KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	:	**FLUID MECHANICS**
COURSE CODE	:	**DKM 2122**
EXAMINATION	:	**OCTOBER 2017**
DURATION	:	**2 HOURS**

INSTRUCTION TO CANDIDATES

1. This examintaion paper consists **FIVE (5)** questions.
   Answer **FOUR (4)** questions **ONLY** in Answer Booklet.

2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator.

3. Please check to make sure that this examination pack consist of:
   i. Question Paper
   ii. Answer Booklet

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

*This examination paper consists of **16** printed pages including front page*

QUESTION 1 / *SOALAN* 1

a) Convert the temperature below according to the specified scales:
Gantikan suhu di bawah mengikut skala di kehendaki.

i. 300K to Rankine (°R)

ii. 300F to Rankine (°R)

iii. 300F to Kelvin (°K)

(6 marks / 6 *markah*)

b) If the volume of oil is 5.6 m^3 and weight is 46 000 N, calculate:
Jika volume minyak adalah 5.6 m^3 dan berat adalah 46 000 N, kirakan:

i. Mass density, ρ in unit kg/m^3
Ketumpatan jisim , ρ dalam unit kg/m^3

ii. Specific weight, ω
Berat tentu , ω

iii. Specific gravity of oil, S
Gravity tentu, S

(6 marks / 6 *markah*)

c) A bourdon pressure gauge attached to a boiler located at sea level shows a reading pressure of 10 bars. If atmospheric pressure is 1.01 bars, determine:
Satu tolok tekanan bourdon di pasang pada sebuah dandang yang terletak pada aras laut menunjukkan bacaan tekanan sebanyak 10 bars. Jika tekanan atmosfera adalah 1.01 bars, tentukan:

i. The absolute pressure in kN/m^2
Tekanan mutlak

ii. The pressure head of water, h
Tekanan air awalan

(8 marks / 8 *markah*)

[20 marks / 20 *markah*]

QUESTION 2 / *SOALAN* 2

a) Define Pascal's Law.
Definisi Hukum Paskal.

(2 marks / 2 *markah*)

b) As in **Figure 1**, a hydraulic jack consists of a small and a large cylinder with diameters of 7 cm and 20 cm respectively. The required force, F to lift up a load, W is 400 N. If the large piston is 15 cm higher than the small one, determine the weight, W that can be lifted if the specific weight of oil is 8730 N/m³.

*Seperti **Rajah 1,** Sebuah jack hidrolik terdiri daripada satu silinder besar berdiameter 20 cm dan silinder kecil berdiameter 7 cm. Daya, F yang di perlukan untuk mengangkat beban, W adalah 400 N. Jika piston besar adalah 15 cm lebih tinggi daripada yang kecil, tentukan berat, W yang boleh di angkat sekiranya berat tentu bagi minyak adalah 8730 N/m³.*

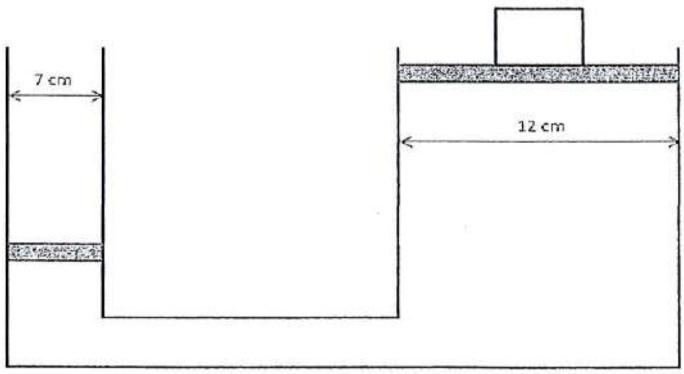


Figure 1 / *Rajah* 1

(8 marks / 8 *markah*)

c) **Figure 2** shows a differential manometer that is used to measure the difference of pressure between two pipelines. The U-tube contains water and mercury with specific weight of 9810 N/m³ and 133 416 N/m³ respectively. The pressure difference between point A and point B is kN/m². Given that h_2 = 0.7 m and h_3 = 0.4 m, determine the height of h_1.

***Rajah* 2** *menunjukkan satu manometer yang berbeza digunakan untuk mengukur tekanan yang berbeza di antara dua pipe. Kandungan U-tube terdiri daripada air dan merkuri dengan berat tentu masing - masing adalah 9810 N/m³ and 133 416 N/m³. Perbezaan tekanan antara titik A dan titk B adalah kN/m². di beri h_2 = 0.7 m dan h_3 = 0.4 m, tentukan tinggi h_1.*

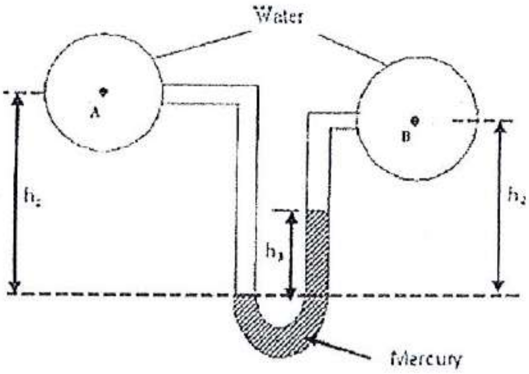


Figure 2 / *Rajah 2*

(10 marks / 10 *markah*)

[20 marks / 20 *markah*]

QUESTION 3 / *SOALAN* 3

a) Define the following types of flow:
Definisi jenis aliran berikut:

i. Steady flow
Aliran stabil

ii. Uniform flow
Aliran sekata

iii. Laminar flow
Aliran lamina

(3 marks / 3 *markah*)

b) **Figure 3** shows Oil flows in a circular pipe with a diameter of 30 mm with a velocity of 0.2 m/s. Then the pipe is split into two. One of the branches is 10 mm in diameter while the other branch has a diameter of 15 mm and flow velocity of 0.5 m/s. Determine the flow velocity in the pipe with the diameter of 10 mm.

***Rajah* 3** *menunjukkan aliran minyak dalam paip bulat diameter 30 mm dengan halaju 0.2 m/s. Paip di bahagikan kepada dua. Salah satu saluran berdiameter 10 mm manakala saluran yang lain berdiameter 15 mm dan halaju aliran adalah 0.5 m/s. Tentukan halaju aliran dalam paip dengan diameter 10 mm.*

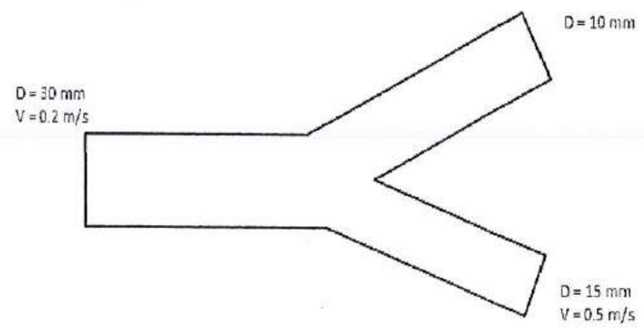


Figure 3 / *Rajah* 3

(8 marks / 8 *markah*)

c) **Figure 4** shows a ventury meter is installed in the inclined pipe carrying oil having a relative density of 0.9, an entrance of 30 cm in diameter and a throat of 20 cm. the throat is 40 cm above the entrance. If the oil velocity in the ventury meter, V_1 is 4 m/s, calculate:

Rajah 4 *menunjukkan satu meter venture yang di pasang pada paip condong berisi minyak dengan ketumpatan bandingan 0.9. Diameter masuk adalah 30 cm dan leher adalah 20 cm. Ketinggian leher masukan adalah 40 cm. Jika halaju minyak dalam ventury meter, V_1 adalah 4 m/s, kirakan:*

i. The difference in pressure between the entrance and throat.
Perbezaan dalam tekanan antara masukan dan leher.

ii. The difference of mercury level in U-tube manometer.
Perbezaan paras merkuri dalam U-tube manometer.

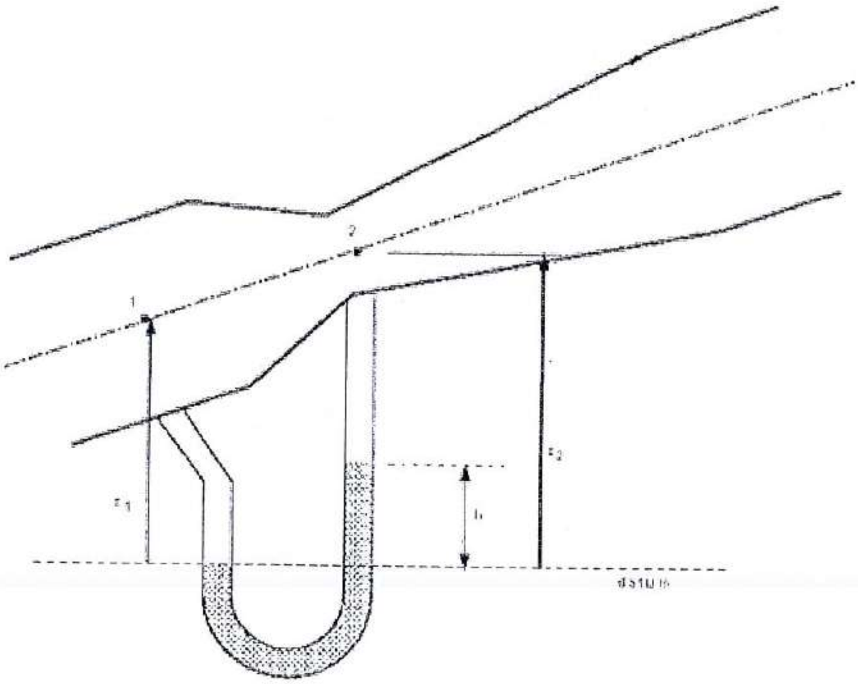


Figure 4 / *Rajah 4*

(9 marks / 9 *markah*)

[20 marks / 20 *markah*]

QUESTION 4 / *SOALAN* 4

a) State **THREE (3)** limitations of Bernoulli's equation
*Nyatakan **TIGA (3)** batasan persamaan Bernoulli*

(3 marks / 3 *markah*)

b) A sharp – edged orifice meter with a 80 mm diameter hole is installed to a pipeline of 210 mm diameter. The pipeline supplies oil of specific gravity, $S.G_{oil}$ = 0.9. The pressure difference measured by mercury manometer is 690 mm (where mercury specific gravity, $S.G_{Hg}$ = 13.6). Determine the actual discharge if the coefficient of discharge is 0.62. (Given ρ_{water} = 1000 kg/m³)

Satu meter orifice bersisi tajam dengan diameter lubang 80 mm di pasang pada saluran paip berdiameter 210 mm. Saluran paip bekalan minyak dengan graviti tentu, $S.G_{oil}$ = 0.9. Perbezaan tekanan di ukur dengan menggunakan manometer merkuri adalah 690 mm (di mana graviti tentu merkuri, $S.G_{Hg}$ = 13.6). Tentukan keluaran sebenar jika pekali keluaran adalah 0.62. (Diberi ρ_{air} = 1000 kg/m³)

(10 marks / 10 *markah*)

c) An inclined pipe is used to supply water as shown in **figure 5**. The cross – sectional areas of the pipe at entrance and exit are 0.05 m^2 and 0.005 m^2 respectively. The water pressure at entrance is 686.7 kN/m^2. If the velocity at the entrance is 1.5 m/s, determine the pressure at exit.

Satu paip condong di gunakan untuk membekalkan air seperti ***rajah 5****. Luas keratan rentas paip pada masukan dan keluaran adalah 0.05 m^2 dan 0.005 m^2. Tekanan air pada masukkan adalah 686.7 kN/m^3. Jika halaju pada masukkan adalah 1.5 m/s, tentukan tekanan pada keluaran.*

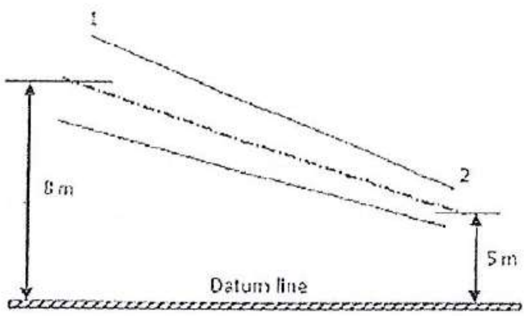


Figure 5 / *Rajah 5*

(7 marks / 7 *markah*)

[20 marks / 20 *markah*]

QUESTION 5 / *SOALAN 5*

a) In climates with low night – time temperatures, an energy – efficient way of cooling a house is to install a fan in the ceiling that draws air from the interior of the house and discharges it to a ventilated attic space. As shown in **figure 6** consider a house is to be exchanged once every 20 minutes. Determine the required flow rate of the fan and the average discharge speed of air if the fan diameter is 0.5 m.

Dalam keadaan cuaca bersuhu rendah pada waktu malam. Kecekapan tenaga dalam menyejukkan sebuah rumah adalah dengan cara memasang kipas pada syiling. Seperti ***rajah 6*** *dengan pemasangan kipas tersebut udara panas boleh dilepaskan ke udara di luar rumah. Beranggapan kipas akan berhenti berpusing setiap 20 minit beroperasi. Tentukan kadar putaran kipas dan kelajuan kipas jika ukur lilit bilah kipas adalah 0.5 m.*

(5 marks / 5 *markah*)

b) Based on **figure 6** water is pumped from a lake to a storage tank 18 m above at a rate of 70 L/s while consuming 20.4 kW of electric power. Disregarding any frictional losses in the pipes and any changes in kinetic energy. Determine the overall efficiency of the pump – motor unit and the pressure difference between the inlet and the exit of the pump.

Berdasarkan ***rajah 6*** *air di pam daripada tasik untuk di isi ke dalam sebuah tangki simpanan pada ketinggian 18 m dengan kadar alir 70 l/s menggunakan tenaga elektrik 20.4 kW. Daya geseran dan tenaga kinetik dalam paip di abaikan. Tentukan keseluruhan kecekapan unit pam dan perbezaan tenaga antara lubang masukkan dan keluaran pam tersebut.*

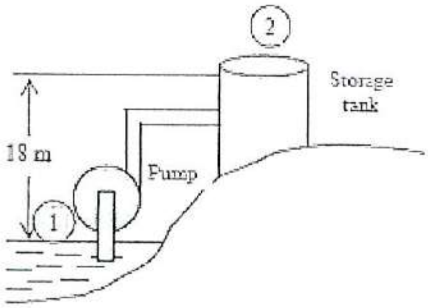


Figure 6 / Rajah 6

(15 marks / 15 *markah*)

[20 marks / 20 *markah*]

QUESTION END

FORMULA

Density :
$\rho = m/v$
Pressure :
$P = F / A$
$P = \rho gh$
$P = P_0 - \rho gh$
$P_{gage} = P_{abs} - P_{atm}$
$P_{vac} = P_{atm} - P_{abs}$
$P_{abs} = P_{gage} - P_{atm}$

Specific Gravity : $y_{substance} / y_{water}$
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 :

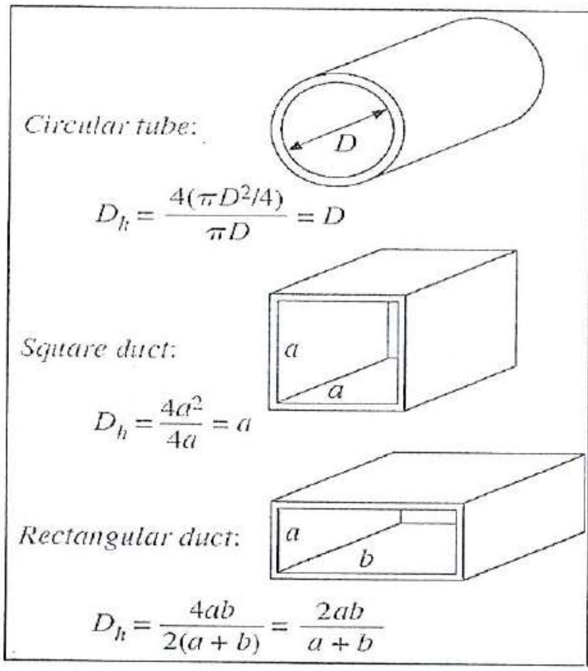
$$\frac{P_c}{P_1} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma+1}}$$

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

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

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

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

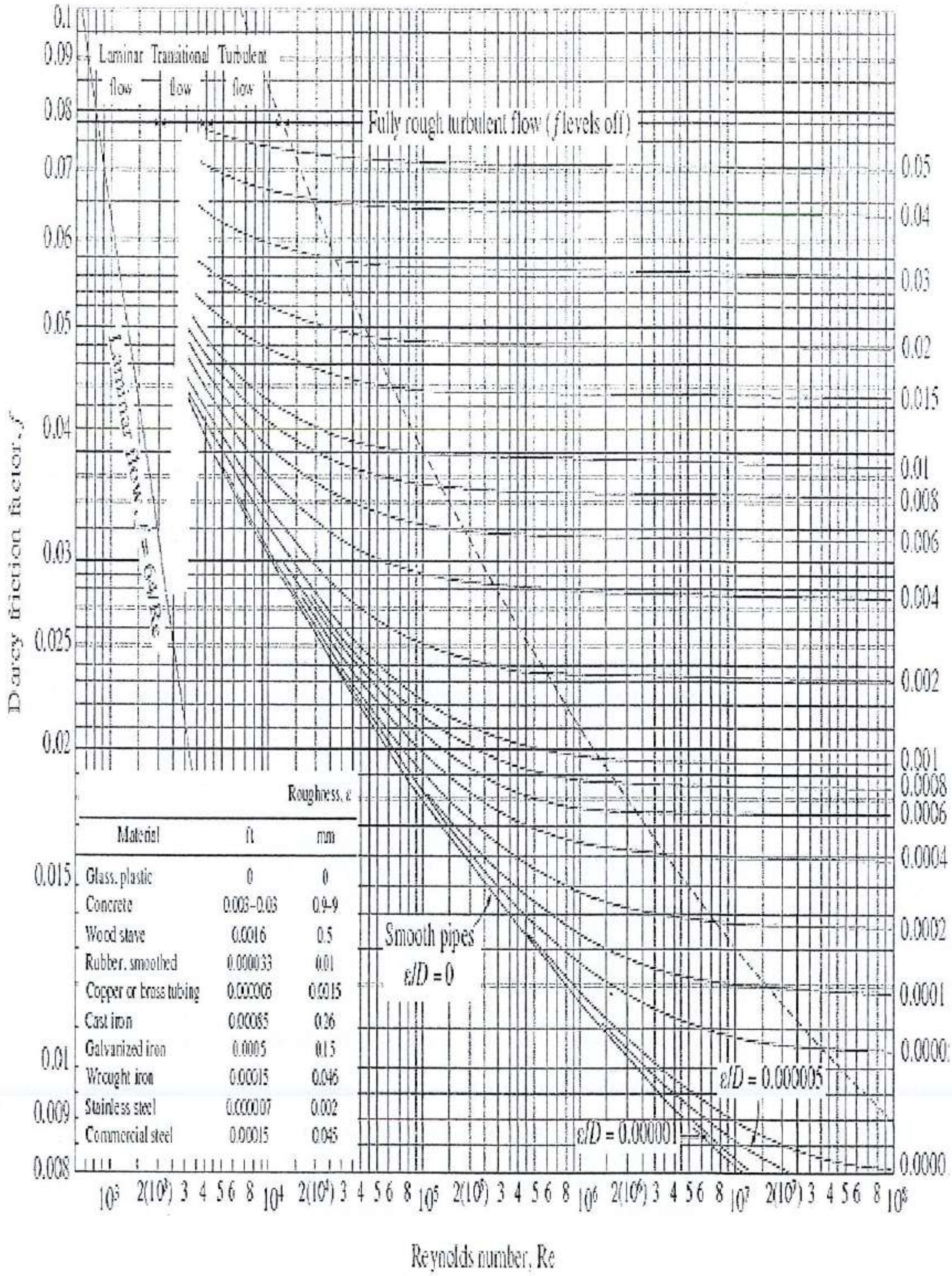


Relative Roughness, ε/D	Friction Factor, f
0.0*	0.0119
0.00001	0.0119
0.0001	0.0134
0.0005	0.0172
0.001	0.0199
0.005	0.0305
0.01	0.0380
0.05	0.0716

* 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



Material	Roughness, ε ft	Roughness, ε mm
Glass, plastic	0	0
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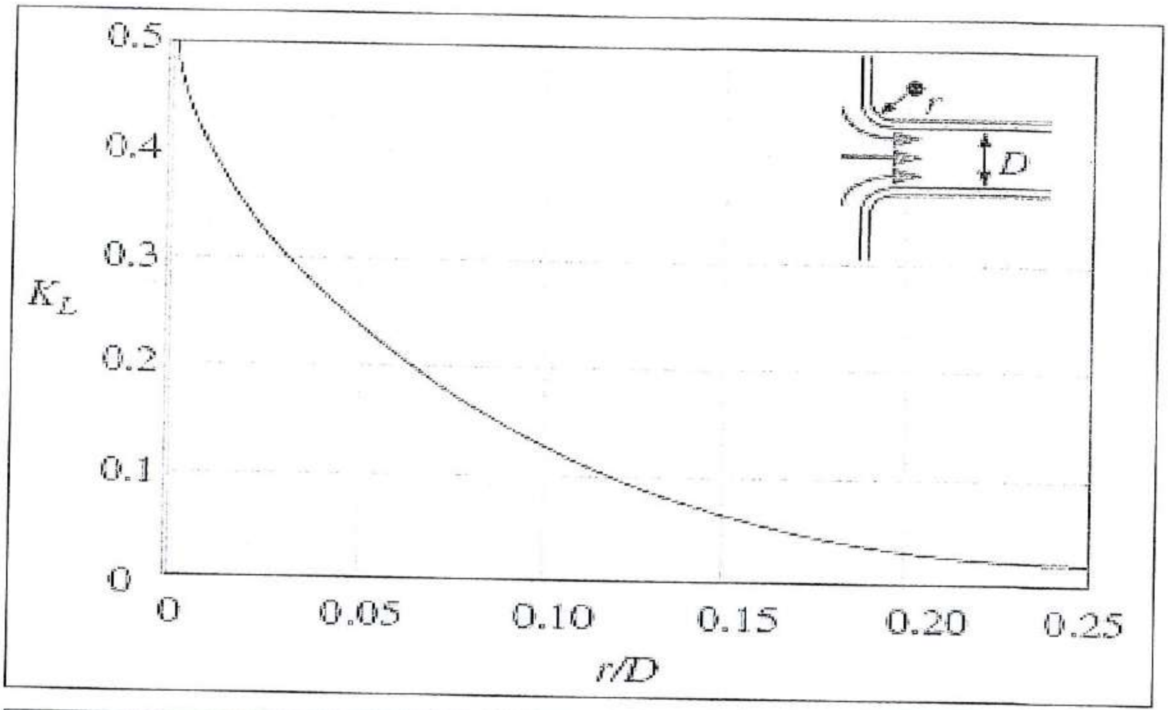
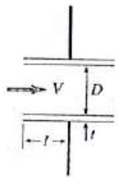


TABLE 14–3

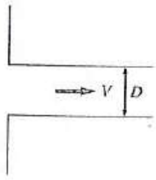
Loss coefficients K_L of various pipe components for turbulent flow (for use in the relation $h_L = K_L V^2/(2g)$, where V is the average velocity in the pipe that contains the component)*

Pipe Inlet

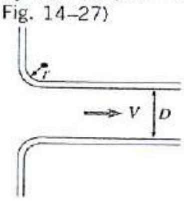
Reentrant: $K_L = 0.80$
($t \ll D$ and $l \approx 0.1D$)



Sharp-edged: $K_L = 0.50$

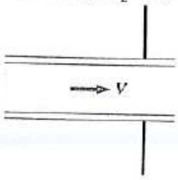


Well-rounded ($r/D > 0.2$): $K_L = 0.03$
Slightly rounded ($r/D = 0.1$): $K_L = 0.12$
(see Fig. 14–27)

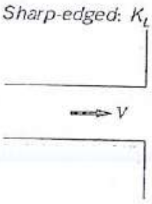


Pipe Exit

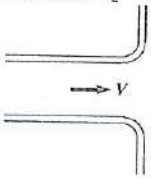
Reentrant: $K_L = \alpha$



Sharp-edged: $K_L = \alpha$



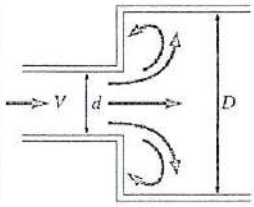
Rounded: $K_L = \alpha$



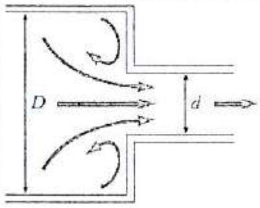
Note: The kinetic energy correction factor is $\alpha = 2$ for fully developed laminar flow, and $\alpha \approx 1.05$ for fully developed turbulent flow.

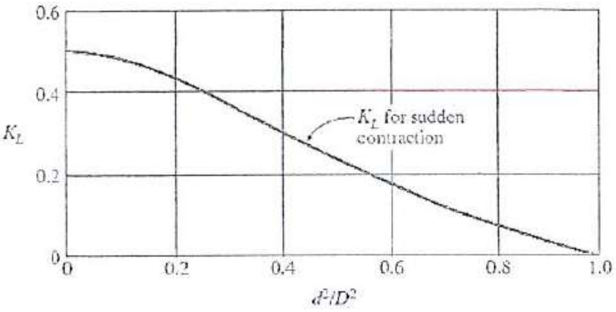
Sudden Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

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



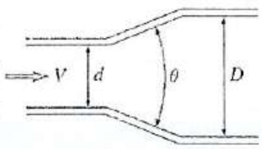
Sudden contraction: See chart.



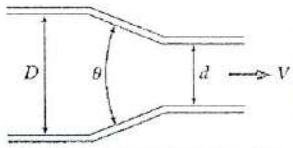


Gradual Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

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 $d/D = 0.8$

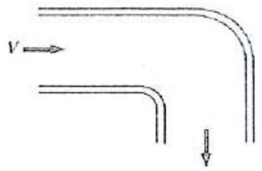


Contraction:
$K_L = 0.02$ for $\theta = 30°$
$K_L = 0.04$ for $\theta = 45°$
$K_L = 0.07$ for $\theta = 60°$

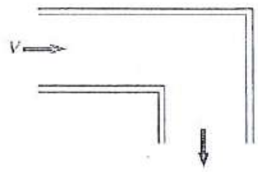


Bends and Branches

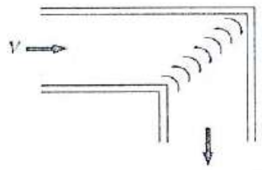
90° smooth bend:
Flanged: $K_L = 0.3$
Threaded: $K_L = 0.9$



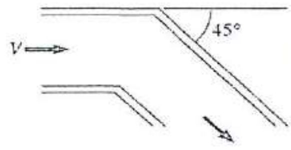
90° miter bend (without vanes): $K_L = 1.1$



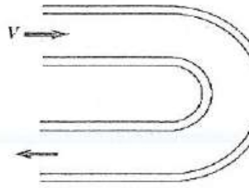
90° miter bend (with vanes): $K_L = 0.2$



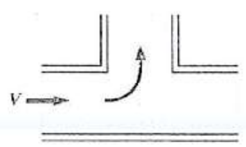
45° threaded elbow:
$K_L = 0.4$



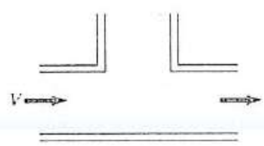
180° return bend:
Flanged: $K_L = 0.2$
Threaded: $K_L = 1.5$



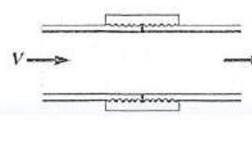
Tee (branch flow):
Flanged: $K_L = 1.0$
Threaded: $K_L = 2.0$



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.