true?
    (A) No spectrum is produced.
    (B) A spectrum is produced, but the deviation of the beam is opposite to that in the air.
    (C) The position of red and violet are reversed in the spectrum.
    (D) The spectrum produced has greater separation between red and violet than that produced in air.
    (E) The spectrum produced has less separation between red and violet than that produced in air.

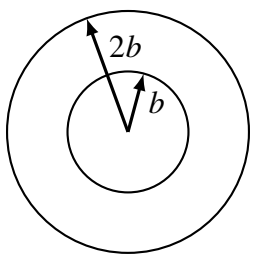
13. When light passes from air into water, the frequency of the light remains the same. What happens to the speed and wavelength of the light as it crosses the boundary in going from air into water?

	Speed	Wavelength
(A)	Increases	Remains the same
(B)	Remains the same	Decreases
(C)	Remains the same	Remains the same
(D)	Decreases	Increases
(E)	Decreases	Decreases



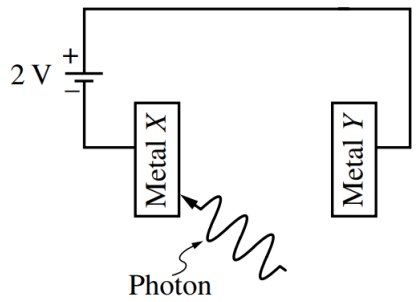
14. A circuit consists of a battery and some wire with significant resistance. The wire is bent so that the circuit is in the shape of a square, and the circuit is aligned in the plane of the page, as shown above. Which of the following best describes the direction of the magnetic field near point P?

(A) Clockwise around point P
(B) Out of the page
(C) Into the page
(D) The field has no direction because the magnitude of the field is zero.



15. Two concentric loops of radii b and $2b$, made of the same type of wire, lie in the plane of the page, as shown above. The total resistance of the wire loop of radius b is R. What is the resistance of the wire loop of wire $2b$?

(A) $R/4$
(B) $R/2$
(C) R
(D) $2R$
(E) $4R$

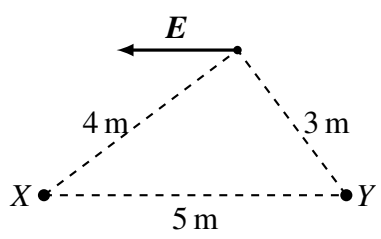


16. A photon with energy 4 eV is incident on metal X, which has a work function of 3 eV. Metal X is electrically connected to metal Y through a 2 V voltage supply with the polarity shown in the figure above. What is the maximum kinetic energy an emitted electron could have when it reaches metal Y?

(A) 1 eV
(B) 2 eV
(C) 3 eV
(D) 5 eV

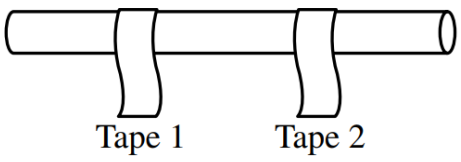
17. In an experiment, light of a particular wavelength is incident on a metal surface, and electrons are emitted from the surface as a result. To produce more electrons per unit time but with less kinetic energy per electron, the experimenter should do which of the following?

(A) Increase the intensity and decrease the wavelength of the light.
(B) Increase the intensity and the wavelength of the light.
(C) Decrease the intensity and the wavelength of the light.
(D) Decrease the intensity and increase the wavelength of the light.
(E) None of the above would produce the desired result.



18. Two charged spheres, X and Y, are held fixed at two vertices of a triangle, as shown above. The direction of the electric field $\boldsymbol{E}$ at the third vertex due to the two spheres is also shown. Which of the following correctly indicates the sign of the charges on the spheres?

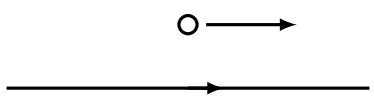
	Sphere X	**Sphere** Y
(A)	Positive	Positive
(B)	Positive	Negative
(C)	Negative	Positive
(D)	Negative	Negative



	Tape 1	Tape 2
Positively charged object	Attracted	Repelled
Negatively charged object	Repelled	Attracted
Uncharged object	Attracted	Attracted

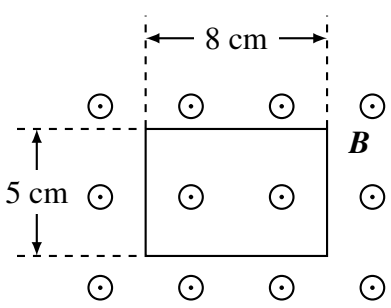
19. Two pieces of transparent adhesive tape, labeled 1 and 2, are stuck together. The pieces of tape are then quickly pulled apart and stuck to an insulating rod, as shown above. Three objects are brought near each piece of tape, one at a time. One of the objects is positively charged, one is negatively charged, and one is uncharged. The reaction of each piece of tape is recorded in the table above. Based on the results, what can be concluded about the signs of the charges on the tapes, and why?

(A) Tape 1 is positively charged, because it is attracted to the positively charged object. Tape 2 is negatively charged because it is repelled by the positively charged object.
(B) Tape 1 is negatively charged, because it is repelled by the negatively charged object. Tape 2 is positively charged, because it is repelled by the positively charged object.
(C) Tape 1 and tape 2 are both positively charged because they are both attracted to the uncharged object.
(D) Tape 1 and tape 2 are both negatively charged because they are both attracted to the uncharged object.



20. At the instant shown above, a particle with a positive charge travels to the right near a wire carrying a current to the right. What is the direction of the force exerted by the charge on the wire?

(A) Toward the bottom of the page
(B) Toward the top of the page
(C) Out of the page
(D) Into the page



21. A rectangular wire loop is at rest in a uniform magnetic field $\boldsymbol{B}$ of magnitude 2 T that is directed out of the page. The loop measures 5 cm by 8 cm, and the plane of the loop is perpendicular to the field, as shown above. The total magnetic flux through the loop is

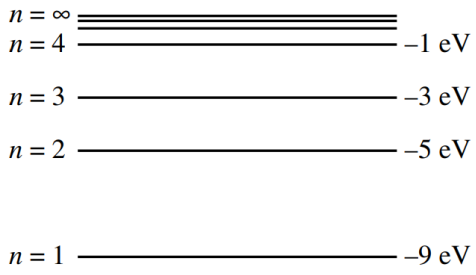
(A) zero
(B) $2 \times 10^{-3}\ \mathrm{T \cdot m^2}$
(C) $8 \times 10^{-3}\ \mathrm{T \cdot m^2}$
(D) $2 \times 10^{-1}\ \mathrm{T \cdot m^2}$
(E) $8 \times 10^{-1}\ \mathrm{T \cdot m^2}$

22. A beam of electrons is incident on a crystal, creating a diffraction pattern. How should the speed of the electrons be changed to increase the separation of the spacing of the maxima in the pattern, and why would the pattern change?

(A) The speed should be increased, because that would increase the de Broglie wavelength of the electrons.
(B) The speed should be increased, because that would decrease the de Broglie wavelength of the electrons.
(C) The speed should be decreased, because that would increase the de Broglie wavelength of the electrons.
(D) The speed should be decreased, because that would decrease the de Broglie wavelength of the electrons.

23. A canister and the hydrogen gas it contains are at 100 °C. The canister is placed in a vacuum, and the temperature of the canister and gas begins to decrease. Which of the following statements of reasoning best explains how the canistergas system loses energy?

(A) High-energy hydrogen molecules collide with lower-energy molecules and the walls inside the canister, losing energy during the collisions.
(B) The molecules collide with the walls of the canister, causing the canister molecules to vibrate and carry energy from the canister to the canister's surroundings.
(C) Energy is released from the canister as infrared radiation that can travel through the vacuum, causing a decrease in the average energy of the canister and the molecules.
(D) Energy is released from the canister and travels through the vacuum by convection, causing a decrease in the average energy of the canister and the molecules.



24. The figure above shows the energy levels for a hypothetical atom. For which transitions will the emitted photon have an energy of 4 eV? Select two answers.

(A) $n = 4$ to $n = 3$
(B) $n = 4$ to $n = 2$
(C) $n = 3$ to $n = 1$
(D) $n = 2$ to $n = 1$

25. A student is asked to use the steps listed below to induce a positive charge on an aluminum soda can. In what order could the steps be done to accomplish the task? Select two answers.

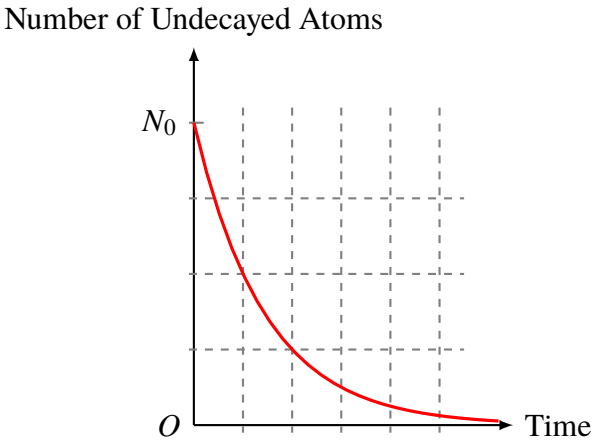
Step W: Bring a negatively charged rod near, but not touching, the can.

Step X: Ground the can.

Step Y: Remove the ground from the can.

Step Z: Move the charged rod away from the can.

(A) W, X, Y, Z
(B) W, X, Z, Y
(C) X, W, Y, Z
(D) X, W, Z, Y



26. The graph above shows the decay of a sample of carbon-14 that initially contained N_0 atoms. Which of the lettered points on the time axis chould represent the half-life of carbon-14?

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

27. At noon a radioactive sample decays at a rate of 4000 counts per minute. At 12:30 pm the decay rate has decreased to 2000 counts per minute. The predicted decay rate at 1:30 pm is:

(A) 0 counts
(B) 500 counts
(C) 666 counts
(D) 1000 counts
(E) 1333 counts

28. An ice cube of mass m and specific heat c_i is initially at temperature T_1, where $T_1 < 273\,\text{K}$. If L is the latent heat of fusion of water, and the specific heat of water is c_w, how much energy is required to convert the ice cube to water at temperature T_2 where, $273\,\text{K} < T_2 < 373\,\text{K}$?

(A) $m[c_i(273 - T_1) + L + c_w(373 - T_2)]$
(B) $m[c_i(273 - T_1) + L + c_w(T_2 - 273)]$
(C) $c_i(273 - T_1) + c_w(T_2 - 273)$
(D) $mL + c_w(T_2 - T_1)$
(E) $mL + \left(\frac{c_w - c_i}{2}\right)(T_2 - T_1)$