PHYSICS

BOOKS - MODERN PUBLICATION

Fluid Flow

Example

1. Water flow througyh a horizontal pipe whose internal diameter is 2.0 cm at a speed of $1.0ms^{-1}$ What should be the diameter of

the nozzle, If the water is to emerge at a speed of $4.0ms^{-1}$?

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2. An aeronautical engineer observed that on the upper and the lower surface of the wing of an aeroplane the speed of the air are $90ms^{-1}$ and $75ms^{-1}$ respectively during flight. What is the lift on the wing of aeroplane if its area is 3.2 m^(2)? Given density of air is 1.29 kg//m^(3)

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3. A tank containing water has an orifice on one vertical wall. If the centre of the orifice is 4.9 m below the surface of water in the tank, find the velocity of discharge.

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4. Verify that the quantity $\left(\frac{\rho v D}{\eta}\right)$Reynolds number) is dimensionless.

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5. A liquid of density $1.15 gcm^{-3}$ flows through a pipe of diameter 1.5 cm. What would be the minimum average flow speed, if the flow were turbulent? Given that coefficient of viscosity of the liquid is 0.022 paise.

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6. What is the maximum flow rate of water for laminar flow in a pipe having diameter of 5 cm.

Given that coefficient of viscosity of water is 10^{-3} Pa s.

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7. The flow rate from a tap of diameter 1.25 cm is 3 litres per minute. The coefficient of viscosity of water is 10^{-3} Pa s. Characterize the flow.

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8. A spray pump used for killing insects is made of a cylindrical tube of cross-section of $10cm^2$. It has 50 fine holes, each of radius 0.05 cm. If the insect killing agent (a liquid) enters the tube of the pump at `2.4 m min^-1, what is speed of ejection of the liquid through the holes?

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9. At what speed will the velocity head of stream of water be equal to 40 cm?

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10. The reading of pressure meter attached with a closed water pipe is 3.5 xx 10^(5) Nm^(-2) . On opening the valve of the pipe, the reading of pressure meter is reduced to 3 xx 10^(5) Nm^(-2). Calculate the speed of water

flowing out of the pipe. Given that the density of water = $1,000 kgm^{-3}$

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11. Each of the two wings of an aeroplane han an area of $30m^2$ The speed of the air is $70ms^{-1}$ over the low wing and $90ms^{-1}$ over the upper wing surface. If the plane is in level flight at constant speed, determine the uplift and mass of the plane.Given density of air =1.29 kg m^(-3).

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12. Calculate the velocity of efflux of kerosene oil from an orifice of a tank in which pressure is 4 atmosphere. The density of kerosene oil- $720kgm^{-3}$ and 1 atmospheric pressure 1.013 xx 10^5 N m^2`.

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13. A cylinder of height 20 m is completely or filled with water. Find the velocity of efflux of

water (in m s^-1) through a small hole on the side wall of the cylinder near its bottom. Given, g = $10ms^{-2}$

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14. The flow of blood in a large artery of an anaesthetized dog is diverted through a venturimeter. The wider part of the meter has a cross-sectional area equal to that of the artery i.e.$5mm^2$. The narrower part has an area $4mm^2$ The pressure drop in the artery is

24 Pa. What is the speed of the blood in the artery ? Given that density of the blood $1.06 \times 10^3 kgm^{-3}$

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15. A pitot tube is mounted on an acroplane wing to measure the speed of the plane. The tube contains alcohol and shows a level difference of 40 cm as shown in Fig. What is the speed of the plane relative to air? Given

that relative density of alcohol = 0-8 and density of air= $1kgm^{-3}$

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16. Water is flowing steadily through a horizontal pipe of non-uniform cross-section. The pressure of water is $4 \times 10^4 Nm^{-2}$ at a point, where cross-section is $0.02m^2$ and velocity of flow is $2ms^{-1}$. What is the pressure at a point, where cross-section reduces to $0.01m^2$

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17. Air is streaming past a horizontal air plane wing such that its speed is $120ms^{-1}$ over the upper surface and $90ms^{-1}$ at the lower surface. If the density of air is $1.3kgm^{-3}$ find the difference in pressure between the top and bottom of the wing. If the wing is 10 m long and has an average width of 2 m, calculate the gross lift of the wing

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18. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides. If the radius of the vessel is 0.05m and the speed of rotation is 20 r.p.s., find the difference in the height of the liquid at the centre of the vessel and its sides

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19. Calculate the rate of flow of glycerine of density $1.25 \times 10^3 kgm^{-3}$ through the conical section of a pipe, if the radii of its ends area

0.1 m and 0.04 m and the pressure drop across its length is $10Nm^{-2}$.

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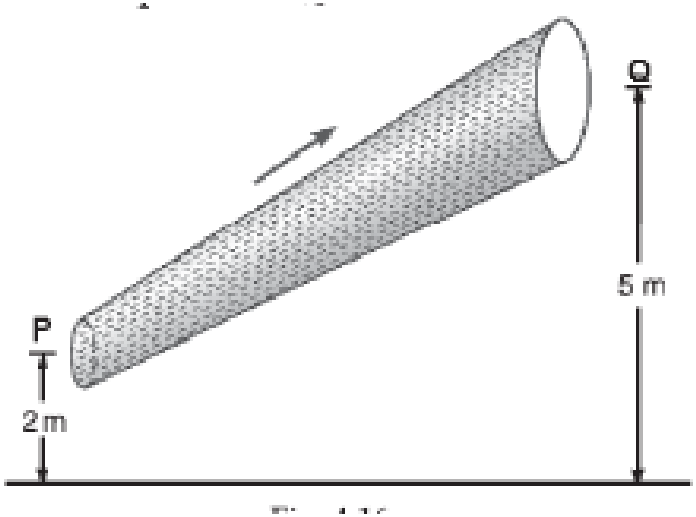
20. A non viscous liquid of constant density 10^(3) kg//m^(3) flows in stream line motion along a tube of variable cross-section. The tube is kept inclined in the verticaly plane as shown in Fig. The area of cross section of the tube at two points P and Q at heights if 2 m and 5 m are respectively $4 \times 10^{-3}m^2$ and

$8 \times 10^{-3} m^2$. Find the work done per unit volume by pressure and gravity forces as liquid flows from P to Q.



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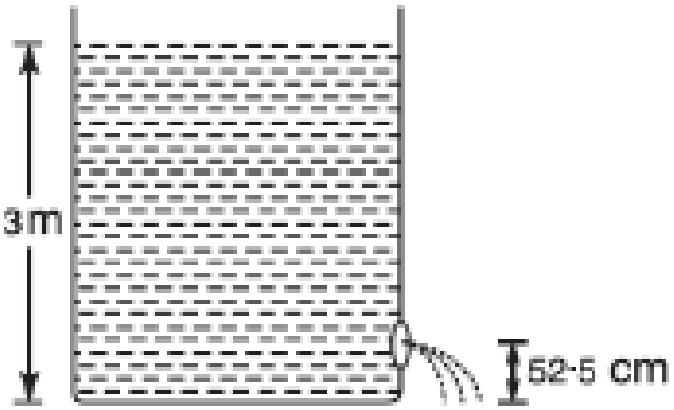
21. Water is filled in a cylindrical container to a height of 3 m [Fig.]. The ratio of the cross-

sectional area of the orifice and the beaker is 0.1. Find the speed of the liquid coming out from the orifice. Given, g=$10ms^{-2}$



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22. Cars and aeroplanes are streamlined. Explain,why?

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23. What is meant by the critical velocity of a liquid?

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24. What happens, when velocity of the liquid becomes greater than its critical velocity?

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25. What happens to the external energy maintaining the flow during turbulent flow?

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26. Why does the speed of a liquid increase, when the liquid passes through a constriction in a pipe ?

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27. What should be the properties of a liquid to satisfy Bernoulli's theorem?

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28. What is pressure head?

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29. What is velocity head?

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30. Bemoulli's theorem holds for incompressible, non-viscous fluids. What will happen, if the viscosity of the fluid is not negligible?

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31. Distinguish between streamline and turbulent flow of a liquid.

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32. Two streamlines cannot cross each other. Explain why.

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33. What is Reynolds number? What is its importance?

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34. Why does the speed of a liquid increase, when the liquid passes through a constriction in a pipe ?

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35. Why is it dangerous to stand on the edge of the platform near the railway line when the train is passing by?

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36. Why two ships moving in parallel directions close to each other get attracted?

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37. The speed of inner layer of the whirl wind in a tornado is alarmingly high. Explain why

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38. During a certain-wind storm, light roofs are blown off. Why?

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39. If you hold a narrow strip of paper in front of your mouth and blow over the top surface, the strip will rise. Why?

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40. Why flags flutter on a windy day?

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41. When air is blown in between the two balls suspended from a string such that they do not touch each other, the balls come nearer to each other, instead of moving away. Why?

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42. Why a light ball can remain suspended on a vertical jet of water?

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43. If a small ping pong ball is placed in a vertical jet of air or water, it will rise to a certain height above the nozzle and stay at that level. Explain.

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44. A ping pong ball remains trapped in the funnel. When air is blown downward through the funnel, the ping pong ball remains trapped in the funnel. Why?

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45. Why is it impossible to remove a filter paper from a funnel by blowing it into the narrow end of the funnel?

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46. Explain using Bernoulli's equation, why there is a lifting force produced by the flow of air past the wings of an aeroplane.

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47. Wings help an aeroplane to rise high against gravity. Explain.

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48. The accumulation of snow on an aeroplane wings may reduce the lift. Explain.

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49. Explain, how does the wing of an aeroplane get an upward lift.

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50. (a) What is the largest average velocity of blood flow in an artery of radius 2×10^{-3} m if the flow must remain laminar? (b) What is the corresponding flow rate? (Taking viscosity of blood to be $2.084 \times 10^{-3} Pas$)

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51. What should be the average velocity of water in a tuber of diameter 0.4 cm, so that

the flow is laminar. The viscosity of water is $10^{-3} Nm^{-2} s$

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52. Find the minimum average velocity of water flow through a pipe of diameter 1cm so that the flow is definitely turbulent. The viscosity and density of water can be taken as $10^{-3} Ns/m^2$ and $1000 kg/m^3$, respectively:

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53. The water entering a hauze flows with a speed of $0.1ms^{-1}$ through a pipeat 21 mm inside diameter. What is the speed of water at a point, where pipe lapers to a diameter of 7 mm?

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54. A liquid is flowing through a horizontal pipe line of varying cross - section .At a certain point the diameter of the pipe is $6cm$ and the velocity of flow of liquid is $2cms^{-1}$ Calculate

the velocity of flow at another point where the diameter is $1.5cm$.

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55. A garden hose having an internal diameter 2.0 cm is connected to a lawn sprinkle that consists of an enclosure with 24 holes , each 0.125 cm in diameter. If water in the hose has a speed of $90.0cms^{-1}$, find the speed of the water having the sprinkler hole.

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56. Air of density $1.3kgm^{-3}$ blows horizontally with a speed of $108kmh^{-1}$ A house has a plane roof of area $40m^2$ Find the magnitude of aerodynamic lift on the roof.

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57. Water flowing ina horizontal main of unifrom bore has a velocity of $100cms^{-1}$ at a point ,where the pressure is 1/10 of the atmospheric pressure .what will be the velocity

at a point ,where the pressure is one half of that at the first point ?

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58. Waler is flowing through a horizontal pipe of varying cross section. If the pressure of water equals 2 cm of mercury, where the velocity of the flow is $32cms^{-1}$, what is the pressure at another point, where the velocity of flow is $60cms^{-1}$?

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59. A horizontal pipe is running full of water. At a certain point A it tapers from 60 cm diameter to 20 cm diameter at B. The pressure difference between A and B is 100 cm of water column. Find the rate of flow of water through the pipe.

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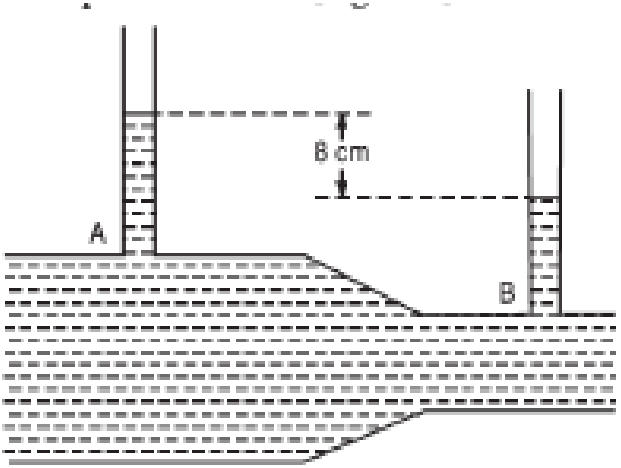
60. A horizontal tube has different cross-sectional areas at point A and B .The diameter

of A is 4 cm and that of B is 2 cm. Two manometer limbs are attached at A and B. When a liquid of density $800kgm^{-3}$ flows through the tube, the pressure difference between the limbs of the manometer is 8 cm. Calculate the rate of flow of the liquid in the tube deriving the necessary formula. (g= $9.8ms^{-2}$)



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61. Waler is flowing through a horizontal pipe of varying cross section. If the pressure of water equals 2 cm of mercury, where the velocity of the flow is $32cms^{-1}$, what is the pressure at another point, where the velocity of flow is $60cms^{-1}$?

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62. At what speed will the velocity head of a stream of water he equal in 4.9 m?

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63. Water is maintained at a height of 10 m in a tank. Calculate the diameter of a circular aperture needed at the base of the tank to discharge water at the rate of $26.4m^3 \text{ min}^{-1}$ Given that g=$9.8ms^{-2}$

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64. A small hole is made at a height of $\frac{1}{\sqrt{2}}$ m from the bottom of a cylindrical water tank and at a depth of $\sqrt{2}$ m from the free surface of water in the tank. Find the distance, where the water emerging from the hole strikes the ground.

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65. A venturimeter is 37.5 cm is diameter in the mains and 15 cm diameter in the throat. The

difference between the pressure of water in the mains and the throat is 23 cm of mercury. Find the rate of discharge of water from the venturimeter.

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66. The radii of the two parts of a venturimeter are 20 cm and 10 cm respectively. When the venturimeter is connected to a water pipe, the levels of water in the manometer tubes differ

by 10 cm. Find the rate of flow of water through the pipe.

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67. A fully loaded Boeing aircraft has a mass of 3.3×10^5 kg. Its total wing area is $500m^2$. It is in level flight with a speed of $960kmh^{-2}$. Estimate the pressure difference between the lower and upper surfaces of the wings. The density of air is $1.2kgm^{-3}$.

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68. A fully loaded Boeing aircraft has a mass of 3.3×10^5 kg. Its total wing area is $500m^2$. It is in level flight with a speed of $960kmh^{-2}$. Estimate the fracitional increases in the speed of the air on the upper surfaces of the wing relative to the lower surface. The density of air is $1.2kgm^{-3}$.

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69. Calculate the minimum pressure required to force the blood from the heart to the top of the head (vercical distance = 50 cm). Assume that the denisity of blood to be $1.06 g cm^{-3}$.

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70. Water stands at a depth 'H' in a tank whose side walls are vertical. A hole is made on one of the walls at a depth 'h' below the water surface.

AT what distance R from the foot of the wall does themerging stream of water strike tha floor?

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Exercise

1. Distinguish between streamline and turbulent flow of a liquid.

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2. Distinguish between turbulent and streamlined flow of liquids.

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3. Derive the equation of continuity for steady flow of an ideal liquid.

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4. What is Reynolds number? What is its importance?

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5. Derive the equation of continuity for steady flow of an ideal liquid.

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7. What are the various types of energies of a flowing liquid? Express them in terms of unit mass of the liquid.

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8. Give some practicle applications of Bernoulli's theorem.

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9. Give the principle of working of Atomiser by making use of simple diagram.

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10. Give the principle of working of Bunsen burner by making use of simple diagram.

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11. Write a note on venturimeter.

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12. Distinguish between turbulent and streamlined flow of liquids.

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13. Write down the relation between critical velocity, coefficient of viscosity of the liquids, its density and the radius of the tube.

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14. What is the value of Reynolds number for streamline flow?

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15. State and prove Bernoulli's theorem for liquid having streamline flow.

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16. State and prove Bernoulli's theorem for liquid having streamline flow.

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17. State and prove Bernoulli's theorem for liquid having streamline flow.

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18. What are the various forms of energy possessed by a flowing liquid ? Write their expressions.

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19. What are the various forms of energy possessed by a flowing liquid ? Write their expressions.

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20. Bernoulli's equation is important in the field of

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