

## **ELECTROSTATICS WORKSHEET**

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**PART 1 Q**     [www.ravitestpapers.in](http://www.ravitestpapers.in) **TYPE IN SEARCH BOX FOR ANSWERS**

- Q 1. The mass of an electron is  $9.11 \times 10^{-31}$  kg, that of a proton is  $1.67 \times 10^{-27}$  kg. Find the ratio  $F_e/F_g$  of the electric force and the gravitational force exerted by the proton on the electron,
- Q 2. Find the dimensions and units of  $\epsilon_0$ .
- Q 3. Three point charges  $q$  are placed at three vertices of an equilateral triangle of side  $a$ . Find magnitude of electric force on any charge due to the other two.
- Q 4. Three point charges each of value  $+q$  are placed on three vertices of a square of side  $a$  metre. What is the magnitude of the force on a point charge of value  $-q$  coulomb placed at the centre of the square?
- Q 5. Coulomb's law states that the electric force becomes weaker with increasing distance. Suppose that instead, the electric force between two charged particles were independent of distance. In this case, would a neutral insulator still be attracted towards the comb.
- Q 6. A metal sphere is suspended from a nylon thread. Initially the metal sphere is uncharged. When a positively charged glass rod is brought close to the metal sphere, the sphere is drawn towards the rod. But if the sphere touches the rod, it suddenly flies away from the rod. Explain, why the sphere is first attracted then repelled?
- Q 7. Is there any lower limit to the electric force between two particles placed at a certain distance?
- Q 8. Does the force on a charge due to another charge depend on the charges present nearby?
- Q 9. The electric force on a charge  $q_1$  due to  $q_2$  is  $(4 \hat{i} - 3 \hat{j})$  N. What is the force on  $q_2$  due to  $q_1$  ?

## **PART 2 Q**

- Q 1. A point charge  $q_1 = 1.0 \mu\text{C}$  is held fixed at origin. A second point charge  $q_2 = -2.0 \mu\text{C}$  and a mass  $10^{-4}$  kg is placed on the x-axis, 1.0 m from the origin. The second point charge is released from rest. What is its speed when it is 0.5 m from the origin?
- Q 2. A point charge  $q_1 = -1.0 \mu\text{C}$  is held stationary at the origin. A second point charge  $q_2 = +2.0 \mu\text{C}$  moves from the point (1.0 m, 0, 0) to (2.0 m, 0, 0). How much work is done by the electric force on  $q_2$ ?

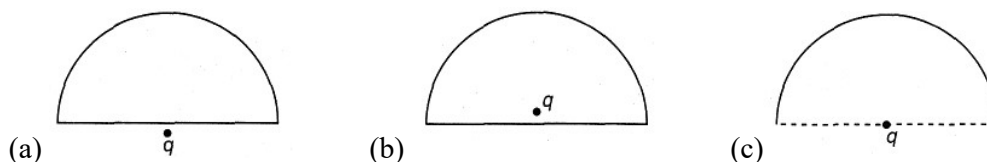
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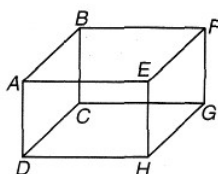
- Q 3. A point charge  $q_1$  is held stationary at the origin. A second charge  $q_2$  is placed at a point a, and the electric potential energy of the pair of charges is  $-6.4 \times 10^{-8}$  J. When the second charge is moved to point b, the electric force on the charge does  $4.2 \times 10^{-8}$  J of work. What is the electric potential energy of the pair of charges when the second charge is at point b ?
- Q 4. Is it possible to have an arrangement of two point charges separated by finite distances such that the electric potential energy of the arrangement is the same as if the two charges were infinitely far apart? What if there are three charges?

## PART 3 Q

- Q 1. In figure (a), a charge  $q$  is placed just outside the centre of a closed hemisphere. In figure (b), the same charge  $q$  is placed just inside the centre of the closed hemisphere and in figure (c), the charge is placed at the centre of hemisphere open from the base. Find the electric flux passing through the hemisphere in all the three cases.

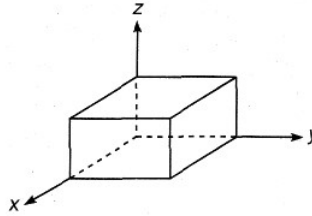


- Q 2. A charge  $q$  is placed at point D of the cube. Find the electric flux passing through the face EFGH and face AEHD.



- Q 3. Net charge within an imaginary cube drawn in a uniform electric field is always zero. Is this statement true or false.
- Q 4. A hemisphere body of radius  $R$  is placed in a uniform electric field  $E$ . What is the flux linked with the curved surface if, the field is  
(a) parallel to the base                      (b) perpendicular to the base.
- Q 5. A charge  $q_0$  is distributed uniformly on a ring of radius  $R$ . A sphere of equal radius  $R$  is constructed with its centre on the circumference of the ring. Find the electric flux through the surface of the sphere.
- Q 6. A cube has sides of length  $L = 0.2$  m. It is placed with one corner at the origin as shown in figure.

The electric field is uniform and given by  $\vec{E} = (2.5 \text{ N/C})\hat{i} - (4.2 \text{ N/C})\hat{j}$ . Find the electric flux through the entire cube.

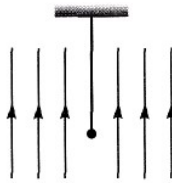


## PART 4 MCQS

Q 1. Units of electric flux are

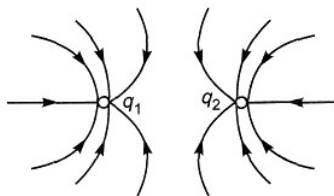
- (a)  $\frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$       (b)  $\frac{\text{N}}{\text{C}^2 \cdot \text{m}^2}$       (c) volt-m      (d) volt-m<sup>3</sup>

Q 2. A neutral pendulum oscillates in a uniform electric field as shown in figure. If a positive charge is given to the pendulum then its time period



- (a) will increase      (b) will decrease      (c) will remain constant  
(d) will first increase then decrease

Q 3. Identify the correct statement about the charges  $q_1$  and  $q_2$



- (a)  $q_1$  and  $q_2$  both are positive      (b)  $q_1$  and  $q_2$  both are negative  
(c)  $q_1$  is positive  $q_2$  is negative      (d)  $q_2$  is positive and  $q_1$  is negative

Q 4. Three identical charges are placed at corners of an equilateral triangle of side  $l$ . If force between any two charges is  $F$ , the work required to double the dimensions of triangle is

- (a)  $-3Fl$       (b)  $3Fl$       (c)  $(-3/2) Fl$       (d)  $(3/2) Fl$

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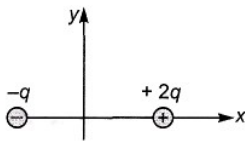
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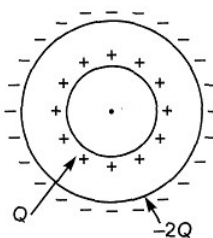
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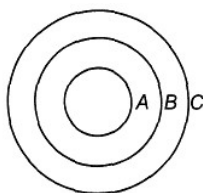
- Q 5. A proton, a deuteron and an alpha particle are accelerated through potentials of  $V$ ,  $2V$  and  $4V$  respectively. Their velocity will bear a ratio  
(a)  $1 : 1 : 1$  (b)  $1 : \sqrt{2} : 1$  (c)  $\sqrt{2} : 1 : 1$  (d)  $1 : 1 : \sqrt{2}$
- Q 6. Electric potential at a point P,  $r$  distance away due to a point charge  $q$  at point A is  $V$ . If twice of this charge is distributed uniformly on the surface of a hollow sphere of radius  $4r$  with centre at point A, the potential at P now is  
(a)  $V$  (b)  $V/2$  (c)  $V/4$  (d)  $V/8$
- Q 7. Four charges  $+q$ ,  $-q$ ,  $+q$  and  $-q$  are placed in order on the four consecutive corners of a square of side  $a$ . The work done in interchanging the positions of any two neighbouring charges of the opposite sign is  
(a)  $\frac{q^2}{4\pi\epsilon_0 a}(-4 + \sqrt{2})$  (b)  $\frac{q^2}{4\pi\epsilon_0 a}(4 + 2\sqrt{2})$  (c)  $\frac{q^2}{4\pi\epsilon_0 a}(4 - 2\sqrt{2})$  (d)  $\frac{q^2}{4\pi\epsilon_0 a}(4 + \sqrt{2})$
- Q 8. Two concentric spheres of radii  $R$  and  $2R$  are charged. The inner sphere has a charge of  $1 \mu\text{C}$  and the outer sphere has a charge of  $2 \mu\text{C}$  of the same sign. The potential is  $9000 \text{ V}$  at a distance  $3R$  from the common centre. The value of  $R$  is  
(a)  $1 \text{ m}$  (b)  $2 \text{ m}$  (c)  $3 \text{ m}$  (d)  $4 \text{ m}$
- Q 9. A ring of radius  $R$  is having two charges  $q$  and  $2q$  distributed on its two half parts. The electric potential at a point on its axis at a distance of  $2\sqrt{2}R$  from its centre is  $k = \frac{1}{4\pi\epsilon_0}$   
(a)  $\frac{3kq}{R}$  (b)  $\frac{kq}{3R}$  (c)  $\frac{kq}{R}$  (d)  $\frac{kq}{\sqrt{3}R}$
- Q 10. A particle A having a charge of  $2.0 \times 10^{-6} \text{ C}$  and a mass of  $100 \text{ g}$  is fixed at the bottom of a smooth inclined plane of inclination  $30^\circ$ . Where should another particle B having same charge and mass, be placed on the inclined plane so that B may remain in equilibrium?  
(a)  $8 \text{ cm}$  from the bottom (b)  $13 \text{ cm}$  from the bottom  
(c)  $21 \text{ cm}$  from the bottom (d)  $27 \text{ cm}$  from the bottom
- Q 11. Four positive charges  $(2\sqrt{2} - 1)Q$  are arranged at the four corner of a square. Another charge  $q$  is placed at the centre of the square. Resulting force acting on each corner charge is zero if  $q$  is  
(a)  $-\frac{7Q}{4}$  (b)  $-\frac{4Q}{7}$  (c)  $-Q$  (d)  $-(\sqrt{2} + 1)Q$

- Q 12. A proton is released from rest, 10 cm from a charged sheet carrying charged density of  $-2.21 \times 10^{-9} \text{ C/m}^2$ . It will strike the sheet after the time (approximately)
- (a)  $4\mu\text{s}$  (b)  $2\mu\text{s}$  (c)  $2\sqrt{2}\mu\text{s}$  (d)  $4\sqrt{2}\mu\text{s}$
- Q 13. Two point charges  $+q$  and  $-q$  are placed a distance  $x$  apart. A third charge is so placed that all the three charges are in equilibrium. Then
- (a) unknown charge is  $-4q/9$  (b) unknown charge is  $-9q/4$   
(c) it should be at  $(x/3)$  from smaller charge between them  
(d) None of the above
- Q 14. Charges  $2q$  and  $-q$  are placed at  $(a, 0)$  and  $(-a, 0)$  as shown in the figure. The coordinates of the point at which electric field intensity is zero will be  $(x, 0)$  where
- 
- (a)  $-a < x < a$  (b)  $x < -a$  (c)  $x > a$  (d)  $0 < x < a$
- Q 15. Five point charges ( $+q$  each) are placed at the five vertices of a regular hexagon of side  $2a$ . What is the magnitude of the net electric field at the centre of the hexagon?
- (a)  $\frac{1}{4\pi\epsilon_0} \frac{q}{a^2}$  (b)  $\frac{q}{16\pi\epsilon_0 a^2}$  (c)  $\frac{\sqrt{2}q}{4\pi\epsilon_0 a^2}$  (d)  $\frac{5q}{16\pi\epsilon_0 a^2}$
- Q 16. Two identical small conducting spheres having unequal positive charges  $q_1$  and  $q_2$  are separated by a distance  $r$ . If they are now made to touch each other and then separated again to the same distance, the electrostatic force between them in this case will be
- (a) less than before (b) same as before (c) more than before (d) zero
- Q 17. Three concentric conducting spherical shells carry charges  $+4Q$  on the inner shell  $-2Q$  on the middle shell and  $+6Q$  on the outer shell. The charge on the inner surface of the outer shell is
- (a) 0 (b)  $4Q$  (c)  $-Q$  (d)  $-2Q$
- Q 18. 1000 drops of same size are charged to a potential of 1 V each. If they coalesce to form a single drop, its potential would be
- (a) V (b) 10 V (c) 100 V (d) 1000 V
- Q 19. Two concentric conducting spheres of radii  $R$  and  $2R$  are carrying charges  $Q$  and  $-2Q$  respectively. If the charge on inner sphere is doubled, the potential difference between the two spheres will



- (a) become two times (b) become four times  
(c) be halved (d) remain same

Q 20. Charges  $Q$ ,  $2Q$  and  $-Q$  are given to three concentric conducting spherical shells A, B and C respectively as shown in figure. The ratio of charges on the inner and outer surfaces of shell C will be



- (a)  $+\frac{3}{4}$  (b)  $-\frac{3}{4}$  (c)  $\frac{3}{2}$  (d)  $-\frac{3}{2}$

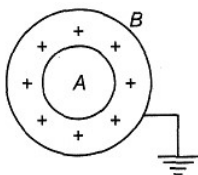
Q 21. The electric field in a region of space is given by  $\vec{E} = 5\hat{i} + 2\hat{j}$  N/C. The flux of  $\vec{E}$  due to this field through an area  $1 \text{ m}^2$  lying in the y-z plane, in SI units, is

- (a) 5 (b) 10 (c) 2 (d)  $5\sqrt{29}$

Q 22. A charge  $Q$  is placed at each of the two opposite corners of a square. A charge  $q$  is placed at each of the other two corners. If the resultant force on each charge  $q$  is zero, then

- (a)  $q = \sqrt{2}Q$  (b)  $q = -\sqrt{2}Q$  (c)  $q = 2\sqrt{2}Q$  (d)  $q = -2\sqrt{2}Q$

Q 23. A and B are two concentric spherical shells. If A is given a charge  $+q$  while B is earthed as shown in figure, then



- (a) charge on the outer surface of shell B is zero  
(b) the charge on B is equal and opposite to that of A  
(c) the field inside A and outside B is zero

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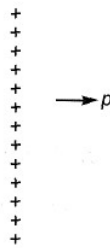
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- (d) All of the above
- Q 24. A solid sphere of radius R has charge 'q' uniformly distributed over its volume. The distance from its surface at which the electrostatic potential is equal to half of the potential at the centre is
- (a) R                      (b) 2R                      (c)  $\frac{R}{3}$                       (d)  $\frac{R}{2}$
- Q 25. Four dipoles each of magnitudes of charges  $\pm e$  are placed inside a sphere. The total flux of  $\frac{1}{\epsilon_0} \vec{E}$  coming out of the sphere is
- (a) zero                      (b)  $\frac{4e}{\epsilon_0}$                       (c)  $\frac{8e}{\epsilon_0}$                       (d) None of these
- Q 26. A pendulum bob of mass m carrying a charge q is at rest with its string making an angle  $\theta$  with the vertical in a uniform horizontal electric field E. The tension in the string is
- (a)  $\frac{mg}{\sin \theta}$                       (b) mg                      (c)  $\frac{qE}{\sin \theta}$                       (d)  $\frac{qE}{\cos \theta}$
- Q 27. Two isolated, charged conducting spheres of radii a and b produce the same electric field near their surfaces. The ratio of electric potentials on their surfaces is
- (a)  $\frac{a}{b}$                       (b)  $\frac{b}{a}$                       (c)  $\frac{a^2}{b^2}$                       (d)  $\frac{b^2}{a^2}$
- Q 28. Two point charges + q and - q are held fixed at (- a, 0) and (a, 0) respectively of a x-y coordinate system, then
- (a) the electric field  $\frac{1}{\epsilon_0} \vec{E}$  at all points on the x-axis has the same direction  
(b)  $\frac{1}{\epsilon_0} \vec{E}$  at all points on the y-axis is along  $\hat{i}$   
(c) positive work is done in bringing a test charge from infinity to the origin  
(d) All of the above
- Q 29. A conducting shell  $S_1$  having a charge Q is surrounded by an uncharged concentric conducting spherical shell  $S_2$ . Let the potential difference between  $S_1$  and that  $S_2$  be V. If the shell  $S_2$  is now given a charge -3Q, the new potential difference between the same two shells is
- (a) V                      (b) 2V                      (c) 4 V                      (d) -2V
- Q 30. At a certain distance from a point charge, the field intensity is 500 V/m and the potential is - 3000 V. The distance to the charge and the magnitude of the charge respectively are
- (a) 6m and 6 $\mu$ C                      (b) 4m and 2 $\mu$ C                      (c) 6m and 4 $\mu$ C                      (d) 6m and 2 $\mu$ C

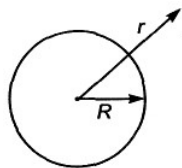
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- Q 31. Two point charges  $q_1$  and  $q_2$  are placed at a distance of 50 m from each other in air, and interact with a certain force. The same charges are now put in oil whose relative permittivity is 5. If the interacting force between them is still the same, their separation now is  
 (a) 16.6 m (b) 22.3 m (c) 28.4 m (d) 25.0 cm
- Q 32. An infinite line of charge  $\lambda$  per unit length is placed along the y-axis. The work done in moving a charge  $q$  from A(a, 0) to B(2a, 0) is  
 (a)  $\frac{q\lambda}{4\pi\epsilon_0} \ln 2$  (b)  $\frac{q\lambda}{2\pi\epsilon_0} \ln\left(\frac{1}{2}\right)$  (c)  $\frac{q\lambda}{4\pi\epsilon_0} \ln \sqrt{2}$  (d)  $\frac{q\lambda}{4\pi\epsilon_0} \ln 2$
- Q 33. An electric dipole is placed perpendicular to an infinite line of charge at some distance as shown in figure. Identify the correct statement.



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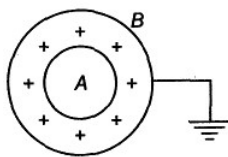
- (a) The dipole is attracted towards the line charge  
 (b) The dipole is repelled away from the line charge  
 (c) The dipole does not experience a force  
 (d) The dipole experiences a force as well as a torque
- Q 34. An electrical charge  $2 \times 10^{-8}$  C is placed at the point (1,2,4)m. At the point (4, 2, 0) m, the electric  
 (a) potential will be 36 V (b) field will be along y-axis  
 (c) field will increase if the space between the points is filled with a dielectric  
 (d) All of the above
- Q 35. If the potential at the centre of a uniformly charged hollow sphere of radius R is V then electric field at a distance r from the centre of sphere will be ( $r > R$ )



- (a)  $\frac{VR}{r^2}$  (b)  $\frac{Vr}{r^2}$  (c)  $\frac{VR}{r}$  (d)  $\frac{VR}{R^2 + r^2}$
- Q 36. A and B are two concentric spheres. If A is given a charge Q while B is earthed as shown in figure,

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- (a) the charge density of A and B are same    (b) the field inside and outside A is zero  
 (c) the field between A and B is not zero    (d) the field inside and outside B is zero

Q 37. There is an electric field  $E$  in  $x$ -direction. If the work done on moving a charge of  $0.2\text{ C}$  through a distance of  $2\text{ m}$  along a line making an angle  $60^\circ$  with  $x$ -axis is  $4\text{ J}$ , then what is the value of  $E$ ?

- (a)  $\sqrt{3}\text{ N/C}$     (b)  $4\text{ N/C}$     (c)  $5\text{ N/C}$     (d)  $20\text{ N/C}$

Q 38. Two thin wire rings each having radius  $R$  are placed at a distance  $d$  apart with their axes coinciding. The charges on the two rings are  $+Q$  and  $-Q$ . The potential difference between the centres of the two rings is

- (a) zero    (b)  $\frac{Q}{4\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$   
 (c)  $\frac{Q}{4\pi\epsilon_0 d^2}$     (d)  $\frac{Q}{2\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$

Q 39. The electric field at a distance  $2\text{ cm}$  from the centre of a hollow spherical conducting shell of radius  $4\text{ cm}$  having a charge of  $2 \times 10^{-3}\text{ C}$  on its surface is

- (a)  $1.1 \times 10^{10}\text{ V/m}$     (b)  $4.5 \times 10^{-10}\text{ V/m}$     (c)  $4.5 \times 10^{10}\text{ V/m}$     (d) zero

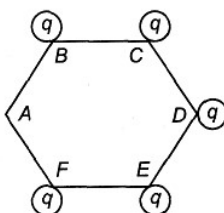
Q 40. Charge  $Q$  is given a displacement  $\vec{r} = a\hat{i} + b\hat{j}$  in an electric field  $\vec{E} = E_1\hat{i} + E_2\hat{j}$ . The work done is

- (a)  $Q(E_1a + E_2b)$     (b)  $Q\sqrt{(E_1a)^2 + (E_2b)^2}$   
 (c)  $Q(E_1 + E_2)\sqrt{a^2 + b^2}$     (d)  $Q\sqrt{E_1^2 + E_2^2}\sqrt{a^2 + b^2}$

**PART 5 Q****Match the Columns**

- Q 1. Five identical charges are kept at five vertices of a regular hexagon. Match the following two columns at centre of the hexagon. If in the given situation electric field at centre is E. Then

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Column I	Column. II
(a) If charge at B is removed then electric field will become	(P) 2E
(b) If charge at C is removed then electric field will become	(q) E
(c) If charge at D is removed then electric field will become	(r) zero
(d) If charges at B and C both are removed then electric field will become	(s) $\sqrt{3}E$

**Note** Only magnitudes of electric field are given.

- Q 2. In an electric field  $\vec{E} = (2\hat{i} + 4\hat{j}) \text{ N/C}$ , electric potential at origin is 0 V. Match the following two columns.

Column I	Column II
(a) Potential at (4m, 0)	(p.) 8 V
(b) Potential at (-4m, 0)	(q) -8V
(c) Potential at (0, 4m)	(r) 16 V
(d) Potential at (0, -4 m)	(s) -16 V

- Q 3. Electric potential on the surface of a solid sphere of charge is V. Radius of the sphere is 1 m. Match the following two columns.

Column I	Column II
(a) Electric potential at $r = \frac{R}{2}$	(p) $\frac{V}{4}$
(b) Electric potential at $r = 2R$	(q) $\frac{V}{2}$

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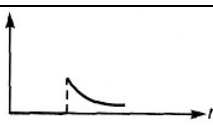
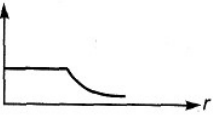

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(c) Electric field at $r = \frac{R}{2}$	(r) $\frac{3V}{4}$
(d) Electric field at $r = 2R$	(s) None of these

Q 4. Match the following two columns.

Column I	Column II
(a) Electric potential	(p) $[MLT^{-3}A^{-1}]$
(b) Electrical field	(q) $[ML^3T^{-3}A^{-1}]$
(c) Electric flux	(r) $[ML^2T^{-3}A^{-1}]$
(d) Permittivity of free space	(s) None of these

Q 5. Match the following two columns.

Column I	Column II
(a) Electric field due to charged spherical shell	(P) 
(b) Electric potential due to charged spherical shell	(q) 
(c) Electric field due to charged solid sphere	(r) 
(d) Electric potential due to charged solid sphere	(s) None of these

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