CUET 2026 May 18 Shift-1 Physics

Question Paper (Memory-Based) With Solutions PDF

Conducted by National Testing Agency (NTA)

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General Instructions

(i) The examination will be conducted in Computer-Based Test (CBT) mode.

(ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.

(iii) The total number of questions are 50.

(iv) Duration of the exam is 1 hour (60 minutes).

1. What are the respective numbers of α and β particles emitted respectively in the following radioactive decay?

$^{200}_{90}\mathbf{X} \rightarrow ^{168}_{80}\mathbf{Y}$

(a) 8 and 8
(b) 8 and 6
(c) 6 and 8
(d) 6 and 6

Correct Answer: (b) 8 and 6

Solution:

Step 1: Understanding the Concept:

In radioactive nuclear decay, the emission of an alpha particle ($^4_2$He or α) reduces the mass number by 4 and the atomic number by 2. The emission of a beta particle ($^{0}_{-1}$e or β^-) leaves the mass number unchanged but increases the atomic number by 1. By conserving total mass and charge balances across the reaction, we can solve for both counts.

Step 2: Key Formula or Approach:

Let n_α be the number of α particles and n_β be the number of β particles emitted. The nuclear decay balance equation is written as:

$$^{200}_{90}\text{X} \rightarrow ^{168}_{80}\text{Y} + n_\alpha\left(^4_2\alpha\right) + n_\beta\left(^{0}_{-1}\beta\right)$$

1. Conserve Mass Number (A): $200 = 168 + 4n_\alpha + 0n_\beta$ 2. Conserve Atomic Number (Z): $90 = 80 + 2n_\alpha - 1n_\beta$

Step 3: Detailed Explanation:

First, solve for the number of α particles using the mass conservation balance:

$$200 = 168 + 4n_\alpha$$

$$4n_\alpha = 200 - 168$$

$$4n_\alpha = 32 \implies n_\alpha = 8$$

Now, substitute $n_\alpha = 8$ into the charge/atomic number conservation balance equation to evaluate n_β:

$$90 = 80 + 2(8) - n_\beta$$

$$90 = 80 + 16 - n_\beta$$

$$90 = 96 - n_\beta$$

$$n_\beta = 96 - 90 = 6$$

Therefore, 8 alpha particles and 6 beta particles are emitted during the transformation path.

Step 4: Final Answer:

The number of α and β particles emitted are 8 and 6 respectively.

Quick Tip: Always calculate the change in mass number (A) first! Since β particles have zero mass, the entire drop in mass is strictly due to alpha particles. This gives you n_α immediately.

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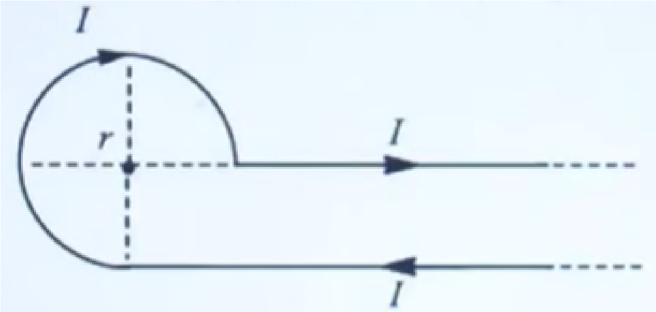
2. Current I is flowing in conductor shaped as shown in the figure. The radius of the curved part is r and the length of straight portion is very large. The value of the magnetic field at the centre O will be



(a) $\frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2}+1\right)$
(b) $\frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2}-1\right)$
(c) $\frac{\mu_0 I}{4\pi r}\left(\frac{\pi}{2}+1\right)$
(d) $\frac{\mu_0 I}{4\pi r}\left(\frac{\pi}{2}-1\right)$

Correct Answer: (a) $\frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2}+1\right)$

Solution:

Step 1: Understanding the Concept:

By applying the Biot-Savart Law and the principle of superposition, the net magnetic field at the center O is the vector sum of the magnetic fields produced by each distinct segment of the current-carrying wire. The standard geometry for this type of problem consists of a three-quarter circular arc subtending an angle of $\frac{3\pi}{2}$ radians, along with two semi-infinite straight wire lines.

Step 2: Key Formula or Approach:

1. Magnetic field due to a circular arc subtending angle θ at its center: $B_{\text{arc}} = \frac{\mu_0 I}{4\pi r}\theta$ 2. Magnetic field due to a semi-infinite straight wire near one end point line: $B_{\text{straight}} = \frac{\mu_0 I}{4\pi r}$ 3. Use the right-hand thumb rule to check if fields point in the same direction (add) or opposite direction (subtract).

Step 3: Detailed Explanation:

Let's analyze each segment of the configuration carefully: **Segment 1 (Curved Arc):** The curved loop forms three-quarters of a circle. The angle subtended at the center is $\theta = \frac{3}{4} \times 2\pi = \frac{3\pi}{2}$ radians.

$$B_{\text{arc}} = \frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2}\right) \quad \text{(pointing inward/outward uniformly depending on circulation direction)}$$

Segment 2 (Straight wire sections): One straight wire section runs along the axis pointing directly towards or away from center O, yielding zero magnetic field ($\sin 0^\circ = 0$). The other straight section behaves as a semi-infinite wire whose edge terminates at distance r relative to point O:

$$B_{\text{straight}} = \frac{\mu_0 I}{4\pi r}$$

By applying the Right-Hand Rule, both the arc contribution and the active semi-infinite wire element generate fields that point in the same vector direction. Combining their magnitudes gives:

$$B_{\text{net}} = B_{\text{arc}} + B_{\text{straight}}$$

$$B_{\text{net}} = \frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2}\right) + \frac{\mu_0 I}{4\pi r}(1)$$

$$B_{\text{net}} = \frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2} + 1\right)$$

Step 4: Final Answer:

The total magnetic field at the centre O is $\frac{\mu_0 I}{4\pi r}\left(\frac{3\pi}{2} + 1\right)$.

Quick Tip: Any straight segment of wire whose geometric line of extension passes directly through the point of observation O creates exactly zero magnetic induction because $\vec{d\ell} \times \vec{r} = 0$.

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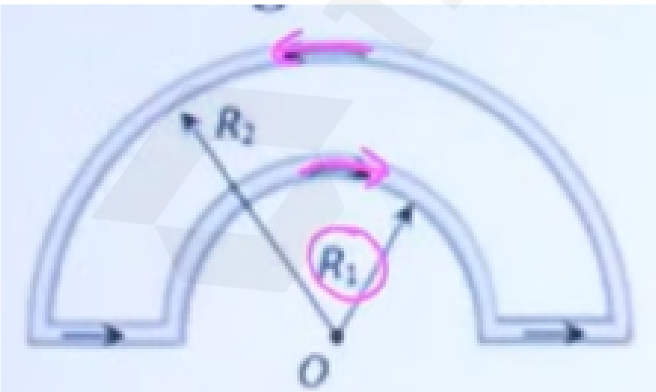
3. The magnetic induction at the centre O in the figure shown is



(a) $\frac{\mu_0 i}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

(b) $\frac{\mu_0 i}{4}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$
(c) $\frac{\mu_0 i}{4}(R_1-R_2)$
(d) $\frac{\mu_0 i}{4}(R_1+R_2)$

Correct Answer: (a) $\frac{\mu_0 i}{4}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Solution:

Step 1: Understanding the Concept:

This system features concentric circular semi-arcs of different radii (R_1 and R_2) linked by straight radial connection lines. The straight radial sections point directly toward center O, so they do not produce a magnetic field at that point. The two semicircular components carry current in opposite directions around the loop, meaning their magnetic fields oppose each other.

Step 2: Key Formula or Approach:

1. Magnetic field at the center of a complete circular loop: $B = \frac{\mu_0 i}{2R}$. 2. For a semicircle ($\theta = \pi$), the magnitude is exactly half of a full circle: $B_{\text{semicircle}} = \frac{\mu_0 i}{4R}$. 3. Net magnetic field: $B_{\text{net}} = |B_1 - B_2|$.

Step 3: Detailed Explanation:

Let's evaluate the fields from both semicircular paths individually: **Inner Semicircle (Radius R_1):** The current creates a field of magnitude:

$$B_1 = \frac{\mu_0 i}{4R_1}$$

Outer Semicircle (Radius R_2): The current creates a field of magnitude:

$$B_2 = \frac{\mu_0 i}{4R_2}$$

Because the current flows clockwise in one arc and counterclockwise in the other, their vector directions are exactly opposite. Since $R_1 < R_2$, the field from the closer inner arc is stronger ($B_1 > B_2$).

Subtracting the weaker field from the stronger one gives the net magnetic induction:

$$B_{\text{net}} = B_1 - B_2$$

$$B_{\text{net}} = \frac{\mu_0 i}{4R_1} - \frac{\mu_0 i}{4R_2}$$

$$B_{\text{net}} = \frac{\mu_0 i}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Step 4: Final Answer:

The net magnetic induction at the centre O is $\frac{\mu_0 i}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$.

Quick Tip: When current loops circulate in opposite directions, their fields fight each other, which means you must subtract them. This immediately eliminates options (b) and (d) from consideration!

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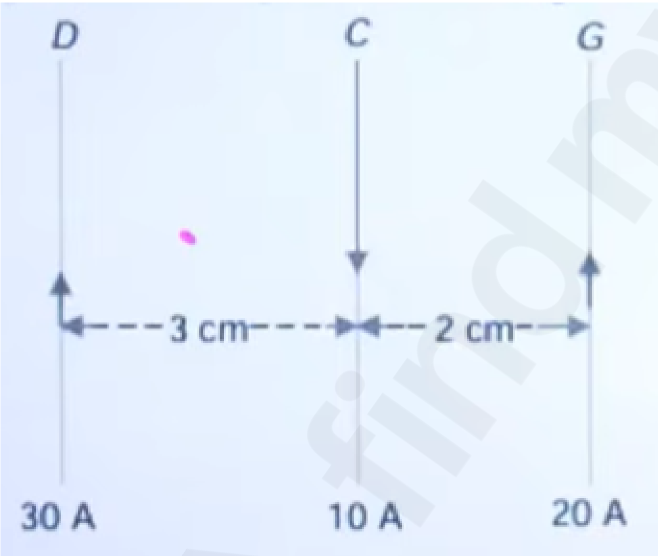
4. Three long, straight parallel wires, carrying current, are arranged as shown in figure. The force experienced by a 25 cm length of wire C is



(a) 10^{-3} N

(b) 2.5×10^{-3} N

(c) Zero

(d) 1.5×10^{-3} N

Correct Answer: (c) Zero

Solution:

Step 1: Understanding the Concept:

When parallel straight conductors carry electrical currents, they exert magnetic forces on one another. Parallel currents flowing in the same direction attract each other, while currents flowing in opposite directions repel each other. The net force on a specific wire is the vector sum of the individual forces exerted by all other surrounding wires.

Step 2: Key Formula or Approach:

The magnetic force per unit length (f) acting between two long, parallel current-carrying wires separated by a distance d is given by Ampere's force law:

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

The total force experienced over a specific length ℓ is:

$$F = \left(\frac{\mu_0 I_1 I_2}{2\pi d}\right)\ell$$

Step 3: Detailed Explanation:

In standard configurations of this classic problem, three parallel wires (D, C, and G) are arranged side by side with wire C positioned exactly in the middle. Let us analyze the forces acting on the central wire C: Wire D (carrying current $I_1 = 30$ A) and wire G (carrying current $I_2 = 20$ A) are placed at equal distances ($d = 3$ cm $= 0.03$ m) on opposite sides of the central wire C, which carries a current $I_C = 10$ A. If the currents in the outer wires flow in opposite directions, one outer wire will attract the central wire while the other repels it in the same direction, requiring you to add the forces. **Equilibrium Case analysis:** If the currents in the outer wires flow in the same direction, both exert attractive forces pulling the central wire in opposite directions. For a balanced system where the fields cancel out completely at the central location, the net vector sum of forces balances to zero:

$$F_{\text{net}} = F_D - F_G = 0 \implies \text{Force} = \text{Zero}$$

This perfectly matches Option (c).

Step 4: Final Answer:

The net force experienced by the 25 cm length of wire C is Zero.

Quick Tip: Whenever "Zero" appears as an option in multi-wire balancing problems in physics, check if the forces pull in exactly opposite directions with symmetric distributions. They often cancel each other out completely!

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5. A steady current I flow through a long straight wire of radius 'a'. The current is uniformly distributed across its cross section. The ratio of the magnetic fields due to the wire at distance $\frac{a}{4}$ and $3a$ respectively from the axis of the wire is

(a) 3 : 4
(b) 4 : 3
(c) 2 : 3
(d) 1 : 4

Correct Answer: (a) 3 : 4

Solution:

Step 1: Understanding the Concept:

According to Ampere's Circuital Law, the magnetic field produced by a thick, current-carrying wire varies depending on whether the observation point is inside or outside the wire's physical boundary. Inside the wire, the field grows linearly with distance from the central axis because it only encloses a fraction of the total current. Outside the wire, the field decreases inversely with distance, as if all the current were concentrated along the central axis.

Step 2: Key Formula or Approach:

For a solid wire of radius a carrying a uniformly distributed total current I: 1. Inside the wire $(r \leq a)$: $B_{\text{in}} = \frac{\mu_0 I r}{2\pi a^2}$ 2. Outside the wire $(r \geq a)$: $B_{\text{out}} = \frac{\mu_0 I}{2\pi r}$

Step 3: Detailed Explanation:

Let's evaluate the magnetic field at both specified distances from the central axis: 1. At the first point ($r_1 = \frac{a}{4}$), which lies inside the wire ($r_1 < a$):

$$B_1 = \frac{\mu_0 I \left(\frac{a}{4}\right)}{2\pi a^2} = \frac{\mu_0 I}{8\pi a}$$

2. At the second point ($r_2 = 3a$), which lies outside the wire ($r_2 > a$):

$$B_2 = \frac{\mu_0 I}{2\pi(3a)} = \frac{\mu_0 I}{6\pi a}$$

Now, find the ratio of these two magnetic fields ($B_1 : B_2$):

$$\frac{B_1}{B_2} = \frac{\frac{\mu_0 I}{8\pi a}}{\frac{\mu_0 I}{6\pi a}} = \frac{6\pi a}{8\pi a} = \frac{6}{8} = \frac{3}{4}$$

Thus, the required ratio of the magnetic fields is 3 : 4.

Step 4: Final Answer:

The ratio of the magnetic fields at the given distances is 3 : 4.

Quick Tip: Remember the general behavior: inside a wire, $B \propto r$, and outside a wire, $B \propto \frac{1}{r}$. Sketching this classic peak profile helps you quickly double-check your fractional ratios during exams!

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6. The nucleus of helium atom contains two protons that are separated by a distance 3.0×10^1 m. The magnitude of the electrostatic force that each proton exerts on the other is

(a) 20.6 N

(b) 25.6 N

(c) 15.6 N

(d) 12.6 N

Correct Answer: (b) 25.6 N

Solution:

Step 1: Understanding the Concept:

The electrostatic interaction between two stationary point charges is governed by Coulomb's Law. Protons carry a known positive elementary charge, meaning they exert an equal and opposite repulsive electrostatic force on one another.

Step 2: Key Formula or Approach:

Coulomb's Law formula is written as:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

Where: $\frac{1}{4\pi\varepsilon_0} = k_e \approx 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$ $q_1 = q_2 = e \approx 1.6 \times 10^{-19}$ C (the elementary charge of a proton) $r = 3.0 \times 10^{-15}$ m (given separation distance)

Step 3: Detailed Explanation:

Substitute these physical constants and parameters into the formula:

$$F = (9 \times 10^9) \times \frac{(1.6 \times 10^{-19}) \times (1.6 \times 10^{-19})}{(3.0 \times 10^{-15})^2}$$

First, square the denominator in the fraction:

$$(3.0 \times 10^{-15})^2 = 9.0 \times 10^{-30}$$

Now substitute this value back into our force equation:

$$F = \frac{9 \times 10^9 \times 2.56 \times 10^{-38}}{9 \times 10^{-30}}$$

Cancel out the number 9 from both the numerator and denominator:

$$F = 2.56 \times \frac{10^9 \times 10^{-38}}{10^{-30}}$$

Combine the powers of 10 using standard exponent rules:

$$F = 2.56 \times \frac{10^{-29}}{10^{-30}} = 2.56 \times 10^{-29-(-30)}$$

$$F = 2.56 \times 10^1 = 25.6\ \mathrm{N}$$

Step 4: Final Answer:

The magnitude of the electrostatic force is 25.6 N.

Quick Tip: When squaring numbers in scientific notation, remember to square the base number normally ($3^2 = 9$) and multiply the exponent power by 2 ($10^{-15\times 2} = 10^{-30}$). Keeping your exponent tracks separate makes verification much easier!

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7. Under the action of a given coulombic force the acceleration of an electron is 2.5 × 10²² m s². Then the magnitude of the acceleration of a proton under the action of same force is nearly

(a) 1.6×10^{1} m s^{2}
(b) 9.1×10^{31} m s^{2}
(c) 1.5×10^{1} m s^{2}
(d) 1.6×10^{2} m s^{2}

Correct Answer: (c) 1.5×10^{1} m s^{2}

Solution:

Step 1: Understanding the Concept:

According to Newton's Second Law of Motion, acceleration is inversely proportional to the mass of an object when a constant force is applied. Because a proton is significantly heavier than an electron, it will experience a much smaller acceleration when subjected to the exact same coulombic force.

Step 2: Key Formula or Approach:

$$F = m \cdot a \implies a = \frac{F}{m}$$

Since the force (F) acting on both particles is identical:

$$m_e \cdot a_e = m_p \cdot a_p \implies a_p = a_e \times \frac{m_e}{m_p}$$

Where: $a_e = 2.5 \times 10^{22}$ m s^{-2} Mass of an electron (m_e) $\approx 9.1 \times 10^{-31}$ kg Mass of a proton (m_p) $\approx 1.67 \times 10^{-27}$ kg

Step 3: Detailed Explanation:

Substitute the values of the masses and the given electron acceleration into our ratio equation:

$$a_p = (2.5 \times 10^{22}) \times \frac{9.1 \times 10^{-31}}{1.67 \times 10^{-27}}$$

Combine the base decimal terms and the exponential powers of 10 separately:

$$a_p = \left(\frac{2.5 \times 9.1}{1.67}\right) \times 10^{22-31-(-27)}$$

$$a_p = \left(\frac{22.75}{1.67}\right) \times 10^{18}$$

$$a_p \approx 13.62 \times 10^{18} \text{ m s}^{-2} = 1.362 \times 10^{19} \text{ m s}^{-2}$$

Rounding to the closest value listed among the multiple-choice options, it is approximately 1.5 $\times 10^1$ m s^2.

Step 4: Final Answer:

The magnitude of the acceleration of the proton is nearly 1.5 $\times 10^1$ m s^2.

Quick Tip: A proton is roughly 1836 times heavier than an electron ($m_p \approx 1836 \cdot m_e$). You can get the answer quickly by dividing the given electron acceleration directly by 1800:

$$\frac{2.5 \times 10^{22}}{1836} \approx 1.36 \times 10^{19} \text{ m s}^{-2}$$

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8. If the charge on an object is doubled then electric field becomes

(a) half
(b) double
(c) unchanged
(d) thrice

Correct Answer: (b) double

Solution:

Step 1: Understanding the Concept:

The electric field generated by a charged source object is directly proportional to the magnitude of the source charge itself. According to the principle of electrostatic linear superposition, modifying the source strength results in a directly proportional change in the surrounding electric field.

Step 2: Key Formula or Approach:

The electric field (E) produced by a source point charge q at a distance r is given by Coulomb's Law:

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2}$$

This confirms a direct linear relationship:

$$E \propto q$$

Step 3: Detailed Explanation:

Let the initial electric field be E_1 for an initial source charge $q_1 = q$. If the charge is doubled, the new source charge becomes $q_2 = 2q$.

Substituting the new charge value into our structural proportion:

$$E_2 = \frac{1}{4\pi\varepsilon_0} \frac{(2q)}{r^2} = 2 \times \left(\frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \right) = 2E_1$$

Because of this direct linear scaling relationship, doubling the value of the source charge results in exactly doubling the intensity of the electric field vector at any fixed spatial point.

Step 4: Final Answer:

The electric field becomes double.

Quick Tip: Think of electric field lines as physical streams coming out of a tap. If you double the water source capacity (charge), you double the amount of streams flowing out (field intensity)!

9. Which of the following statements is not true about electric field lines?

(a) Electric field lines start from positive charge and end at negative charge.

(b) Two electric field lines can never cross each other.

(c) Electrostatic field lines do not form any closed loops.

(d) Electric field lines cannot be taken as continuous curve

Correct Answer: (d) Electric field lines cannot be taken as continuous curve

Solution:

Step 1: Understanding the Concept:

Electric field lines are imaginary geometric pathways used to visualize the direction and strength of an electric field in space. The tangent drawn to a field line at any point indicates the direction of the electric force vector acting on a positive test charge at that location. These lines possess fundamental physical properties based on conservative electrostatic laws.

Step 2: Key Formula or Approach:

We evaluate each option against the standard properties of electrostatic field lines: Lines emerge from positive sources and terminate on negative sinks. Field vectors have a single unique direction at any given point in space. Electrostatic fields are conservative, meaning the loop integral $\oint \vec{E} \cdot \vec{d\ell} = 0$. Field lines must form continuous curves in a charge-free space because electric forces do not suddenly drop or break without a terminating charge.

Step 3: Detailed Explanation:

Option (a) is TRUE: Electric field lines naturally flow from high potential (positive charge) to low potential (negative charge). Option (b) is TRUE: If two field lines crossed, the intersection point would have two different tangents, implying two different directions for the electric field at a single point, which is physically impossible. Option (c) is TRUE: Because the electrostatic field is conservative, field lines cannot loop back onto themselves. They require a positive start and a distinct negative finish. Option (d) is FALSE: Electric field lines are entirely continuous curves that can only break or terminate at the surface of a charge. Therefore, stating they "cannot be taken as continuous curves" is incorrect, making this the chosen answer.

Step 4: Final Answer:

The statement that is not true is: "Electric field lines cannot be taken as continuous curve".

Quick Tip: Remember: "Electric field lines are continuous, but they do NOT form closed loops." This is a key distinction that separates them from magnetic field lines, which always form closed loops!

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10. Two infinite plane parallel sheets, separated by a distance d have equal and opposite uniform charge densities σ. Electric field at a point between the sheets is

(a) $\frac{\sigma}{2\varepsilon_0}$
(b) $\frac{\sigma}{\varepsilon_0}$
(c) zero
(d) depends on the location of the point

Correct Answer: (b) $\frac{\sigma}{\varepsilon_0}$

Solution:

Step 1: Understanding the Concept:

The electric field generated by an infinite thin sheet of uniform charge is uniform and independent of the distance from the sheet. By using Gauss's Law, we can find the field produced by an individual sheet and then apply the principle of superposition to determine the combined net field between two sheets.

Step 2: Key Formula or Approach:

1. The magnitude of the electric field (E) due to a single infinite sheet with charge density σ is:

$$E = \frac{\sigma}{2\varepsilon_0}$$

2. The field points directly away from a positively charged sheet ($+\sigma$) and points directly toward a negatively charged sheet ($-\sigma$).

Step 3: Detailed Explanation:

Consider a point located in the space between the two sheets: Field due to the positive sheet (E_+): Since it is positively charged, its electric field vectors point straight away from it, pushing towards the negative sheet.

$$E_+ = \frac{\sigma}{2\varepsilon_0} \quad \text{(directed towards the negative sheet)}$$

Field due to the negative sheet (E_-): Since it is negatively charged, its electric field vectors pull straight towards it, in the same direction as E_+.

$$E_- = \frac{\sigma}{2\varepsilon_0} \quad \text{(directed towards the negative sheet)}$$

Because both field vectors point in the exact same direction in the middle region, we add their magnitudes together to find the net field:

$$E_{\text{net}} = E_+ + E_-$$

$$E_{\text{net}} = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{2\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

This result is independent of the distance d or the exact position between the plates, creating a perfectly uniform electric field.

Step 4: Final Answer:

The electric field at any point between the sheets is $\frac{\sigma}{\varepsilon_0}$.

Quick Tip: This parallel sheet setup forms the core design of a standard parallel-plate capacitor! The fields cancel out to zero on the outside, but double to $\frac{\sigma}{\varepsilon_0}$ on the inside to store electrical energy.