UNIVERSITI SAINS MALAYSIA

First Semester Examination
2011/2012 Academic Session

January 2012

EAH 221/3 – Fluid Mechanics for Civil Engineers

[*Mekanik Bendalir Untuk Jurutera Awam*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **FIFTEEN (15)** pages of printed material including appendices before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi **LIMA BELAS (15)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
[***Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.*

You may answer the question either in Bahasa Malaysia or English.
[*Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris*].

All questions **MUST BE** answered on a new page.
[*Semua soalan **MESTILAH** dijawab pada muka surat baru*].

In the event of any discrepancies, the English version shall be used.
[*Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) (i) Describe the principle of "centre of buoyancy".

(ii) Explain the term metacentric height of a floating body.

[4 marks]

(b) A block of wood x long, y wide and z deep is floating horizontally in water. If the density of the wood ρs and water density ρw, with ρw greater than (>) ρs, determine the volume of the water displacement and the position of centre of buoyancy.

[8 marks]

(c) A solid cylinder of 1 meter in diameter and height of 1 meter. It is made up of a material which a specific gravity of 0.8. It is floating in water with the axis vertical. Determine its metacentric height and whether it is stable or unstable.

[8 marks]

2. (a) Based on the energy equation, derive the equation for measuring fluid velocity and flow rate in a venture tube.

[4 marks]

(b) An orifice meter is to measure the flow rate of propyl alcohol at 25 ^{o}C through a 1 ½ -in (3.81mm) steel tube having a wall thickness of 0.065 in. The expected range of flow rates is 1.0 m^3/h to 2.5 m^3/h. Specify the diameter for the orifice to obtain β=0.40 and determine the range of readings for mercury manometer for the given flow rates.

[8 marks]

(c) A flat rectangular plate 0.22 x 0.28 m in size is inserted into a lake water at 16^{o}C from a boat that moving at 48 km/h. Determine the force required to hold the plate steady relative to the boat with the flat face towards the water.

[8 marks]

3. (a) Carbon-tetra chloride has a mass density of 1594 kg/m^3. Determine its

(i) specific weight

(ii) specific volume

(iii) specific gravity

[6 marks]

(b) If the equation of a velocity profile over a plate is $v = 2\ y^{2/3}$; in which v is the velocity in m/s at a distance of y meters above the plate, determine the shear stress at y = 0 and y = 0.075 m. Given $\mu = 0.835$ N. s/m^2.

[10 marks]

(c) Determine the internal diameter of glass tube if capillary rise of water in it does not to exceed 2.0 mm Given $\sigma = 0.0735$ N/m.

[4 marks]

4. (a) At the sea surface the pressure intensity is 1.006 MN/m^2 and specific gravity of sea water is 1.025. Determine the depth if a point x is below the sea surface, shown in **Figure 4(a)**.

[6 marks]

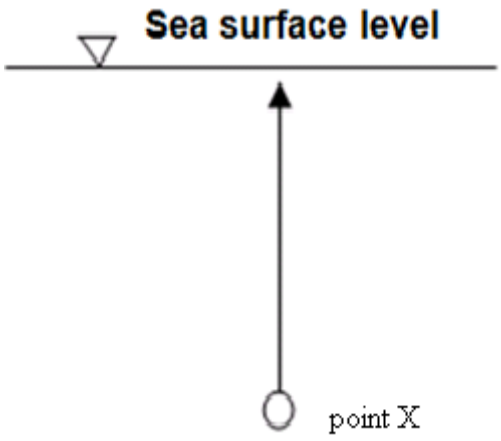


Figure 4(a)

(b) A triangular gate which has a base of 1.5 m and an altitude of 2 m lies in a vertical plane. The vertex of the gate is 1 m below the surface of a tank which contains oil of specific gravity 0.8. Determine the force exerts by oil on the gate and position of center of pressure, shown in **Figure 4(b)**.

[8 marks]

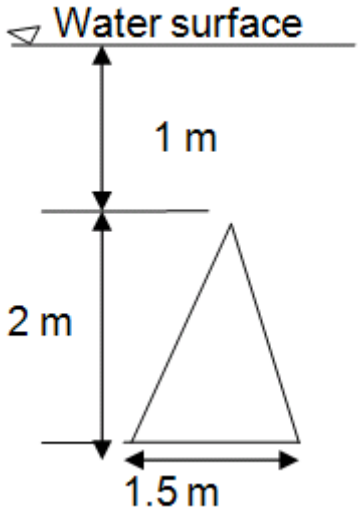


Figure 4(b)

(c) A closed cylindrical tank, partly filled with oil of relative density 0.8 to a depth of 1.5 m, has air pressure of 200 kN/m^2 above the oil. Calculate the pressure on the bottom of the tank.

[6 marks]

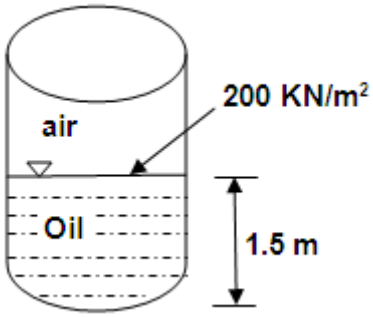


Figure 4(c)

5. (a) A vertical jet of water of diameter 20mm leaves a nozzle at a speed of 10 m/s in **Figure 1**. It impacts a suspended plate of mass 1.5 kg on top of the jet. Determine the jet vertical height (h) with 1.5 kg suspended plate.

[10 marks]

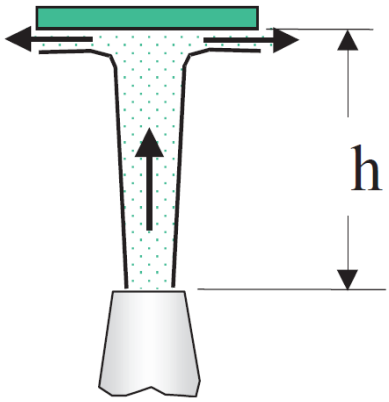


Figure 1

(b) A 500 mm diameter siphon discharges water from a large reservoir as in **Figure 2**. Take atmospheric pressure as 1 bar and neglect all losses. Determine

(i) the maximum possible elevation at point B for a discharge of 2.15 m^3/s without the pressure becoming less than $20kN/m^2$ absolute.

[5 marks]

(ii) the elevation at the discharge end(z_c) at point C.

[5 marks]

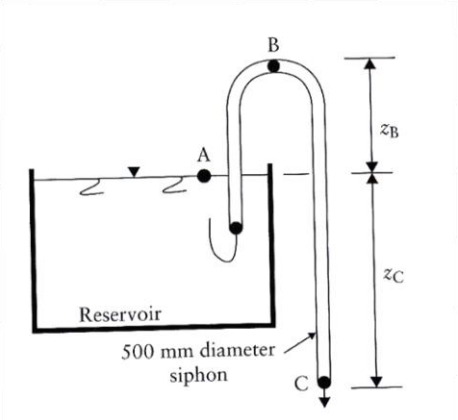


Figure 2

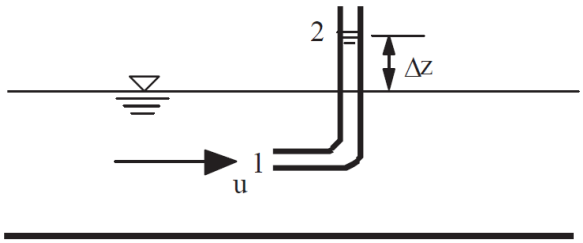


Figure 3

6. (a) A Pitot tube shown in **Figure 3** is used to determine the velocity of liquid at point 1. The flow forces liquid to rise in the vertical section of the tube to the height of Δz above the free water surface. Determine the velocity at the point 1 (in term of equation).

[3 marks]

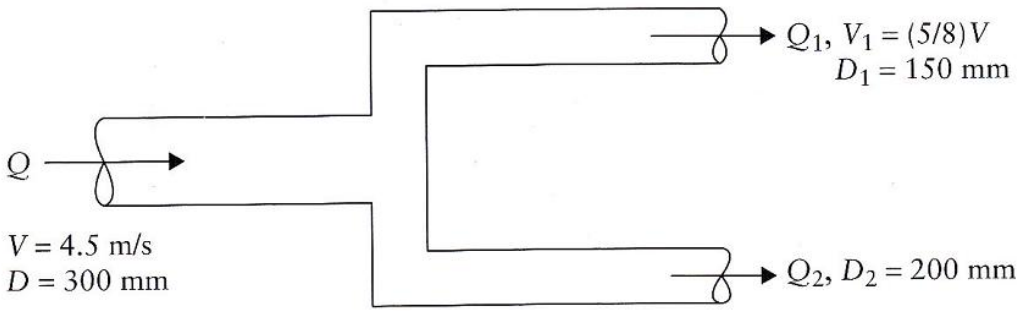


Figure 4

(b) A pipeline of 300 mm diameter carrying water at an average velocity of 4.5 m/s branches into two pipes of 150 mm and 200 mm diameters as in **Figure 4**. If the average velocity in the 150 mm pipe is 5/8 of the velocity in the main pipeline, determine

(i) the average velocity of flow in the 200 mm pipe

(ii) the total flow rate in the system in litres per second

[5 marks]

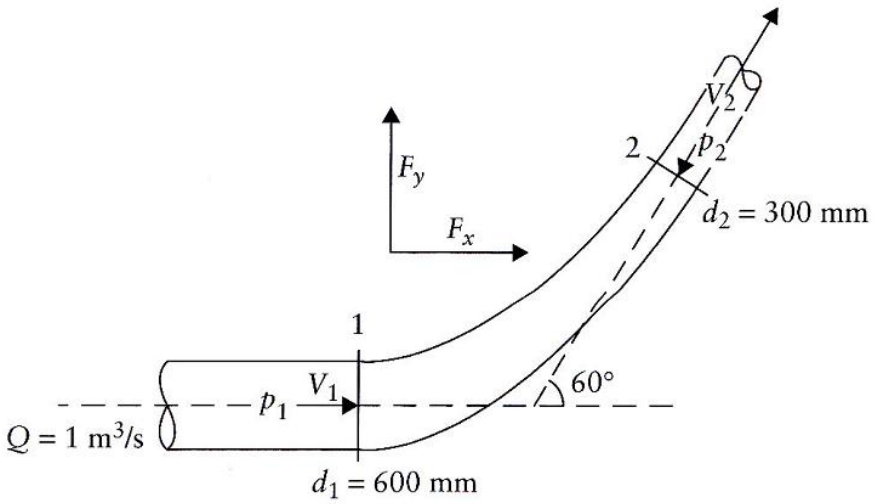


Figure 5

(c) A horizontal bend in a pipeline conveying 1 m^3/s of water gradually reduces from 600 mm to 300 mm in diameter and deflects the flow through an angle of 60^o as shown in **Figure 5**. At the larger end the pressure is 170 kN/m^2. Determine the magnitude and direction of force exerted on the bend.

[12 marks]

1. (a) (i) *Terangkan istilah "pusat keapungan".*

(ii) *Menjelaskan apa yang dimaksud dengan ketinggian pusatmeta badan terapung*

[4 markah]

(b) *Blok kayu x panjang, y lebar dan z tebal terapung secara mendatar di dalam air. Jika ketumpatan kayu ρs, ρw ketumpatan air dengan ρw > ρs, Berapakan isipadu air yang dipindahkan dan kedudukan pusat keapungan.*

[8 markah]

(c) *Selinder solid dengan 1 meter mempunyai tinggi 1meter. Ia terdiri daripada bahan yang spesifik gravity 0.8 dan terapung dalam air dengan paksi tegak. Cari ketinggian pusat meta, dan nyatakan apakah sama ada keseimbangan yang stabil atau tidak stabil.*

[8 markah]

2. (a) *Terbitkan formula untuk mengukur halaju bendalir dan kadar alir dengan menggunakan tiub teroka.*

[4 markah]

(b) *Meter orifis untuk mengukur kadar aliran propyl alcohol pada 25^{o}C melalui 1 ½ -in tiub keluli yang mempunyai ketebalan dinding 0.065. Julat yang dijangka kadar alirannya adalah 1.0 m^{3}/jam sampai 2.5 m^{3}/jam. Diameter orifis sesuai dengan β=0.40 dan tentukan julat pembacaan manometer raksa untuk kadar aliran yang diberikan.*

[8 markah]

(c) *Suatu flat segiempat dengan saiz 0.22 x 0.28 dimasukan kedalam air tasik pada 16^{o}C dari bot yang bergerak pada 48 km/jam. Berapa daya yang diperlukan untuk menahan plat mantap terhadap bot dengan muka flat menhadap air?*

[8 markah]

3. (a) *Klorida tetra karbon mempunyai ketumpatan jisim 1594 kg/m^3. Hitung pengaruh*

(i) berat tetra

(ii) isipadu tentu

(iii) spesifik graviti

[6 markah]

(b) *Jika persamaan profil halaju atas satu plat ialah v = 2 y^2/3; dimana v ialah halaju dalam m/s di satu jarak meter y di atas plat, tentukan tegasan ricih di y = 0 dan y = 0.075 m. Gunakan μ= 0.835 N. s /m^2.*

[10 markah]

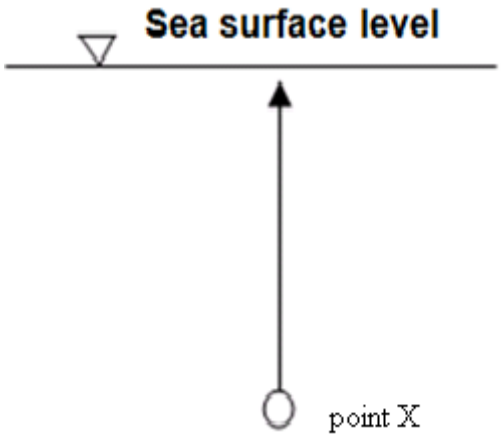
(c) *Tentukan garis pusat dalam tiub kaca jika kenaikan kapilari air di dalamnya tidak melebihi 2.0 mm?*

Guna σ = 0.0735 N/m.

[4 markah]

4. (a) *Tentukan nilai kedalaman titik di bawah permukaan air laut di mana tekanan ialah 1.006 MN / m2 dan graviti spesifik air laut adalah 1.025. Sila rujuk* ***Rajah 4(a)***.

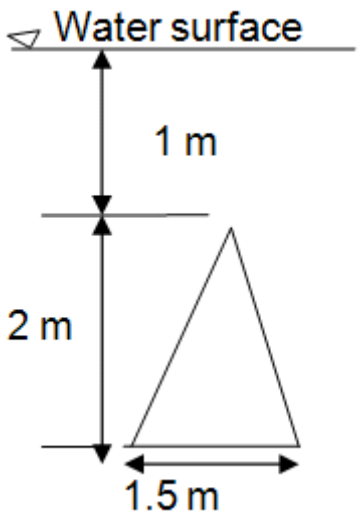
[6 markah]



Rajah 4(a)

(b) *Satu get segitiga yang mempunyai asas 1.5 m dan ketinggian 2 m terletak dalam satu satah tegak. Bucu get segitiga adalah 1 m di bawah permukaan sebuah tangki yang mengandungi minyak graviti spesifik 0.8. Tentukan daya tekanan yang dikenakan oleh minyak ke atas get tersebut dan posisi pusat tekanan. Sila rujuk* ***Rajah 4(b)****.*

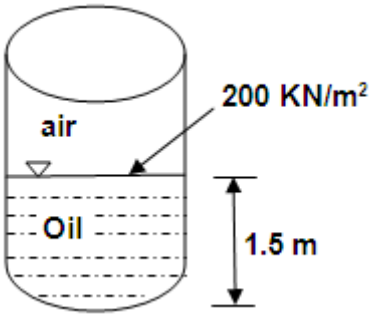
[8 markah]



Rajah 4(b)

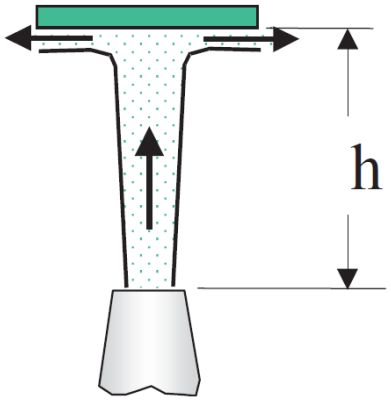
(c) *Satu tangki silinder tertutup, sebahagiannya dipenuhi dengan minyak berketumpatan 0.8 untuk kedalaman 1.5 m dan mempunyai tekanan udara 200 KN / m2 di atas minyak. Cari tekanan pada dasar tangki tersebut. Sila rujuk* ***Rajah 4(c).***

[6 markah]



Rajah 4(c)

5. (a) *Jet air memancut keluar dari sebuah muncung berukuran 200 mm dengan kelajuan 10 m/s seperti* ***Rajah 1****. Tentukan ketinggian vertical (h) dari impak yang mengapungkan sebuah plat berjisim 1.5 kg.* *[10 markah]*



Rajah 1

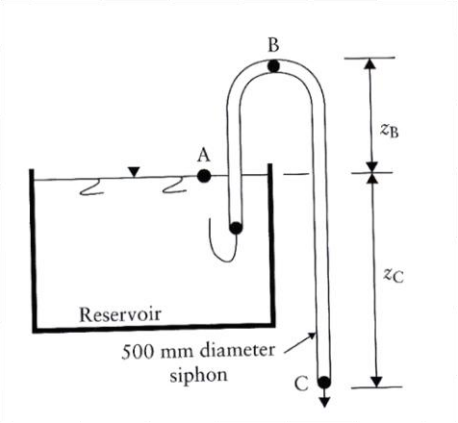
(b) *Sebuah siphon berdiameter 500 mm mengalirkan air dari sebuah takungan besar seperti* ***Rajah 2****. Andaikan tekanan udara adalah 1 bar dan abaikan kehilangan, tentukan.*

(i) *ketinggian maksimum pada titik B sekiranya kadar air adalah 2.15 m^3/s dan tekanan tentu tidak kurang dari 20kN/m^2.*

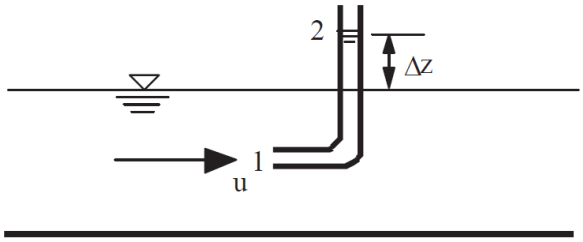
[5 markah]

(ii) *ketinggian titik C*

[5 markah]



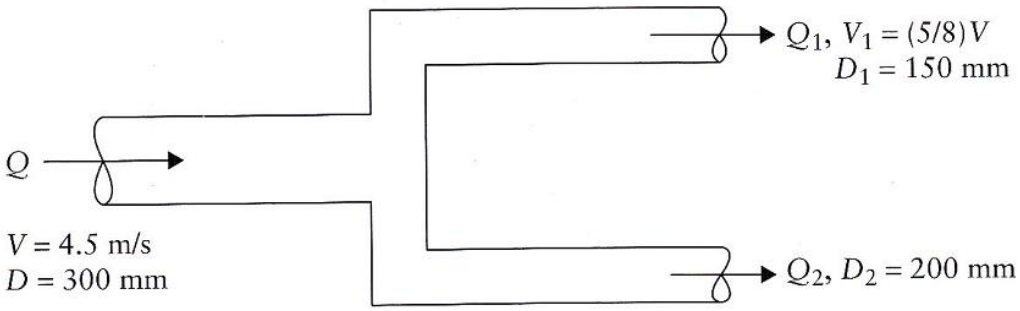
Rajah 2



Rajah 3

6. *(a)* *Sebatang Pitot seperti* ***Rajah 3*** *digunakan untuk mengukur kelajuan cecair pada titik 1. Daya aliran akan menaikan ketinggian paras vertical tiub Pitot tersebut pada jarak Δz dari permukaan cecair. Tentukan halatuju pada titik 1 (dalam bentuk persamaan)*

[3 markah]



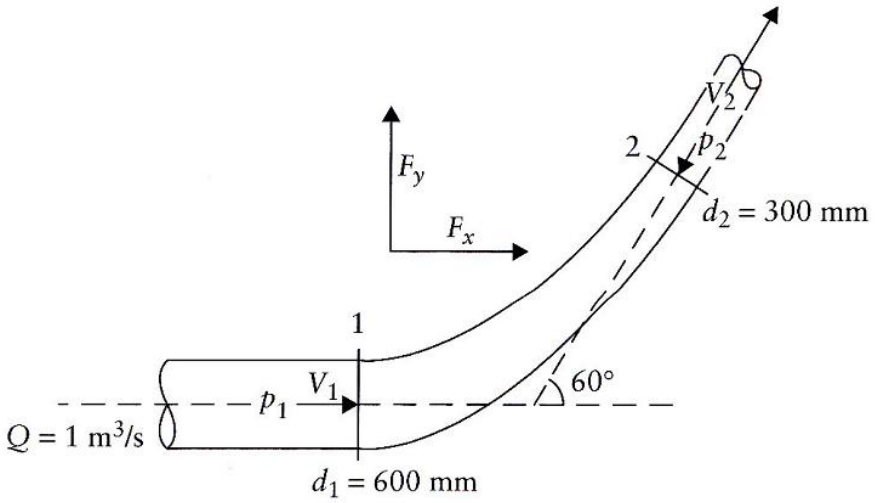
Rajah 4

(b) *Sebatang paip berdiameter 300 mm membawa air dengan purata kelajuan 4.5 m/s ke dua cabang paip yang berdiameter 150 mm dan 200 mm seperti* ***Rajah 4****. Sekiranya purata kelajuan paip 150 mm adakah 5/8 dari purata kelajuan paip utama, tentukan*

(i) *purata kelajuan dalam paip 200 mm*

(ii) *jumlah kadar alir dalam system paip tersebut (e/s)*

[5 markah]



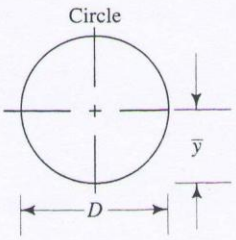
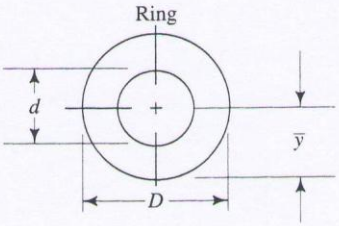
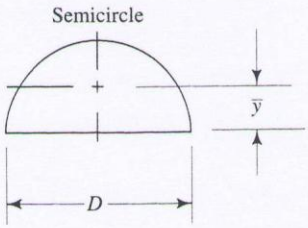
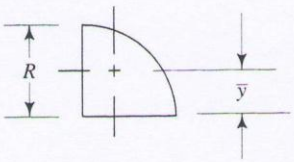
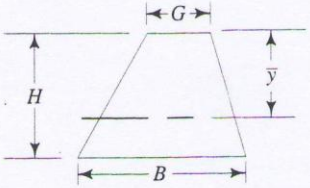
Rajah 5

(c) *Sebatang lengkung paip yang pada asalnya bergarispusat 600 mm dan mengecil kepada 300 mm mengalirkan 1 m^3/s air dan melencongkan aliran dengan sudut 60^o seperti* ***Rajah 5****. Pada peringkat lengkung tersebut, tekanan adalah 170 kN/m^2 . Tentukan nilai dan arah daya yang dikenakan ke atas lengkung tersebut.*

[12 markah]

Appendix 1.

Properties of Areas (*continued*)

Section	Area of Section A	Distance to Centroidal Axis $\bar{y}$	Moment of Inertia about Centroidal Axis I_c
Circle 	$\pi D^2/4$	$D/2$	$\pi D^4/64$
Ring 	$\frac{\pi(D^2-d^2)}{4}$	$D/2$	$\frac{\pi(D^4-d^4)}{64}$
Semicircle 	$\pi D^2/8$	$0.212D$	$(6.86\times10^{-3})D^4$
Quadrant 	$\pi D^2/16$ $\pi R^2/4$	$0.212D$ $0.424R$	$(3.43\times10^{-3})D^4$ $(5.49\times10^{-2})R^4$
Trapezoid 	$\frac{H(G+B)}{2}$	$\frac{H(G+2B)}{3(G+B)}$	$\frac{H^3(G^2+4GB+B^2)}{36(G+B)}$

Appendix 2

TABLE 17.1. Typical drag coefficients

Shape of body	Orientation	C_D
Square cylinder	Flow →	1.60
Semitubular cylinders	→	1.12
	→	2.30
Triangular cylinders	→ 30°	1.05
	→ 30°	1.85
	→	1.39
	→ 60°	2.20
	→	1.60
	→ 90°	2.15
	→	1.75
	→ 120°	2.05
Rectangular plate	Flow → b, a	*a/b*: 1 → 1.16; 4 → 1.17; 8 → 1.23; 12.5 → 1.34; 25 → 1.57; 50 → 1.76; ∞ → 2.00
Tandem disks L = spacing d = diameter	→ d, L	*L/d*: 1 → 0.93; 1.5 → 0.78; 2 → 1.04; 3 → 1.52
One circular disk	→ d	1.11
Cylinder L = length d = diameter	→ d, L	*L/d*: 1 → 0.91; 2 → 0.85; 4 → 0.87; 7 → 0.99

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