KOLEJ YAYASAN PELAJARAN JOHOR

COURSE NAME : FLUID MECHANICS
COURSE CODE : DKM 2122
EXAMINATION : JUNE 2023
DURATION : 2 HOURS

INSTRUCTION TO CANDIDATES /
ARAHAN KEPADA CALON

1. This examination paper consists of **ONE (1)** part : / PART A (60 Marks) /
*Kertas soalan ini mengandungi **SATU (1)** bahagian: BAHAGIAN A (60 Markah)*

2. Answer ALL questions in the answer booklet. /
Jawab SEMUA soalan di dalam buku jawapan.

3. Please check to make sure that this examination pack consists of: /
Pastikan kertas soalan peperiksaan ini mengandungi:
   i. Question Paper /
   Kertas Soalan

   ii. Answering Booklet /
   Buku Jawapan

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /
JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

This examination paper consists of 14 printed pages including front page.
Kertas soalan ini mengandungi 14 muka surat termasuk kulit hadapan.

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This section contains **FIVE (5)** questions.
Answer **FOUR (4)** questions from **FIVE (5)**. Answer in the Answer Booklet.
*Bahagian ini mengandungi **LIMA (5)** soalan.*
*Jawab **EMPAT (4)** daripada **LIMA (5)** soalan. Jawab dalam Buku Jawapan.*

QUESTION 1/ *SOALAN 1*

a) Specify what is surface tension and explain why is the surface tension also called surface energy.

Apakah yang dimaksudkan dengan tegangan permukaan dan terangkan mengapakah tegangan permukaan juga dikenali sebagai tenaga permukaan.

(5 marks/ *5 markah*)

b) A cylinder container has a diameter of 0.5 m and a height of 1m. If the container filled with a liquid having a specific weight of 2000 N/m^3, calculate:

Sebuah bekas silinder mempunyai diameter 0.5 m dan tinggi 1m. Jika bekas berisi cecair mempunyai berat tentu 2000 N/m^3, hitung:

i. Mass of liquid

Jisim bagi bcecair

(4 marks/ *markah*)

ii. The density of liquid

Jisim bagi bendalir

(3 marks/ *markah*)

iii. The specific volume of liquid

Isipadu tentu bendalir

(3 marks/ *markah*)

QUESTION 2/ *SOALAN 2*

a) A U tube manometer in **Figure 1** measures the pressure difference between the two points which are point A and B in a liquid. The U tube contains mercury and water. Calculate the pressure difference if h= 1.5 m, h_2= 0.75 m, h_1 = 0.5 m. The liquid at A and B is water. Given the specific gravity of mercury is 13.6.

*Tiub U manometer dalam **Rajah 1** adalah untuk mengukur perbezaan tekanan pada cecair antara dua titik A dan B. Tiub U mengandungi cecair merkuri dan air. Kirakan perbezaan tekanan jika h = 1.5 m, h_2 = 0.75 m, h_1 = 0.5 m. Cecair di A dan B adalah air. Diberi spesifik graviti bagi merkuri ialah 13.6.*

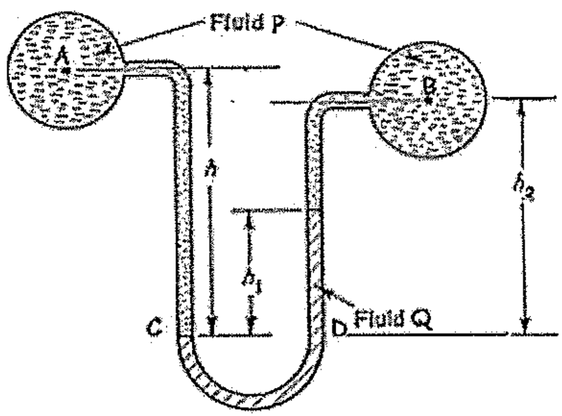


Figure 1/ *Rajah 1*

(5 marks/*markah*)

b) A basketball floats in a pool of water. The ball has a mass of 0.7 kg and a diameter of 25 cm.

Sebiji bola keranjang terapung di kolam air. Bola itu berjisim 0.7 kg dan berdiameter 25 cm.

i. What is the buoyant force for basketball?

Apakah daya apung bagi bola keranjang itu?

(4 marks/*markah*)

ii. What is the volume of water displaced by the ball?

Berapakah isi padu air yang dikeluarkan oleh bola?

(3 marks/*markah*)

iii. What is the average density of the basketball?

Berapakah ketumpatan purata bola keranjang?

(3 marks/*markah*)

QUESTION 3/ *SOALAN 3*

a) Consider a device with one inlet and one outlet. If the volume flow rates at the inlet and at the outlet are the same, is the flow through this device necessarily steady?Explain.

Sebuah peranti dengan satu saluran masuk dan satu saluran keluar. Jika isipadu kadar alir pada saluran masuk dan saluran keluar adalah sama, adakah aliran di dalam peranti itu stabil? Terangkan.

(5 marks/*markah*)

b) Oil flows through a pipe at a velocity of 2.12 m/s. The diameter of the pipe is 80 mm. Given specific gravity of oil is $S_G = 0.85$.

Minyak mengalir melalui sebuah paip pada halaju 2.12 m / s. Diameter paip ialah 80 mm. Diberi graviti tentu minyak ialah $S_G = 0.85$

i. Calculate the volume flow rate for oil.
Hitung kadar aliran isipadu bagi minyak.

(2 marks/*markah*)

ii. Calculate the mass flow rate of oil.
Kadar alir jisim minyak.

(2 marks/*markah*)

c) Water flows through a pipe in **Figure 2** with a diameter of 50 mm. Then the split into two, one of the pipes has a diameter 25 mm with the velocity of flow 0.4 m/s and the other one has a diameter 15 mm with the velocity 0.6 m/s. Calculate the velocity in the main pipe.

*Air mengalir melalui paip seperti **Rajah 2** dengan diameter 50 mm. Kemudian terpisah kepada dua bahagian, satu bahagian paip berdiameter 25 mm dengan aliran halaju 0.4 m/s dan satu bahagian berdiameter 15 mm dengan halaju 0.6 m/s. Kirakan halaju paip utama.*

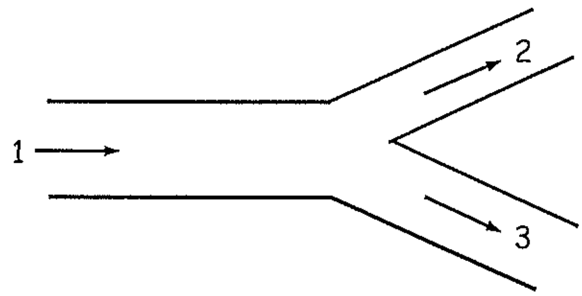


Figure 2/ *Rajah 2*

(6 marks/ *markah*)

QUESTION 4/ *SOALAN 4*

a) Which fluid at room temperature requires a larger pump to flow at a specified velocity in a given pipe: water or engine oil? Explain.

Aliran manakah pada suhu bilik memerlukan pam yang lebih besar untuk mengalir pada halaju tertentu dalam paip yang diberikan: air atau minyak enjin? Terangkan.

(3 marks/ *markah*)

b) Two reservior as shown in **Figure 3** are connected by a pipeline which is 150 mm in diameter for the first 6 m and 225 mm diameter for the remaining 15 m. The entrance and exit are sharp and the change of section sudden. The water surface in the upper reservior is 6 m from bottom. Friction coefficient for both pipe is 0.01.

i. Calculate all the losses of head which occur for this pipeline

(9 marks/ *markah*)

ii. Calculate the volume flow rate.

(3 marks/ *markah*)

Dua takungan seperti ditujukkan dalam ***Rajah 3*** *dihubungkan oleh saluran paip yang berdiameter 150 mm untuk diameter 6 m pertama dan 225 mm untuk baki 15 m. Pintu masuk dan keluar adalah tepat dan perubahan bahagian akan berlaku secara mengejut. Permukaan air di takungan atas adalah 6 m dari bawah. Pekali geseran untuk kedua-dua paip adalah 0.01.*

i. Kirakan semua kehilangan turus yang berlaku pada sistem perpaipan ini.

ii. Hitung kadar aliran isipadu.

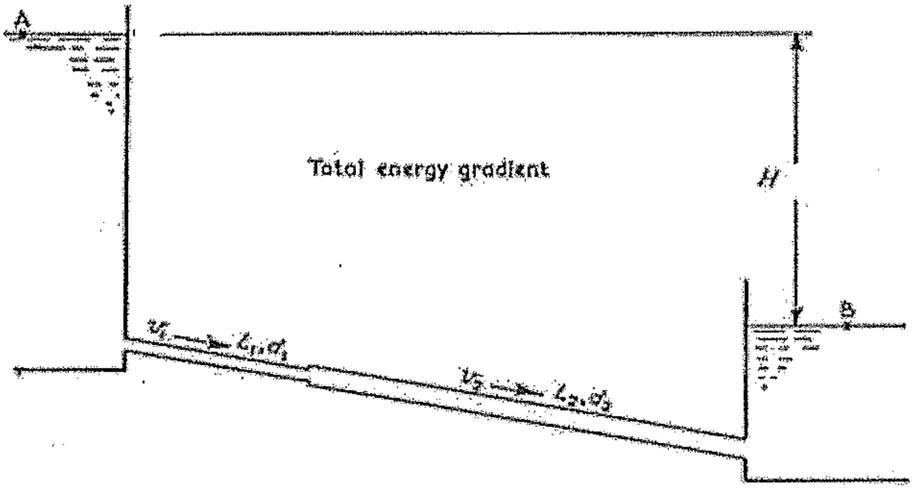


Figure 3/ *Rajah 3*

QUESTION 5/ *SOALAN 5*

a) Define incompressible flow and compressible flow.
Nyatakan aliran mampatan dan aliran tidak mampat

(3 marks / *markah)*

b) Convert the temperature below according to the specified scales:

Tukarkan suhu di bawah mengikut skala tertentu.

i. 250°K to Rankine (°R)

250°K kepada Rankine (°R)

(2 marks/ *2 markah*)

ii. 250°F to Rankine (°R)

250°F kepada Rankine (°R)

(2 marks/ *2 markah*)

iii. 250°C to Kelvin (°K)

250°C kepada Kelvin (°K)

(2 marks/ *2 markah*)

c) Explain about Archimedes principle and the function in buoyant force

Terangkan Prinsip Archimedes dan kegunaannya pada daya keapungan.

(6 marks / 6 *markah*)

[60 MARKS/ *60 MARKAH*]

END OF QUESTION PAPER/ *KERTAS SOALAN TAMAT*

FORMULA AND TABLE

FORMULAR DAN JADUAL

Density :

$\rho = m/v$

Pressure :

$P = F / A$

$P = \rho g h$

$P = P_0 - \rho g h$

$P_{gage} = P_{abs} - P_{atm}$

$P_{vac} = P_{atm} - P_{abs}$

$P_{abs} = P_{gage} - P_{atm}$

Specific Gravity : $\gamma_{substance} / \gamma_{water}$

Specific Weight,W : ρg

Heat, Q : $C_p m \, dT$

Langarian and Eularian :

$$\vec{a} = \frac{d\vec{V}}{dt} = \frac{\partial \vec{V}}{\partial t}\frac{dt}{dt} + \frac{\partial \vec{V}}{\partial x}\frac{dx}{dt} + \frac{\partial \vec{V}}{\partial y}\frac{dy}{dt} + \frac{\partial \vec{V}}{\partial z}\frac{dz}{dt}$$

$$= \frac{\partial \vec{V}}{\partial t}(1) + \frac{\partial \vec{V}}{\partial x}(u) + \frac{\partial \vec{V}}{\partial y}(v) + \frac{\partial \vec{V}}{\partial z}(w)$$

$$= \frac{\partial \vec{V}}{\partial t} + u\frac{\partial \vec{V}}{\partial x} + v\frac{\partial \vec{V}}{\partial y} + w\frac{\partial \vec{V}}{\partial z}$$

Fluid dynamics :

$$\frac{P_1}{\omega} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\omega} + \frac{v_2^2}{2g} + z_2$$

$$Q_{actual} = C_d \times A_1 \sqrt{\frac{2gH}{(m^2 - 1)}}$$

$$Q_{actual} = \frac{C_d \times A_1}{\sqrt{(m^2 - 1)}} \sqrt{2g\left[\frac{P_1 - P_2}{\omega} + (z_1 - z_2)\right]}$$

Energy losses in pipes :

$$h_C = \left[\frac{1}{Cc} \quad 1\right]^2 \times \frac{v_2^2}{2g}$$

$$h_i = 0.5\frac{v_2^2}{2g}$$

$$h_F = \frac{4fl}{d}\frac{v^2}{2g}$$

$$h_L = \frac{(V_1 - V_2)^2}{2g}$$

Nozzle :

$$\frac{P_c}{P_1} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma+1}}$$

$$\frac{T_C}{T_1} = \frac{2}{\gamma+1}$$

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

$$V_C = \frac{RT_C}{P_C} \qquad A_C = \frac{\dot{m}V_C}{C_C}$$

Coefficient of Volume Expansion

Constant : P / p

Specific heat at constant pressure, k : C_p/C_v

Absolute Viscosity : (F/A) / (v/y)

Kinematic Viscosity, V : μ / p

Hydraulic : $F_1 / A_1 = F_2 / A_2$

$F_2 / A_2 = A_2 / A_1$

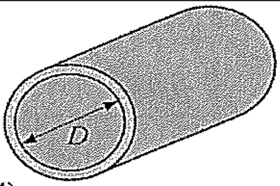
$P_1 = P_2$

Buoyancy : Momen inertia from surface / volume of water displaced

Bernoulli :

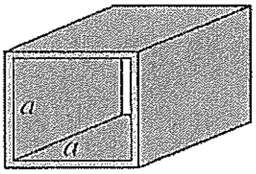
$P_1 / p + V_1^2 / 2 + gz_1 = P_2 /p + V_2^2 + gz_2$

Circular tube:



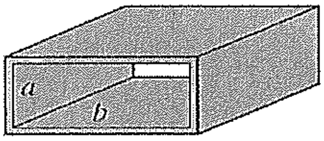
$$D_h = \frac{4(\pi D^2/4)}{\pi D} = D$$

Square duct:



$$D_h = \frac{4a^2}{4a} = a$$

Rectangular duct:



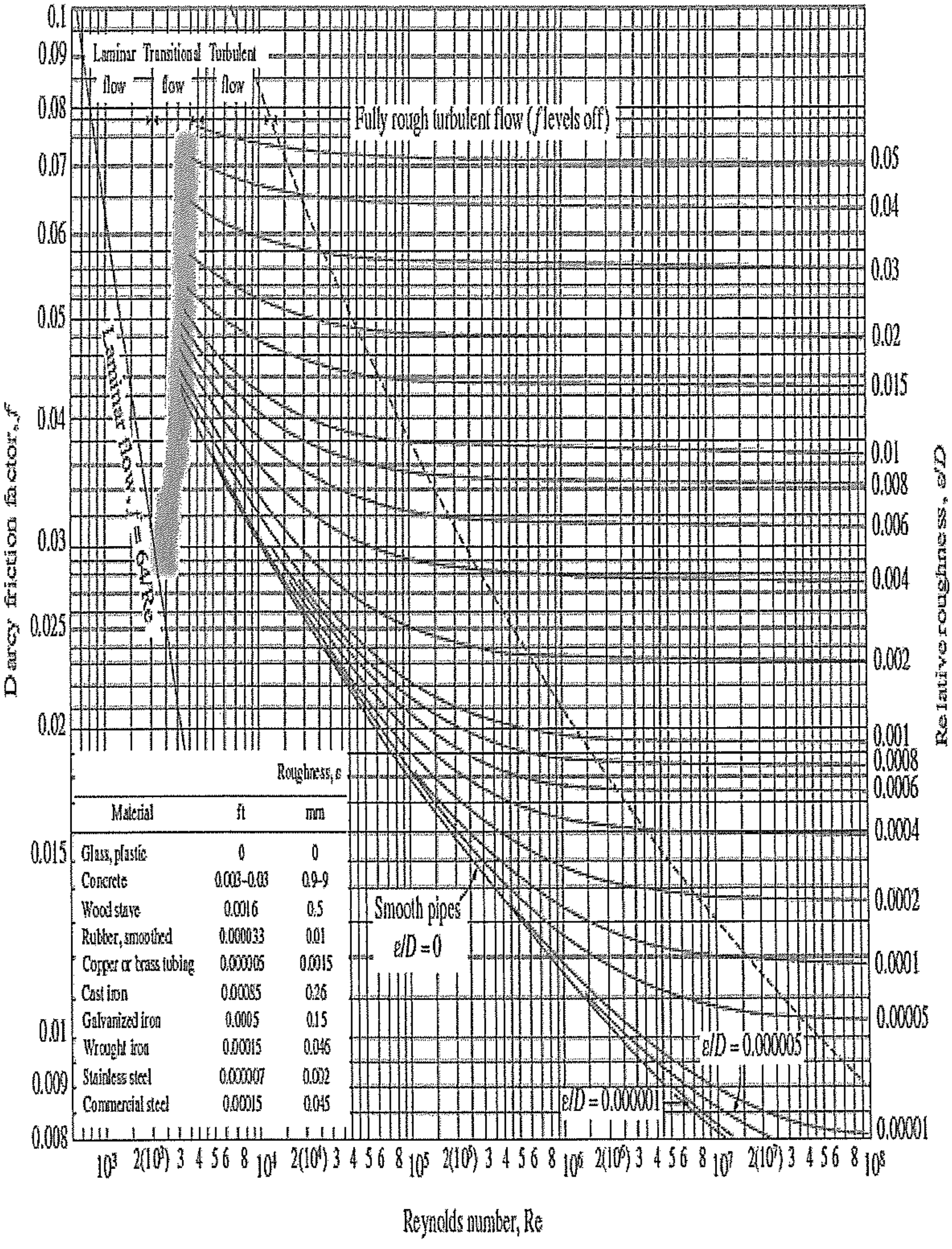
$$D_h = \frac{4ab}{2(a+b)} = \frac{2ab}{a+b}$$

Relative Roughness, ε/D	Friction Factor, f
0.0*	0.0119
0.00001	0.0119
0.0001	0.0134
0.0005	0.0172
0.001	0.0199
0.005	0.0305
0.01	0.0380
0.05	0.0716

* Smooth surface. All values are for Re = 10^6 and are calculated from the Colebrook equation.

Equivalent roughness values for new commercial pipes*

Material	Roughness, ε ft	Roughness, ε mm
Glass, plastic	0 (smooth)	
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045



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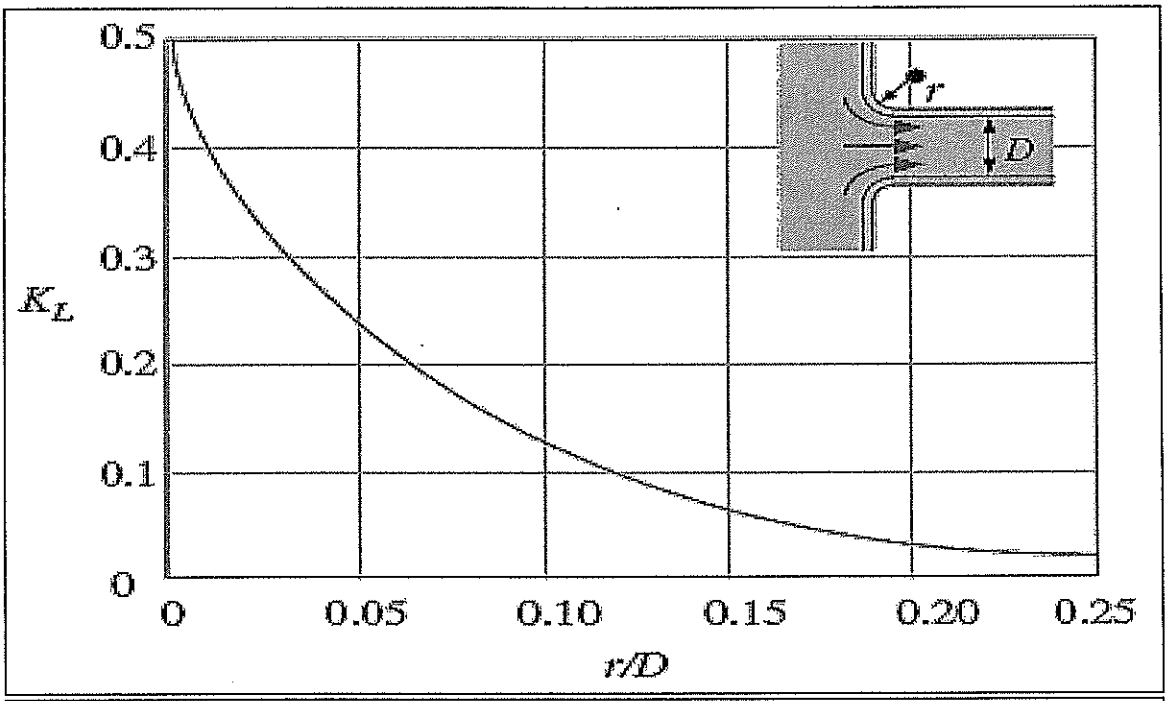
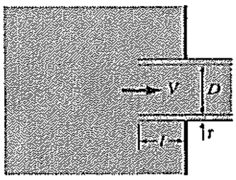


TABLE 14–3

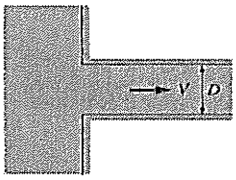
Loss coefficients K_L of various pipe components for turbulent flow (for use in the relation $h_L = K_L V^2/(2g)$, where V is the average velocity in the pipe that contains the component)*

Pipe Inlet

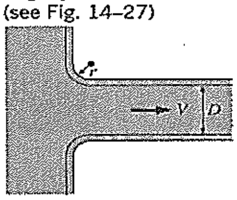
Reentrant: $K_L = 0.80$
($t \ll D$ and $l \approx 0.1D$)



Sharp-edged: $K_L = 0.50$

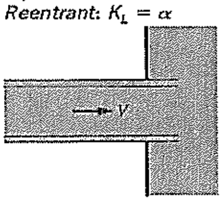


Well-rounded ($r/D > 0.2$): $K_L = 0.03$
Slightly rounded ($r/D = 0.1$): $K_L = 0.12$
(see Fig. 14–27)

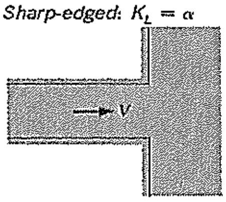


Pipe Exit

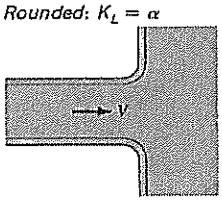
Reentrant: $K_L = \alpha$



Sharp-edged: $K_L = \alpha$



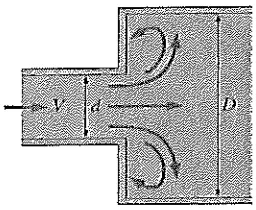
Rounded: $K_L = \alpha$



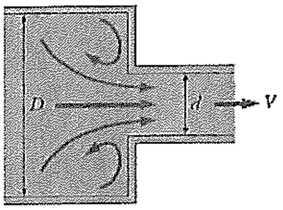
Note: The kinetic energy correction factor is $\alpha = 2$ for fully developed laminar flow, and $\alpha \approx 1.05$ for fully developed turbulent flow.

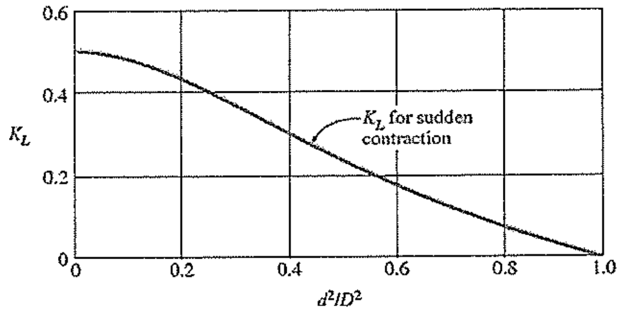
Sudden Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

Sudden expansion: $K_L = \alpha\left(1 - \frac{d^2}{D^2}\right)^2$



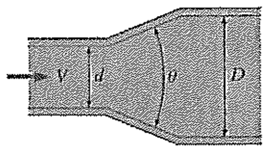
Sudden contraction: See chart.



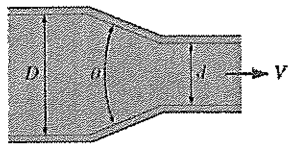


Gradual Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

Expansion (for $\theta = 20°$):
$K_L = 0.30$ for $d/D = 0.2$
$K_L = 0.25$ for $d/D = 0.4$
$K_L = 0.15$ for $d/D = 0.6$
$K_L = 0.10$ for $d/D = 0.8$

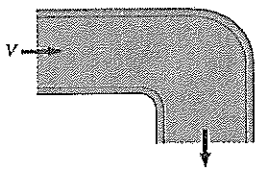


Contraction:
$K_L = 0.02$ for $\theta = 30°$
$K_L = 0.04$ for $\theta = 45°$
$K_L = 0.07$ for $\theta = 60°$

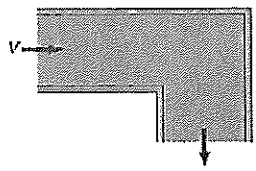


Bends and Branches

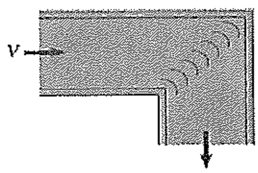
90° smooth bend:
Flanged: $K_L = 0.3$
Threaded: $K_L = 0.9$



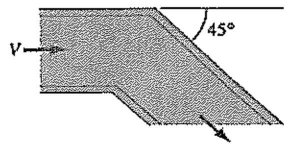
90° miter bend (without vanes): $K_L = 1.1$



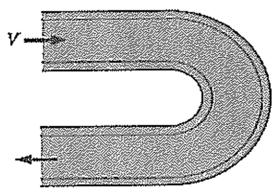
90° miter bend (with vanes): $K_L = 0.2$



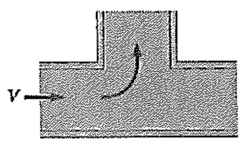
45° threaded elbow: $K_L = 0.4$



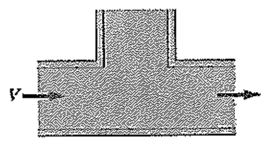
180° return bend:
Flanged: $K_L = 0.2$
Threaded: $K_L = 1.5$



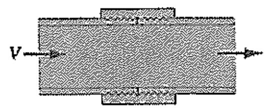
Tee (branch flow):
Flanged: $K_L = 1.0$
Threaded: $K_L = 2.0$



Tee (line flow):
Flanged: $K_L = 0.2$
Threaded: $K_L = 0.9$



Threaded union: $K_L = 0.08$



Valves

Globe valve, fully open: $K_L = 10$
Angle valve, fully open: $K_L = 5$
Ball valve, fully open: $K_L = 0.05$
Swing check valve: $K_L = 2$

Gate valve, fully open: $K_L = 0.2$
$\frac{1}{4}$ closed: $K_L = 0.3$
$\frac{1}{2}$ closed: $K_L = 2.1$
$\frac{3}{4}$ closed: $K_L = 17$

* These are representative values for loss coefficients. Actual values strongly depend on the design and manufacture of the components and may differ from th given values considerably (especially for valves). Actual manufacturer's data should be used in the final design.