JEEt Lo 2021

PHYSICS

GRADE - 12

•LIVE

RELATION BETWEEN ELECTRIC FIELD & POTENTIAL

| SURI SIR |

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Namaste everyone !

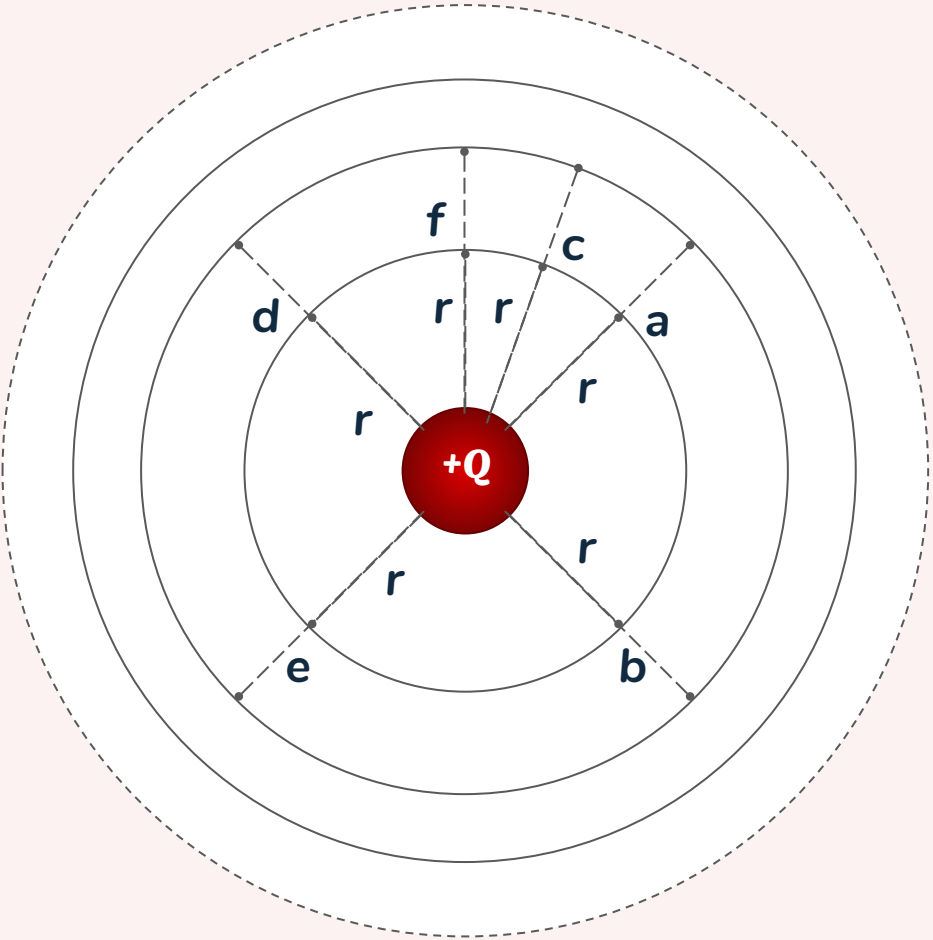
Welcome to today's session

Relation between electric field and potential

Lesson plan

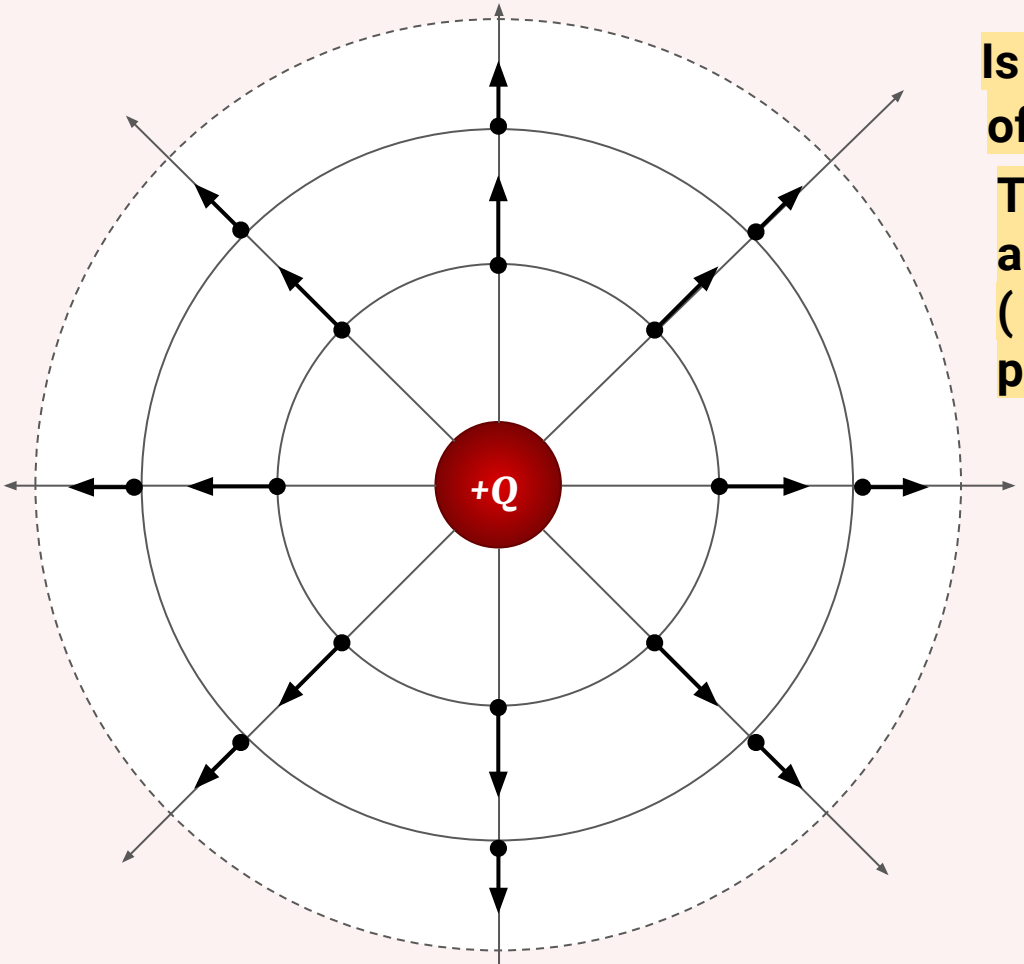
- ➔ Defining equipotential surface
- ➔ Direction of electric field w.r.t equipotential surface
- ➔ Work done to move a charge
- ➔ Finding relation between electric field and potential
- ➔ Various equipotential surfaces

Equipotential surfaces



How many equipotential surfaces can You think of ?n same potential at all points is called equipotential surface potential point charge.

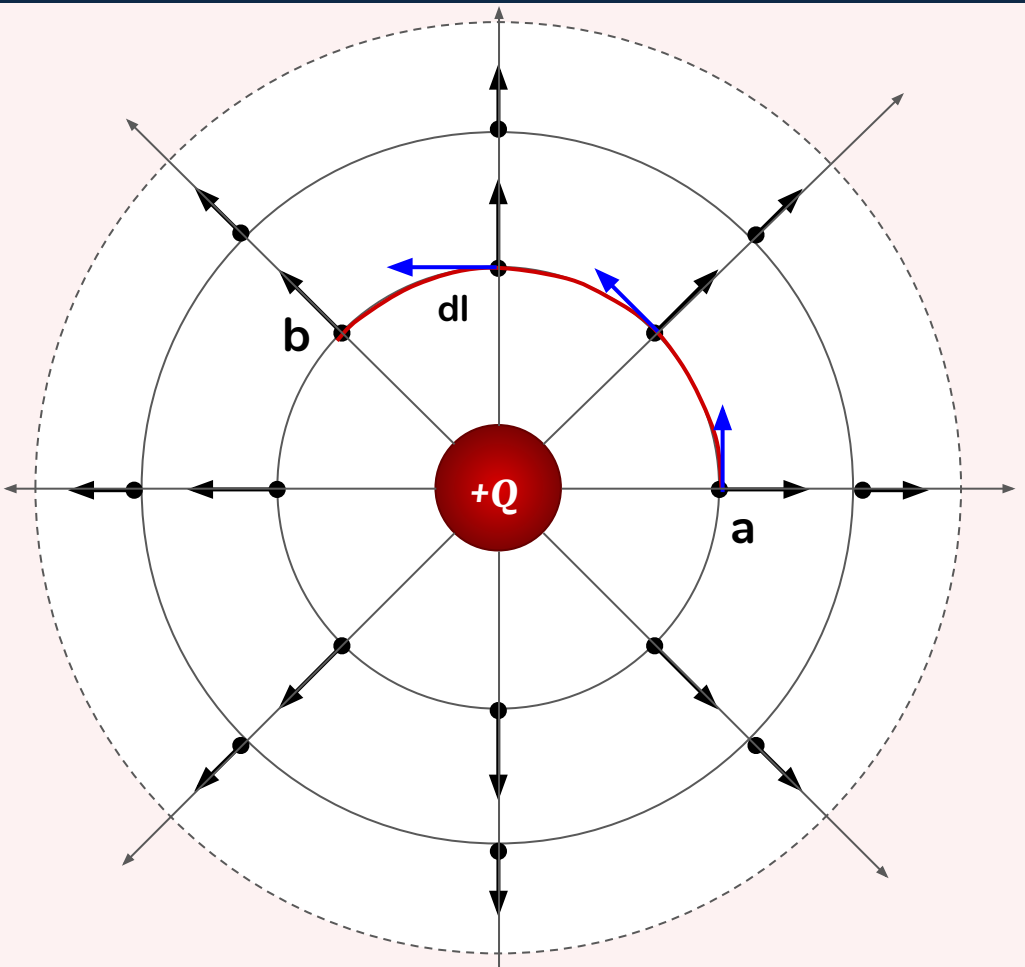
Direction of electric field



Is it true for any equipotential surface ?n of point charge?vards.

This means electric field vector drawn at any point on the equipotential surface (Concentric spherical surfaces) is perpendicular to it.

Work done to move charge



W (a→b)=?

$$V_b - V_a = \frac{W_{ext}}{q} = -\int_a^b \vec{E}.\vec{dl}$$

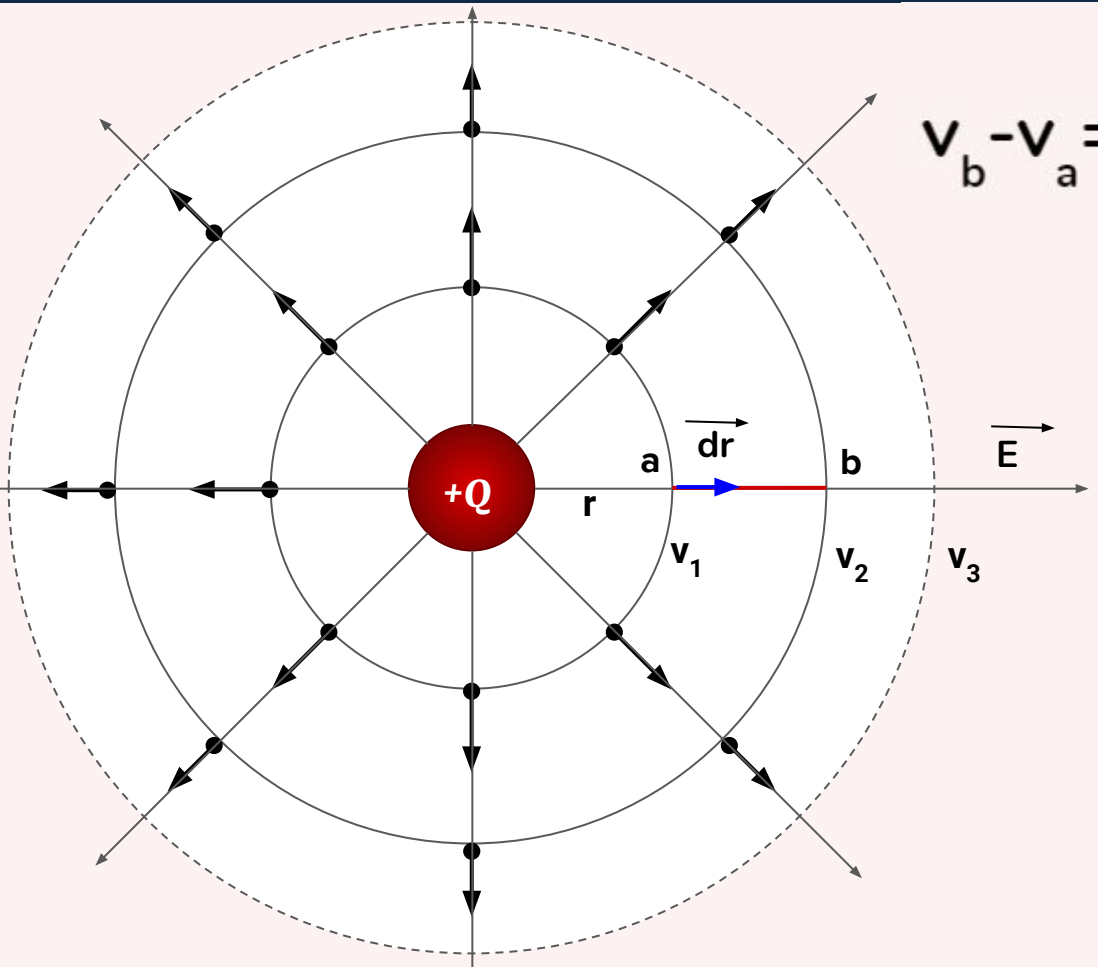
But $V_b = V_a$ =constant

$$W_{ext} = 0 \Rightarrow \vec{E}.\vec{dl} = 0$$

$\Rightarrow \vec{E}$ is pendicular to $\vec{dl}$

This is valid for any equipotential surface. Therefore electric field is always perpendicular to any equipotential surface

Relation between electric field and potential



$$v_b - v_a = v_2 - v_1 = -\int_a^b \vec{E}.\vec{dl} = -\int_a^b \vec{E}.\vec{dr}$$

$$= -\int_a^b E\cos(0)\,dr = -\int_a^b E\,dr$$

Now if the two surfaces are very close to each other, then electric field can be assumed to be constant,

$$v_2 - v_1 = dv = -E\int_r^{r+dr} dr = -E\,dr$$

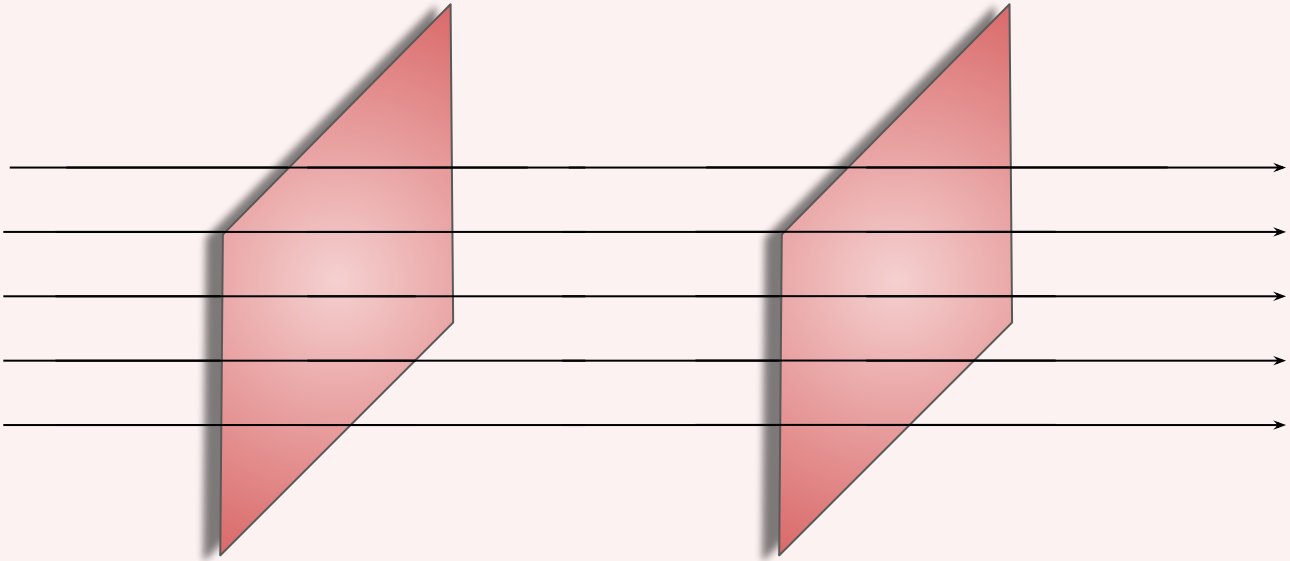
$$-\frac{dv}{dr} = E$$

Let's summarize

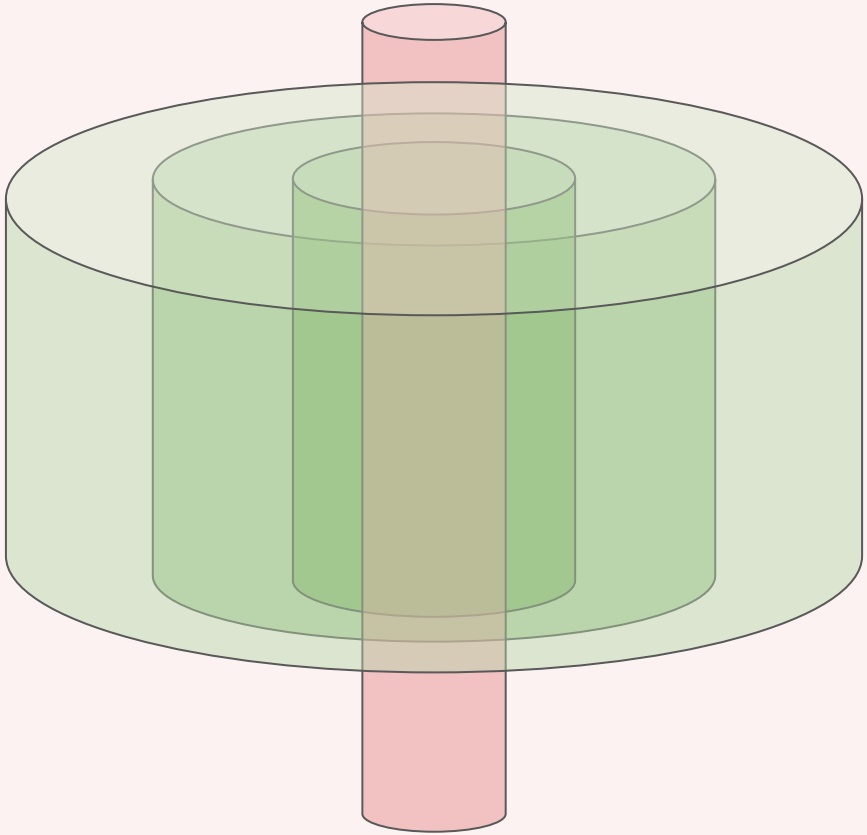
1. Electric lines of force always intersect an equipotential surface perpendicularly
2. Work done to move a charge over an equipotential surface is zero.
3. No two equipotential surfaces can intersect each other. If they do, then they will have two values of potential at the point of intersection which is not possible
4. From E=-dv/dr, E and dr are inversely proportional. This means equipotential surfaces are crowded together in a region of strong electric field whereas further apart where the field is week.

Keeping these points in mind let's try to map out equipotential surfaces for various field patterns

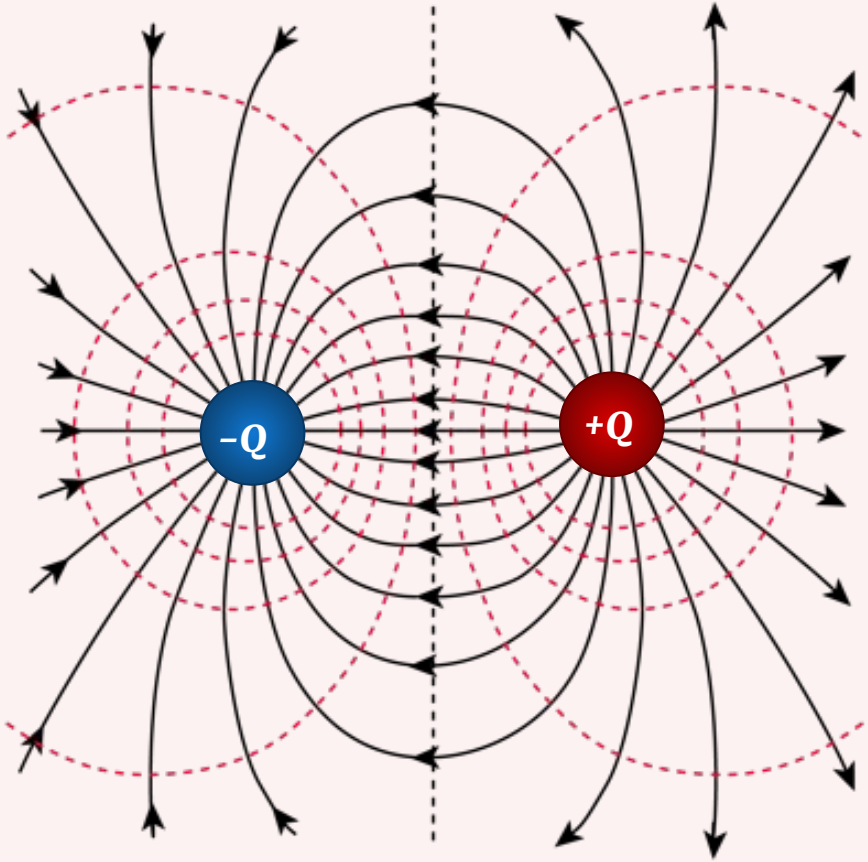
Uniform field



Line charge



Two equal and opposite charges



Notice how the equipotential surfaces are more crowded near the charge and further apart as we go away from it

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A charged particle (q = 1.4 mC) moves a distance of 0.4 m along an equipotential surface of 10 V, calculate the work done by the field during this motion.

The potential at a pot x (measure in μ m) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volt. The electric field E at x = 4 μm is given by (JEE 2007)

A (10/9) vot/μm and in the +ve x direction

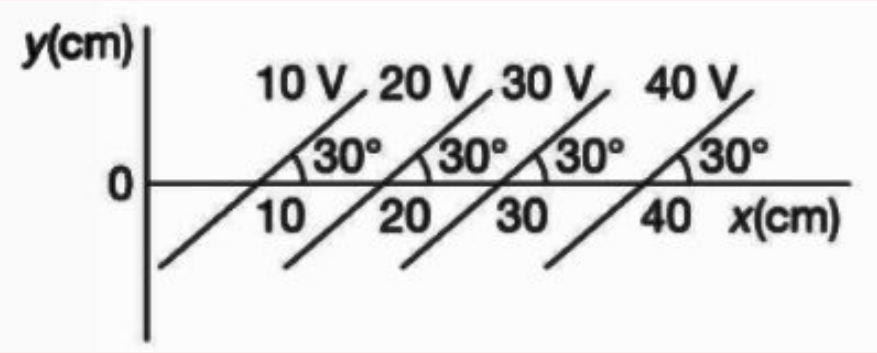
B (5/3) volt/μm and in the -ve x direction

C (5/3) volt/μm and in the +ve x direction

D (10/9) volt/μm and in the -ve x direction

For given $\overrightarrow{E} = 2x\hat{i} + 3y\hat{j}$ find the potential at (x, y) if V at origin is 5 V.

Some equipotential surface are shown in Fig. What can you say about the magnitude and the direction of the electric field?



H.W

Study how conductors and equipotential surfaces are related.

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Assignments

Notes

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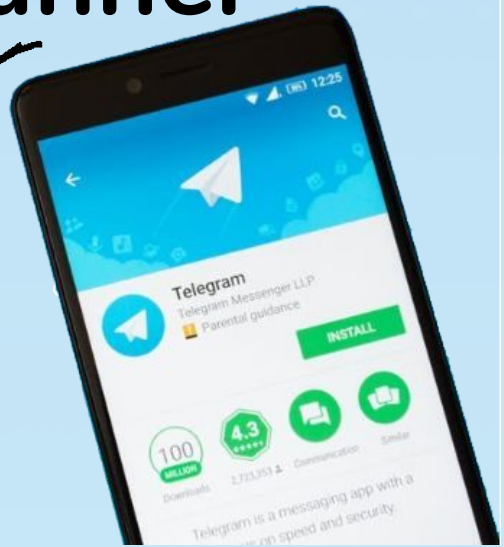

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