CHAPTER

02 Fluid Dynamics

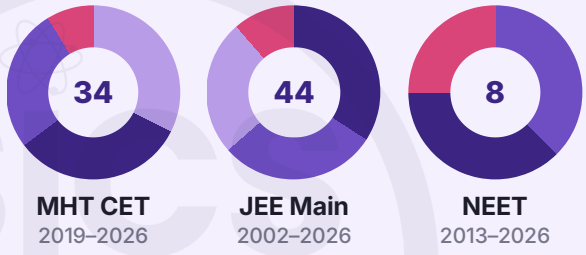
MHT CET · JEE · NEET Physics

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EXAM WEIGHTAGE



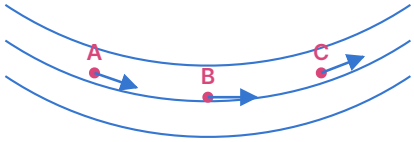
	CET	JEE	NEET
Velocity of Efflux (Torricelli)	11 32%	15 34%	3 38%
Bernoulli's Equation	9 26%	13 30%	3 38%
Types of Flow, Reynolds Number & Continuity	11 32%	11 25%	0 0%
Applications of Bernoulli's Theorem	3 9%	5 11%	2 25%

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01 CONCEPT
Types of Flow, Reynolds Number & Continuity

IN ONE LINE
Slow flow is orderly and fast flow breaks up. In steady flow, the same volume passes every section, so **av = constant**.

2.1.1 Streamline flow

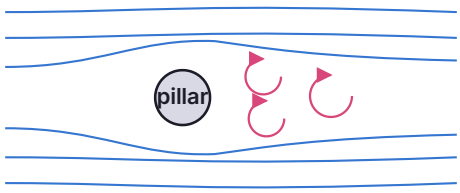


Each element follows the one before it

- Each element follows the same path with the same velocity as the element before it at that point.
- A streamline is a path whose tangent at any point gives the direction of flow.
- Two streamlines **cannot cross**.
- Crowded streamlines mean larger velocity.

2.1.2 Laminar and turbulent flow

- **Laminar**: liquid moves in layers that do not mix. Velocity stays below the critical velocity.
- **Turbulent**: above the critical velocity the motion becomes irregular.
- Most of the energy then goes into eddies, as beside a bridge pillar.



Eddies behind a pillar

2.1.3 Critical velocity and Reynolds number

- **Critical velocity**: the speed up to which flow stays streamline.
- **Reynolds number** R_n is a pure number: inertial force per unit area ÷ viscous force per unit area.

$$R_n = \frac{\rho v d}{\eta}$$

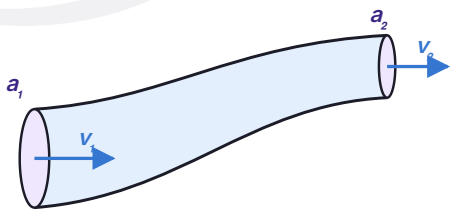
$$v_c = \frac{R_n \eta}{\rho d}$$

- d is the diameter of the tube.
- v_c is directly proportional to η, and inversely proportional to ρ and d.

R_n	Flow
below 1000	streamline (steady)
1000 to 2000	unsteady, changing
above 2000	turbulent

- Some books give 2000 and 3000 as the limits instead. MHT CET questions follow this table.

2.1.4 Equation of continuity



Tube of varying cross-section

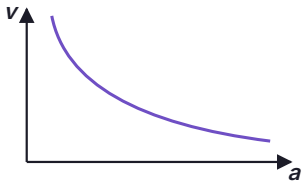
- Mass in per second = mass out per second.

$$a_1\rho_1 v_1 = a_2\rho_2 v_2$$

- For an incompressible liquid, $\rho_1 = \rho_2$.

$$a_1 v_1 = a_2 v_2 \Rightarrow av = \text{constant} \Rightarrow a \propto \frac{1}{v}$$

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Area against speed: a hyperbola

- Circular pipe: $v \propto \frac{1}{r^2} \propto \frac{1}{d^2}$.
- Several outlets: n $a_2v_2 = a_1v_1$ (spray gun, sprinkler).
- Rate of flow Q = av.

2.1.5 Everyday examples

- Hills: narrow, shallow river, faster water. Plains: wide, deep river, slower water.
- Water from a tap speeds up as it falls, so the stream becomes narrower.

JEE · NEET Corner

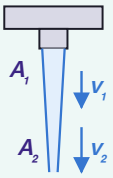
Force of a jet on a wall

- Mass striking per second = ρAv.
- Force = rate of change of momentum.

$$F = \rho Av^2 \text{ (water stopped)}$$

- Water bouncing back at the same speed: $F = 2\rho Av^2$.

Falling stream from a tap



The stream narrows

$$v_2^2 = v_1^2 + 2gh \cdot A_1v_1 = A_2v_2$$

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Solved Examples 01 Types of Flow, Reynolds Number & Continuity

SOLVED 1 MHT CET 2023 · 12 May · Shift 2

Select the WRONG statement. In a streamline flow

(a) velocity of a fluid at a given point is never constant
(b) velocity is smaller than critical velocity
(c) layers are always parallel
(d) the particles do not move in random direction

STEP 1 Streamline flow is steady
STEP 2 Velocity at a given point stays constant in time
STEP 3 Wrong statement: **(a)**

Answer: **(a)**

SOLVED 2 MHT CET 2026 · 20 Apr · Shift 1

In case of a liquid, if Reynolds number R_n is 1450, then the flow of liquid will

(a) be streamline
(b) be turbulent
(c) change from streamline to turbulent flow
(d) be sometimes turbulent and sometimes streamline

STEP 1 R_n below 1000: streamline; above 2000: turbulent
STEP 2 1450 lies between 1000 and 2000
STEP 3 **Flow changes from streamline to turbulent**

Answer: **(c)**

SOLVED 3 MHT CET 2023 · 9 May · Shift 2

A fluid of density ρ and viscosity η flows through a pipe of diameter d with velocity v. Reynolds number is

(a) $\frac{2d\rho v}{\eta}$ (b) $\frac{d\rho v}{\eta}$
(c) $\frac{d\rho v}{\eta^2}$ (d) $\frac{2\eta dv}{\rho}$

STEP 1 R_n compares inertial force with viscous force
STEP 2 Length scale is the diameter d
STEP 3 $R_n = \frac{\rho v d}{\eta}$

Answer: **(b)**

SOLVED 4 MHT CET 2023 · 11 May · Shift 2

A fluid of density ρ flows through a uniform tube of diameter d. The coefficient of viscosity of the fluid is η. The critical velocity of the fluid is

(a) inversely proportional to η
(b) directly proportional to η
(c) directly proportional to d
(d) directly proportional to ρ

STEP 1 At the critical value, $R_n = \frac{\rho v_c d}{\eta}$
STEP 2 $v_c = \frac{R_n \eta}{\rho d}$
STEP 3 v_c is **directly proportional to η**

Answer: **(b)**

SOLVED 5 MHT CET 2021 · 24 Sep · Shift 1

A glass tube of uniform cross-section is connected to a tap. Initially the flow in the tube is streamline. The speed at which it turns turbulent is (radius of tube = 1 cm, $\eta = 1 \times 10^{-3}$ N s/m², $R_n = 2500$, density of water = 10^3 kg/m³)

(a) 0.15 m/s (b) 0.125 m/s
(c) 0.3 m/s (d) 0.2 m/s

STEP 1 $v = \frac{R_n \eta}{\rho d}$, with d = 2 cm = 0.02 m
STEP 2 $v = \frac{2500 \times 10^{-3}}{10^3 \times 0.02}$
STEP 3 v = **0.125 m/s**

Answer: **(b)**

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Solved Examples 01 Types of Flow, Reynolds Number & Continuity (contd.)

SOLVED 6 MHT CET 2026 · 19 Apr · Shift 1

An incompressible fluid flows steadily through a horizontal cylindrical pipe. The pipe has radius 3R at point A and 1.5R at point B. If the velocity at A is v, then at B it is

(a) v (b) 2v
(c) 3v (d) 4v

STEP 1 $a_1v_1 = a_2v_2$, with $a \propto r^2$
STEP 2 $(3R)^2v = (1.5R)^2v_B$
STEP 3 $v_B = \mathbf{4v}$

Answer: **(d)**

SOLVED 7 MHT CET 2025 · 21 Apr · Shift 1

An incompressible fluid flows steadily through a pipe of radius R at A and $\frac{R}{3}$ at B. If the velocity at A is V, then at B it is

(a) $\frac{V}{9}$ (b) $\frac{V}{3}$
(c) 3V (d) 9V

STEP 1 $v \propto \frac{1}{r^2}$
STEP 2 Radius becomes one third
STEP 3 $v_B = \mathbf{9V}$

Answer: **(d)**

SOLVED 8 MHT CET 2025 · 21 Apr · Shift 2

Water flows through a horizontal pipe of varying cross-section at the rate of $\pi \times 10^{-1}$ m^3/s. The velocity where the radius of the pipe is 10 cm is

(a) 0.1 m/s (b) 1 m/s
(c) 10 m/s (d) 100 m/s

STEP 1 $Q = av$
STEP 2 $a = \pi(0.1)^2 = \pi \times 10^{-2}$ m^2
STEP 3 $v = \frac{\pi \times 10^{-1}}{\pi \times 10^{-2}} = \mathbf{10\ m/s}$

Answer: **(c)**

SOLVED 9 MHT CET 2023 · 10 May · Shift 1

Water flows through a horizontal pipe at speed V. The internal diameter is d. If water comes out at speed V_1, the diameter of the nozzle is

(a) $d\sqrt{(\frac{V_1}{V})}$ (b) $d\sqrt{(\frac{V}{V_1})}$
(c) $\frac{dV}{V_1}$ (d) $\frac{V_1}{dV}$

STEP 1 $d^2V = d_1^2V_1$
STEP 2 $d_1^2 = d^2\frac{V}{V_1}$
STEP 3 $d_1 = \mathbf{d\sqrt{(\frac{V}{V_1})}}$

Answer: **(b)**

SOLVED 10 JEE Main 2020 · 7 Jan · Shift 2

An ideal fluid flows through a pipe of non-uniform diameter. The maximum and minimum diameters are 6.4 cm and 4.8 cm. The ratio of the minimum and maximum velocities is

(a) $\frac{3}{4}$ (b) $\frac{9}{16}$
(c) $\frac{\sqrt{3}}{2}$ (d) $\frac{81}{256}$

STEP 1 $v \propto \frac{1}{d^2}$
STEP 2 Minimum v at the largest diameter
STEP 3 $\frac{v_{min}}{v_{max}} = (\frac{4.8}{6.4})^2 = \mathbf{\frac{9}{16}}$

Answer: **(b)**

SOLVED 11 JEE Main 2015 · 10 Apr · Shift 1

If it takes 5 minutes to fill a 15 litre bucket from a tap of diameter $\frac{2}{\sqrt{\pi}}$ cm, the Reynolds number for the flow is close to (density = 10^3 kg/m^3, viscosity = 10^{-3} Pa s)

(a) 5500 (b) 11,000
(c) 550 (d) 1100

STEP 1 $Q = \frac{15 \times 10^{-3}}{300} = 5 \times 10^{-5}$ m^3/s; area = 1 cm^2, so v = 0.5 m/s
STEP 2 $d = 1.13 \times 10^{-2}$ m
STEP 3 $R_e = \frac{10^3 \times 0.5 \times 1.13 \times 10^{-2}}{10^{-3}} \approx \mathbf{5500}$

Answer: **(a)**

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02 CONCEPT Bernoulli's Equation

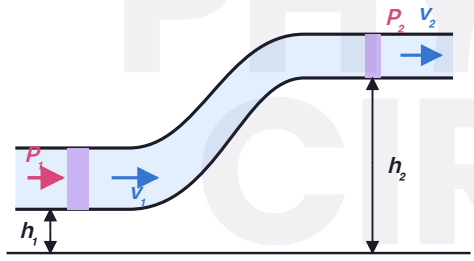
IN ONE LINE

For an ideal fluid in steady flow, **pressure + potential + kinetic energy** per unit volume stays constant.

2.2.1 Energy of a flowing fluid

Per	Pressure	Potential	Kinetic
total	PV	mgh	$\frac{1}{2}mv^2$
unit mass	$\frac{P}{\rho}$	gh	$\frac{1}{2}v^2$
unit volume	P	ρgh	$\frac{1}{2}\rho v^2$

2.2.2 Bernoulli's theorem



Liquid pushed through a tube

- Conditions: incompressible, non-viscous, steady flow, no source or sink.
- Work done by pressure: $W = (P_1 - P_2)V$.
- This work raises the PE and KE: $W = \Delta U + \Delta K$.

$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$P + \rho g h + \frac{1}{2}\rho v^2 = \text{constant}$$

- It is conservation of mechanical energy for a moving fluid.

2.2.3 Other forms

$$\frac{P}{\rho} + gh + \frac{1}{2}v^2 = \text{constant}$$

$$\frac{P}{\rho g} + h + \frac{v^2}{2g} = \text{constant}$$

- $\frac{P}{\rho g}$ is pressure head, h is gravitational head, $\frac{v^2}{2g}$ is velocity head.

2.2.4 Horizontal pipe

- h is the same on both sides, so ρgh cancels.

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2)$$

- Join this with continuity, $a_1v_1 = a_2v_2$.
- **Narrow part: largest v, smallest P.**
- Wide part: smallest v, largest P.

2.2.5 Pressure difference and flow rate

$$P_1 - P_2 = \frac{\rho Q^2}{2}\left(\frac{1}{a_2^2} - \frac{1}{a_1^2}\right)$$

2.2.6 Closed pipe and valve

- Valve shut: v = 0, gauge reads P_1.
- Valve open: gauge falls to P_2.

$$v = \sqrt{\left(\frac{2(P_1 - P_2)}{\rho}\right)}$$

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FLUID DYNAMICS

FLOW · CONTINUITY · BERNOULLI · EFFLUX

LEVEL 1 · EASY

Topic-wise Previous Year Questions

MHT CET · NEET · JEE Main

21	5	4
questions	concepts	topics

CONTENTS

01	Types of Flow, Reynolds Number & Continuity	Q 1–13	13 Qs
02	Bernoulli's Equation	Q 14–15	2 Qs
03	Applications of Bernoulli's Theorem	Q 16–18	3 Qs
04	Velocity of Efflux (Torricelli)	Q 19–21	3 Qs
	Answer key		

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TOPIC 01

Types of Flow, Reynolds Number & Continuity

13 PYQs · Easy 13 · Medium 0 · Difficult 0 | MHT CET 10 · NEET 0 · JEE 3

Concepts covered: Types of flow & Reynolds number (6) · Equation of continuity (7)

LEVEL 1 · EASY 13 questions

◆ Types of flow & Reynolds number 6 Qs

1. In case of liquid, if Reynold's number 'R_n' is 1450, then the flow of liquid will

MHT CET 2026 · 20 APR · SHIFT 1

(a) be streamline.
(b) be turbulent.
(c) change from streamline to turbulent flow.
(d) be sometimes turbulent and sometimes streamline.

2. In case of fluid flowing on horizontal surface the flow of fluid becomes unsteady when Reynolds number (Rn) is

MHT CET 2026 · 18 APR · SHIFT 2

(a) less than 499 (b) between 500 - 999
(c) between 1000 - 1999 (d) greater than 2000

3. Select the WRONG statement from the following. In a streamline flow

MHT CET 2023 · 12 MAY · SHIFT 2

(a) velocity of a fluid at a given point is never constant.
(b) velocity is smaller than critical velocity.
(c) layers are always parallel.
(d) the particles do not move in random direction.

4. A fluid of density 'ρ' is flowing through a uniform tube of diameter 'd'. The coefficient of viscosity of the fluid is 'η', then critical velocity of the fluid is

MHT CET 2023 · 11 MAY · SHIFT 2

(a) inversely proportional to 'η'
(b) directly proportional to 'η'
(c) directly proportional to 'd'
(d) directly proportional to 'ρ'

5. A fluid of density 'ρ' and viscosity 'η' is flowing through a pipe of diameter 'd', with a velocity 'v'. Reynold number is

MHT CET 2023 · 9 MAY · SHIFT 2

(a) $\frac{2\,d\rho v}{\eta}$ (b) $\frac{d\rho v}{\eta}$ (c) $\frac{d\rho v}{\eta^2}$ (d) $\frac{2\eta dv}{\rho}$

6. If ρ is the density and η is coefficient of viscosity of fluid which flows with a speed v in the pipe of diameter d, the correct formula for Reynolds number Re is:

JEE MAIN 2022 · 26 JUN · SHIFT 2

(a) $R_e = \frac{\eta d}{\rho v}$ (b) $R_e = \frac{\rho v}{\eta d}$
(c) $R_e = \frac{\rho v d}{\eta}$ (d) $R_e = \frac{\eta}{\rho v d}$

◆ Equation of continuity 7 Qs

7. An in-compressible fluid flows steadily through a horizontal cylindrical pipe. The pipe has radius '$3R$' at point A and '$1.5R$' at point B, further along the flow direction at the same level. If the velocity at point A is 'v', then that at point B is

MHT CET 2026 · 19 APR · SHIFT 1

(a) v (b) $2v$ (c) $3v$ (d) $4v$

8. Water flows through a horizontal pipe at a speed 'V'. Internal diameter of the pipe is 'd'. If the water is emerging at a speed 'V_1' then the diameter of the nozzle is

MHT CET 2026 · 16 APR · SHIFT 1

(a) $\sqrt{\frac{V}{1}}$ (b) $\sqrt{\frac{V_1}{}}$ d d 1 V 1 V
(c) $\frac{dV}{}$ (d) $\frac{dV_1}{}$ V 1 V

9. Water flows through a horizontal pipe of varying cross-section at the rate of $\pi \times 10^{-1}\ m^3/s$. The velocity of water at a point where the radius of the pipe is 10 cm is ($\pi = 3.14$)

MHT CET 2025 · 21 APR · SHIFT 2

(a) 0.1 m/s (b) 1 m/s (c) 10 m/s (d) 100 m/s

10. An incompressible fluid flows steadily through a cylindrical pipe having radius R at point A and $\left(\frac{R}{3}\right)$ at point B further along the direction of flow of liquid. If the velocity at point A is ' V ' then that at point B is

MHT CET 2025 · 21 APR · SHIFT 1

(a) $\frac{V}{9}$ (b) $\frac{V}{3}$ (c) 3 V (d) 9 V

11. Water flows through a horizontal pipe at a speed 'V'. Internal diameter of the pipe is 'd'. If the water is coming out at a speed 'V_1' then the diameter of the nozzle is

MHT CET 2023 · 10 MAY · SHIFT 1

(a) $d\sqrt{\frac{V_1}{V}}$ (b) $d\sqrt{\frac{V}{V_1}}$ (c) $\frac{dV}{V_1}$ (d) $\frac{V_1}{dV}$

12. A water spray gun is attached to a hose of cross sectional area 30 cm^2. The gun comprises of 10 perforations each of cross sectional area of 15 mm^2. If the water flows in the hose with the speed of 50 cm/s, calculate the speed at which the water flows out from each perforation. (Neglect any edge effects)

JEE MAIN 2026 · 4 APR · SHIFT 2

(a) 100 m/s (b) 10 m/s
(c) 1000 m/s (d) 15×10^2 m/s

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13. An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 cm and 4.8 cm, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is:

JEE MAIN 2020 · 7 JAN · SHIFT 2

(a) $\frac{3}{4}$ (b) $\frac{9}{16}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{81}{256}$

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TOPIC 02

Bernoulli's Equation

2 PYQs · Easy 2 · Medium 0 · Difficult 0 | MHT CET 1 · NEET 0 · JEE 1

Concepts covered: Bernoulli's equation (2)

LEVEL 1 · EASY 2 questions

14. Water is flowing through a horizontal pipe in stream line flow. At the narrowest part of the pipe

MHT CET 2023 · 9 MAY · SHIFT 1

(a) velocity is maximum and pressure minimum.
(b) pressure is maximum and velocity minimum.
(c) both pressure and velocity are minimum.
(d) both pressure and velocity are maximum.

15. Correct Bernoulli's equation is (symbols have their usual meaning):

JEE MAIN 2024 · 8 APR · SHIFT 1

(a) $P+\frac{1}{2}\rho gh+\frac{1}{2}\rho v^2=\text{constant}$
(b) $P+mgh+\frac{1}{2}mv^2=\text{constant}$
(c) $P+\rho gh+\rho v^2=\text{constant}$
(d) $P+\rho gh+\frac{1}{2}\rho v^2=\text{constant}$

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TOPIC 03

Applications of Bernoulli's Theorem

3 PYQs · Easy 3 · Medium 0 · Difficult 0 | MHT CET 2 · NEET 1 · JEE 0

Concepts covered: Applications of Bernoulli's theorem (3)

LEVEL 1 · EASY 3 questions

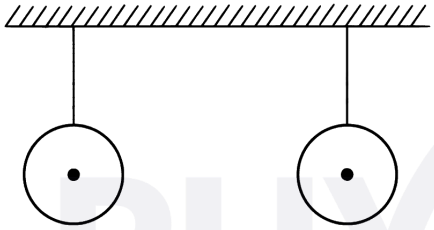
16. Venturimeter is used to

MHT CET 2023 · 13 MAY · SHIFT 1

(a) measure liquid pressure.
(b) measure liquid density.
(c) measure rate of flow of liquids.
(d) measure surface tension.

17. Two light balls are suspended as shown in figure. When a stream of air passes through the space between them, the distance between the balls will

MHT CET 2019 · 2 MAY · SHIFT 2



(a) remain same
(b) increase
(c) may increase or decrease, depending on speed of air
(d) decrease

18. The venturi-meter works on:

NEET 2023

(a) Bernoulli's principle
(b) The principle of parallel axes
(c) The principle of perpendicular axes
(d) Huygen's principle

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TOPIC 04

Velocity of Efflux (Torricelli)

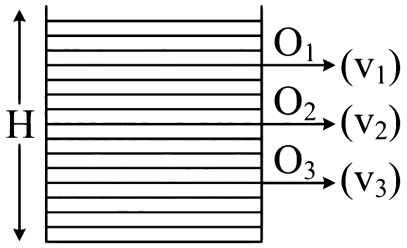
3 PYQs · Easy 3 · Medium 0 · Difficult 0 | MHT CET 1 · NEET 1 · JEE 1

Concepts covered: Velocity of efflux (Torricelli) (3)

LEVEL 1 · EASY 3 questions

19. A cylinder contains water upto a height ' H '. It has three orifices O_1, O_2, O_3 as shown in the figure. Let V_1, V_2, V_3 be the speed of efflux of water from the three orifices. Then

MHT CET 2024 · 16 MAY · SHIFT 1



(a) $V_1 = V_2 = V_3$ (b) $V_1 < V_2 < V_3$
(c) $V_1 > V_2 > V_3$ (d) $V_1 = V_3 > V_2$

20. A small hole of area of cross-section 2 mm2 present near the bottom of a fully filled open tank of height 2 m. Taking g = 10 m/s2, the rate of flow of water through the open hole would be nearly:

NEET 2019

(a) 8.9 × 10–6 m3/s (b) 2.23 × 10–6 m3/s
(c) 6.4 × 10–6 m3/s (d) 12.6 × 10–6 m3/s

21. A cylinder of height 20 m is completely filled with water. The velocity of efflux of water (in ms^{-1}) through a small hole on the side wall of the cylinder near its bottom is

AIEEE 2002

(a) 10 (b) 20 (c) 25.5 (d) 5

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ANSWER KEY

Shaded by level: **Easy**

01 Types of Flow, Reynolds Number & Continuity

1. (c)	2. (d)	3. (a)	4. (b)	5. (b)	6. (c)	7. (d)	8. (a)	9. (c)	10. (d)
11. (b)	12. (b)	13. (b)							

02 Bernoulli's Equation

14. (a)	15. (d)								

03 Applications of Bernoulli's Theorem

16. (c)	17. (d)	18. (a)							

04 Velocity of Efflux (Torricelli)

19. (b)	20. (d)	21. (b)							

Note: *"Bonus" = no option is correct as the question is printed (dropped in the official key). Numerical questions show the numerical answer.*

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