UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

# 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)** printed pages including appendices before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **LIMABELAS (15)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

**Instructions**: This paper contains ***SIX* (6)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.
*[Arahan: Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

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.]*

Write the answered question numbers on the cover sheet of the answer script.
*[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]*

In the event of any discrepancies, the English version shall be used.

*[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Enggeris hendaklah diguna pakai]*

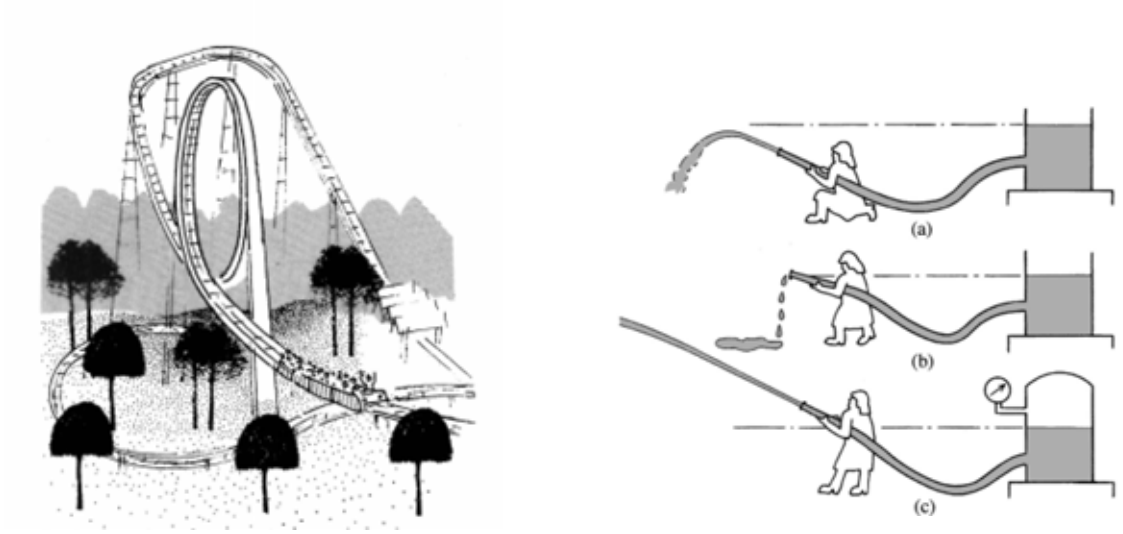


**Figure 1**

1. a) Describe the similarities and differences in the concept of Conservation of Energy in fluid mechanic as in Figure 1.

(5 marks)

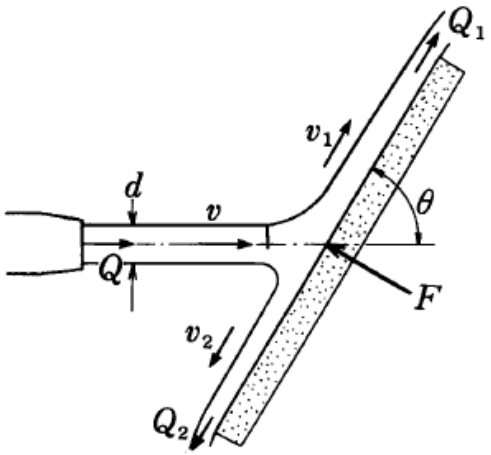


**Figure 2**

b) As show in Figure 2, a jet of water of flow rate Q = 0.12m$^3$/s and diameter d=25mm strikes a plate at angle θ = 60$^o$. Calculate the force and its direction if:

i) the plate is stationary

ii) the plate moving away from the strikes at 0.25 m/s

(15 marks)

…3/-

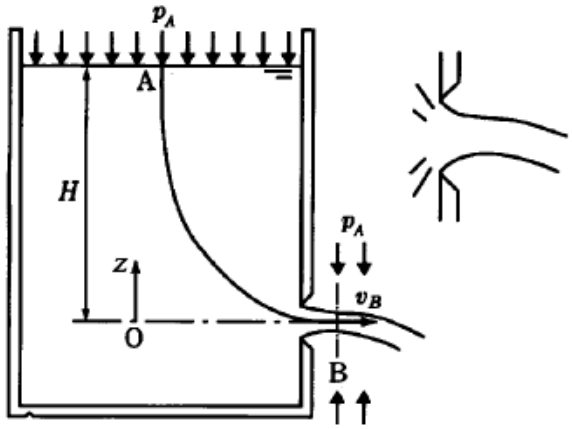


**Figure 3**

2. a) Based on Figure 3, derives the formula of $V_B$ is equal to $\sqrt{2gH}$ and states all your assumptions.

(3 marks)

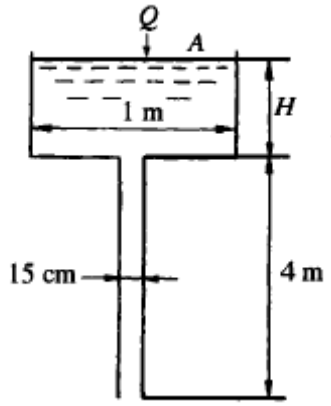


**Figure 4**

b) In the case of Figure 4, water at a flow rate of $0.2m^3/s$ is supplied to the cylindrical water tank of diameter 1m discharging through a round pipe of length 4m and diameter of 15cm. Determine how is the depth of water in the tank (H).

(10 marks)

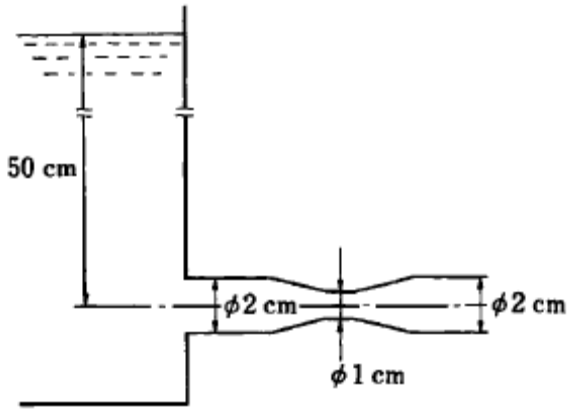


**Figure 5**

c) As shown in Figure 5, if water flows out of the tank of head 50cm through the throttle, obtain the pressure at the throat.

(7 marks)

3. a) A cylinder 25 mm in diameter is placed perpendicular to a fluid stream with a velocity of 0.15 m/s. If the cylinder is 1 m long, calculate the total drag force if the fluid is :

i) Water at 15$^{o}$C and

ii) Air at 10$^{o}$C and atmospheric pressure.

Note : Water 15$^{o}$C $\rho$= 1000 kg/m$^3$ , $\nu$=1.15 x 10$^{-6}$ m$^2$/s; air at 10 $^{o}$C $\rho$= 1.247 kg/m$^3$ , $\nu$=1.42 x 10$^{-5}$ m$^2$/s), refer Appendix 1.

(10 marks)

b) As part of an advertising sign on the top of a tall building, a 2-m-diameter sphere called a "weather ball" glows different colors if the temperature is changed. Calculate the force on the weather ball due to winds of :

i) 15, 30 and 60 km/h at air temperature 0$^{o}$C.

ii) 120 and 160 km/h at air temperature 30$^{o}$C.

Note : Refer Appendix 2

(10 marks)

4. a) Describe the pressure, density, specific weight, specific gravity, dynamic viscosity and Kinematic viscosity.

(4 marks)

b) A rock has a specific gravity of 2.32 and a volume of $1.43 \times 10^{-4}$ $m^3$. How much does its weight at temperature of $10^oC$ and $25^oC$?

(6 marks)

c) Derive equation for the change in height h in a circular tube of liquid with surface tension $\sigma$ and contact angle $\theta$ , as shown in Figure 7.

(10 marks)

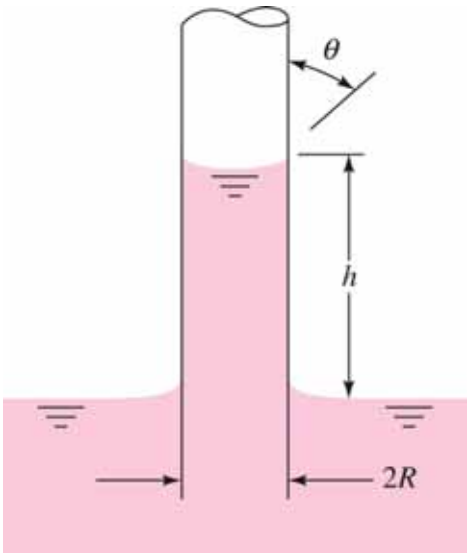


**Figure 7**

5. a) Determine total force and location of centre of pressure in the following cases in Figure 8 (a), (b) and (c).

(12 marks)

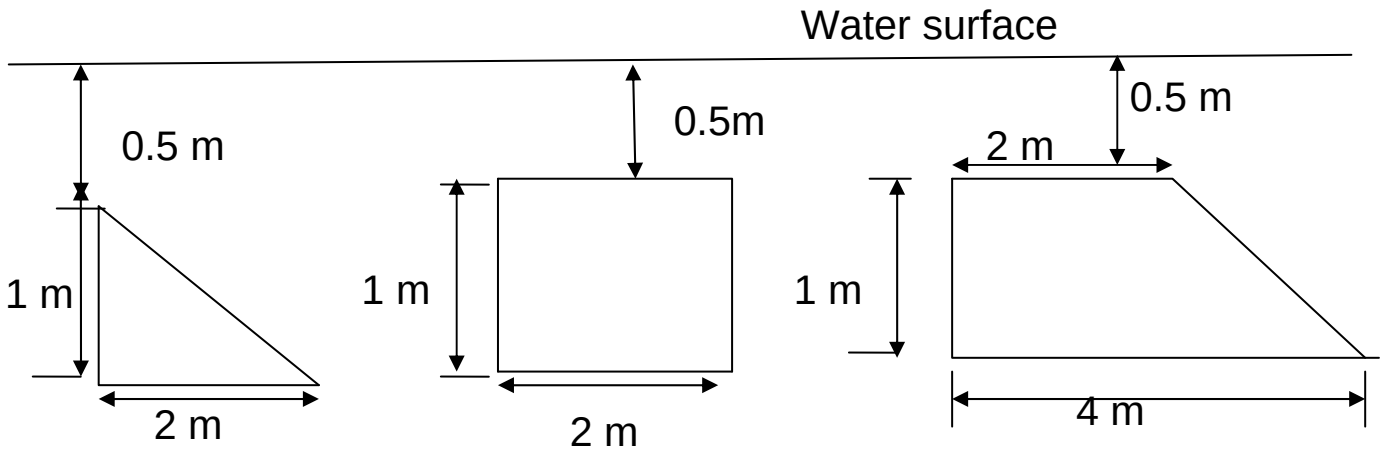


**Figure 8**

b) Pressure gauge B is to measure the pressure at Point A in a water flow. If the pressure at B is 87 KPa, estimate the pressure at A in KPa. Based on Figure 9 assume all fluids are at 20$^{o}$C.

(8 marks)

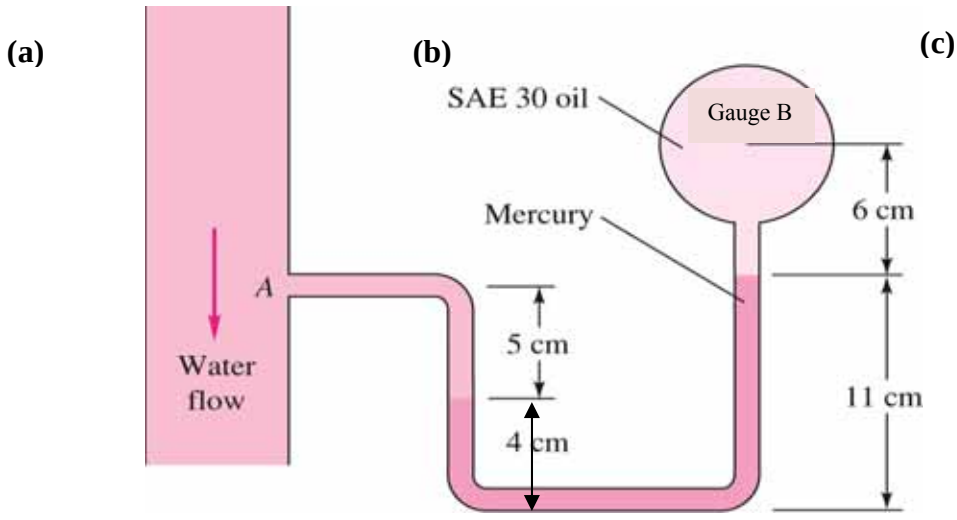


**Figure 9**

6. a) A block of concrete weighs 100 N in air and 'weighs'only 60 N when immesered in fresh water (specific weight of water = 1000 N/m$^3$) . What is the average specific weight of the block. (Please see Figure 10).

(6 marks)

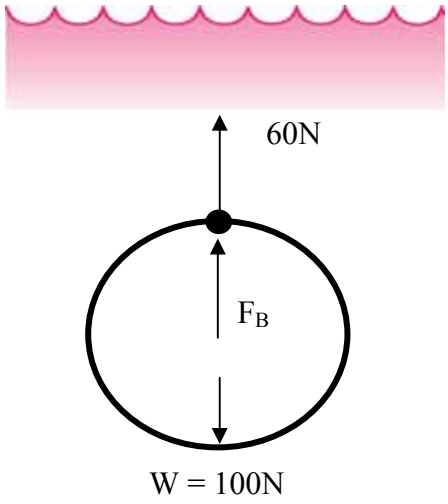


**Figure 10**

b) A pipe diameter changes from 1 m to 2 m in a length of 5 m giving a pipe diffuser or transition. If a discharge Q (m$^3$/s) flows from the 1 m diameter section towards 2 m diameter section, derive a general equation for velocity (Please see Figure 11 for pipe cross section and flow direction).

(8 marks)

c) What are the assumptions in derivation of continuity equation?

(6 Marks)

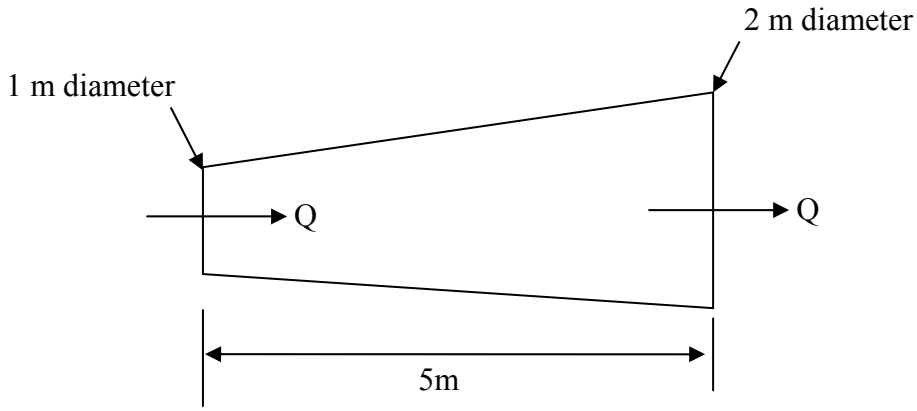


**Figure 11**

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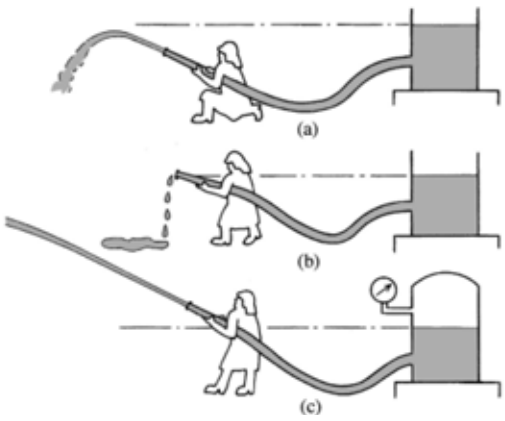
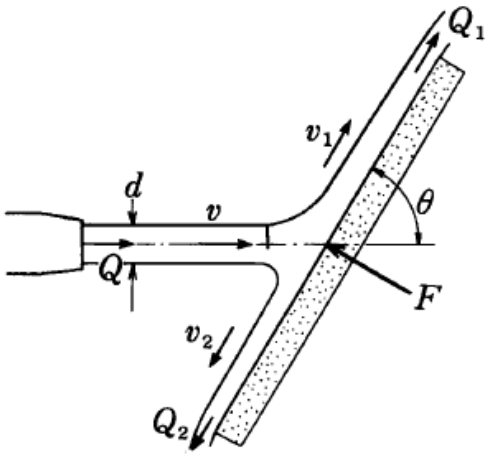



***Rajah 1***

1. a) *Terangkan persamaan dan perbezaan dalam konsep Pengabadian Tenaga dalam 'Roller Coaster' dan mekanik bendalir dari Rajah 1 berikut.*

*(5 Markah)*



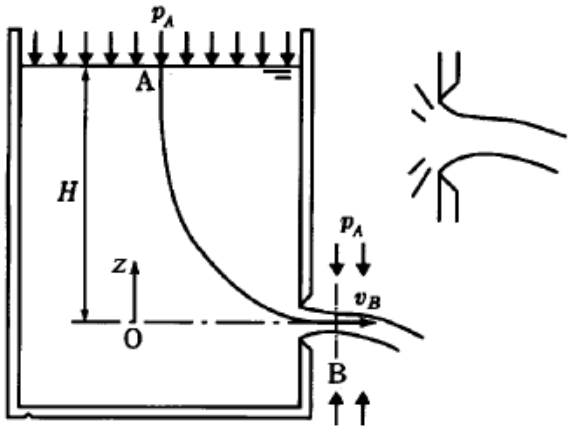

***Rajah 2***

b) *Berpandukan Rajah 2, satu pancutan air dengan kadar alir $Q = 0.12m^3/s$ dan bergarispusat d=25mm menghentam sebuah plat pada sudut $\theta = 60^o$. Cari nilai daya dan arahnya sekira:*

i) *Plat berkedudukan statik*

ii) *Plat bergerak dari pancutan tersebut dengan kelajuan 0.25 m/s*

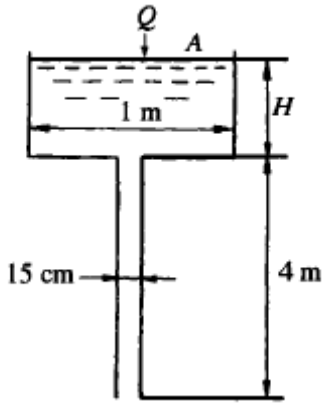
*(15 Markah)*




***Rajah 3***

2. a) *Berdasarkan Rajah 3, bentukkan persamaan* $V_B = \sqrt{2gH}$ *dan nyatakan andaian.*

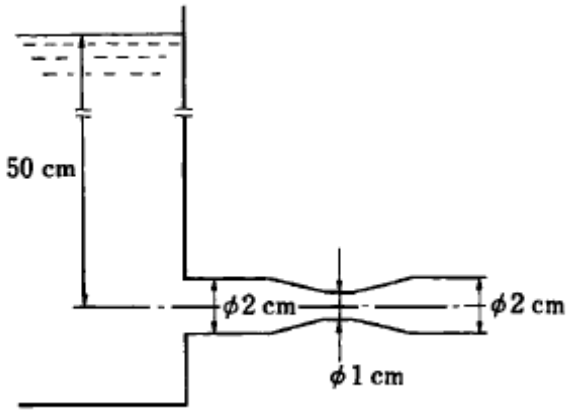
*(3 markah)*




***Rajah 4***

b) *Dalam kes Rajah 4, air mengalir dengan kadar alir sebanyak 0.2m$^3$/s ke dalam tangki silinder yang bergarispusat 1m dan mengalir melalui paip sepanjang 4m dan bergarispusat 15sm. Cari nilai kedalam air dalam tangki silinder tersebut (H).*

*(10 markah)*




***Rajah 5***

c) *Seperti di Rajah 5, sekiranya air mengalir keluar dari tangki yang berturus 50sm melalui sesempit, cari nilai tekanan pada sesempit tersebut.*

*(7 markah)*

3. a) *Suatu selinder dengan diameter 25 mm ditempatkan tegak lurus terhadap aliran bendalir dengan laju 0.5 m/s. Jika selinder mempunyai panjang 1m, hitungkan daya geser total bila bendalirnya adalah*

i) *Air pada 15$^{o}$C dan*

ii) *Udara pada 10$^{o}$C dan tekanan atmosfer.*
*Nota : Air pada 15$^{o}$C $\rho$= 1000 kg/m$^{3}$ , v=1.15 x 10$^{-6}$ m$^{2}$/s; udara pada 10 $^{o}$C $\rho$= 1.247 kg/m$^{3}$ , v=1.42 x 10$^{-5}$ m$^{2}$/s), lihat Lampiran 1.*

*(9 markah)*

b) *Sebagai tanda iklan pada puncak bangunan tinggi, suatu bola-bola disebut "weather ball" yang berkilau dengan warna berbeda bila temperatur diramalkan turun, naik, atau tetap. Hitung daya pada "weather ball" yang disebabkan angin dari :*

i) *15, 30 dan 60 km/h pada suhu udara 0$^{o}$C.*

ii) *120 dan 160 km/h pada suhu udara 30$^{o}$C.*
*Nota : Lihat Lampiran 2.*

*(10 markah)*

*...11/-*

4. a) *Berikan definasi bagi tekanan, ketumpatan, berat tentu, graviti tentu, kelikatan dinamik dan kelikatan kinematik.*

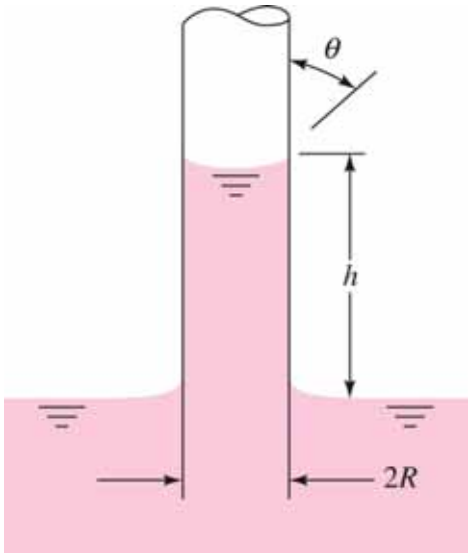
*(4 markah)*

b) *Batu mempunyai graviti tentu 2.32 dan isipadu* $1.43 \times 10^{-4}\ m^3$. *Berapakah berat batu tersebut.*

*(6 markah)*

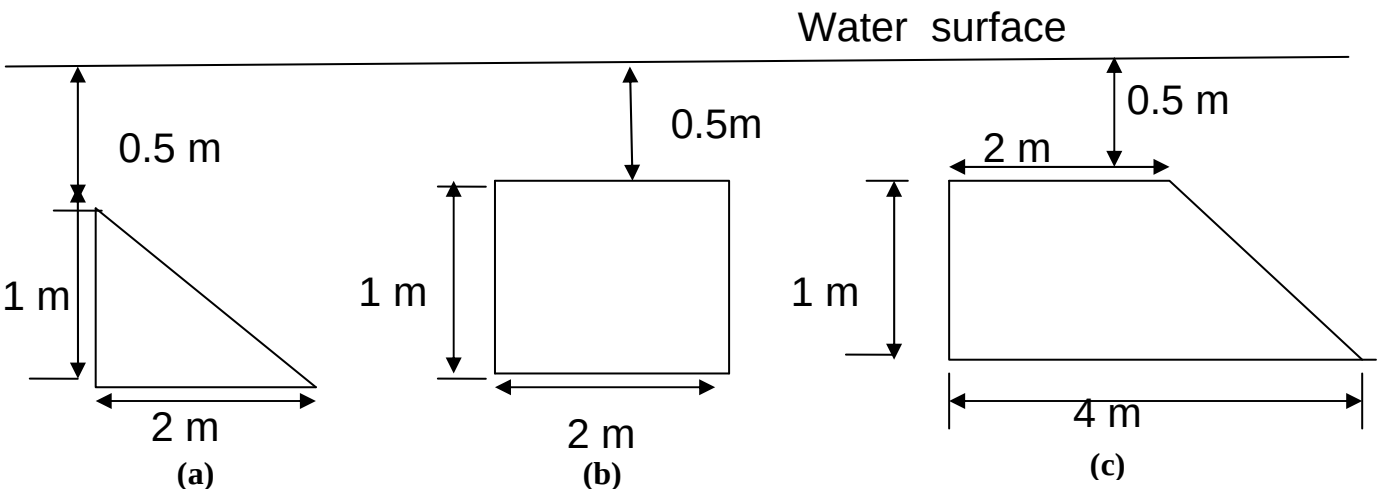
b) *Terbitkan persamaan untuk perubahan ketinggian 'h' untuk tiub yang mengandungi cecair dengan tegangan permukaan* $\sigma$ *dan sudut* $\theta$ *seperti di Rajah 7.*

*(10 markah)*




***Rajah 7***

5. a) *Tentukan jumlah daya dan pusat tekanan untuk kes-kes tersebut :*

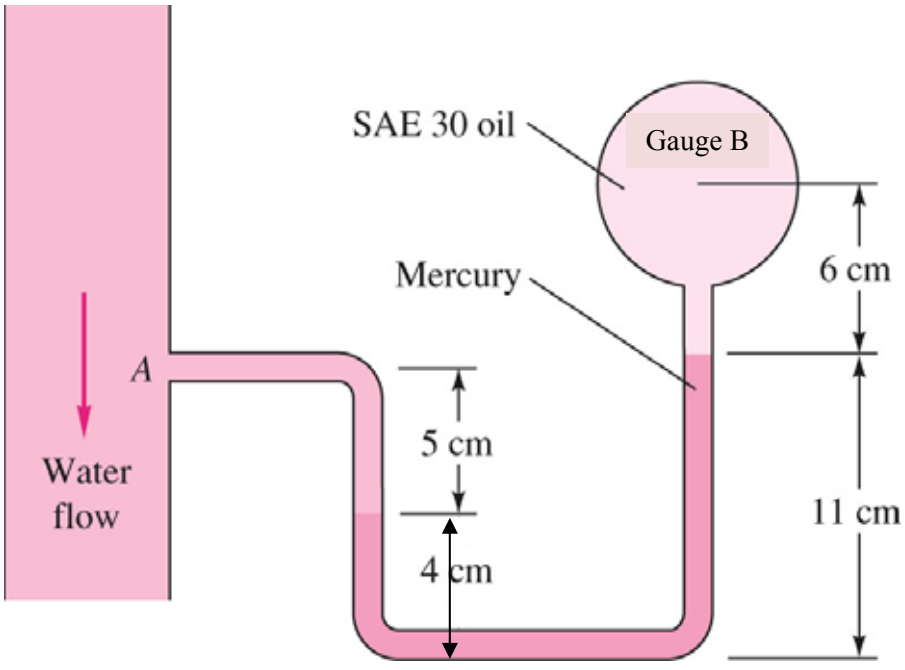



***Rajah 8***

b) *Tekanan tolok di B tentukan oleh tekanan di A. Sekiranya tekanan di B adalah 87 kPa, berdasarkan Rajah 9 hitung tekanan di A.*

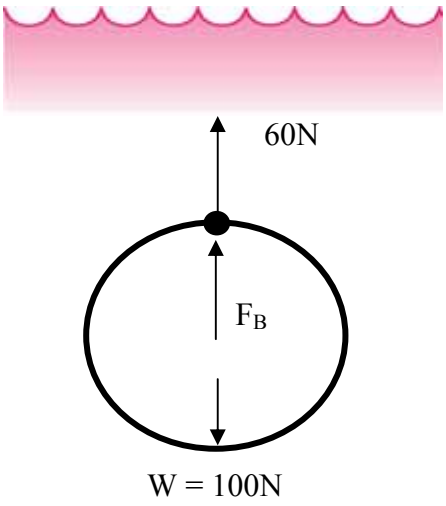
*Andaian :*

*(Suhu adalah 20$^{o}$C, berat tentu air adalah 9810 N/m$^{3}$, berat tentu raksa 133100 N/m$^{3}$ buat tentu minyak 8720 = N/m$^{3}$).*




***Rajah 9***

6. a) *Sebuah blok konkrit mempunyai berat 100N dan berat di dalam air adalah 60N ketika terendam (1000N/m$^3$). Cari nilai purata berat tentu bagi blok tersebut.*



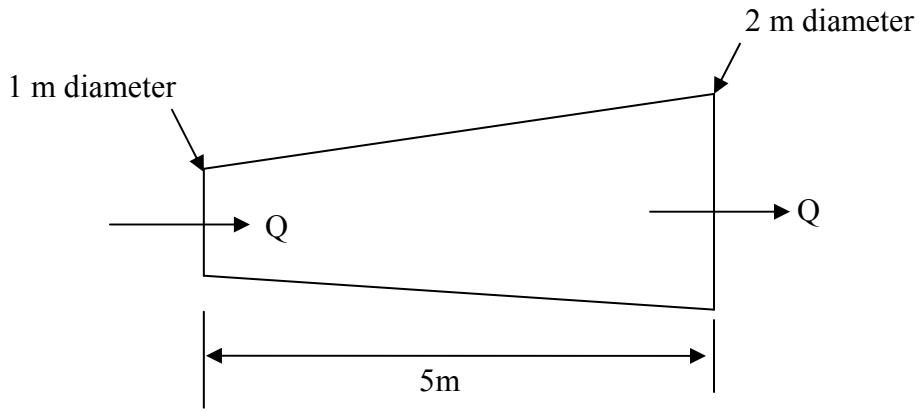

***Rajah 10***

b) *Sebatang paip bertukar diameter 1 m ke 2 m bagi jarak 5 meter. Sekiranya kadar alir Q (m$^3$/s) mengalir dari keratan rentas 1 m ke keratan rentas 2 m, terbitkan persamaan halaju. Sila rujuk pada Rajah 11.*

*(8 marks)*

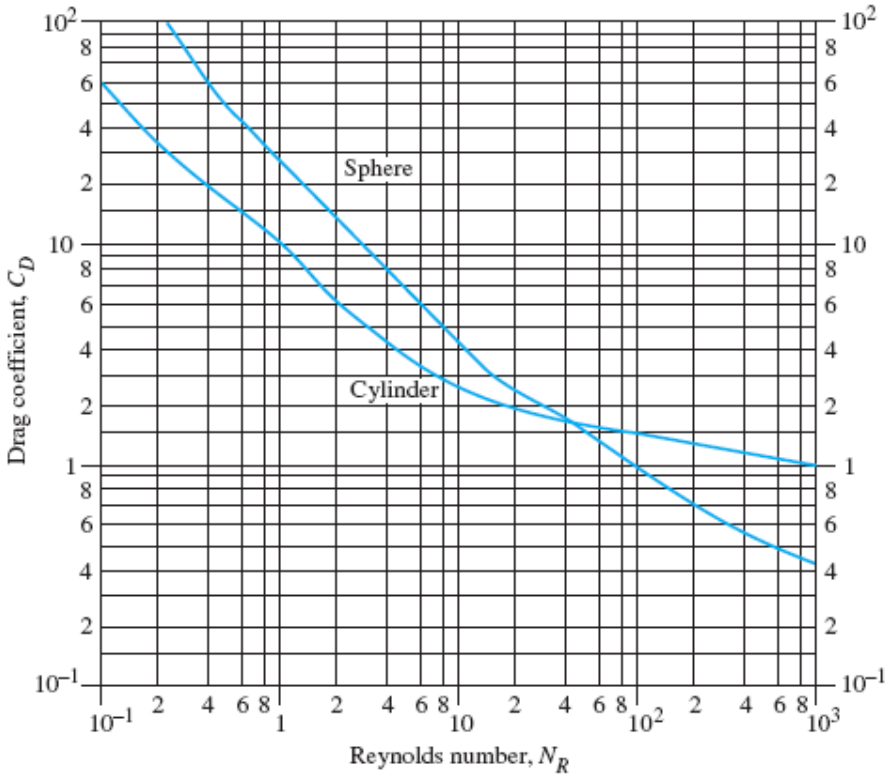
b) *Apakah andaian-andaian dalam penerbitan persamaan keselanjaran?*

*(6 markah)*

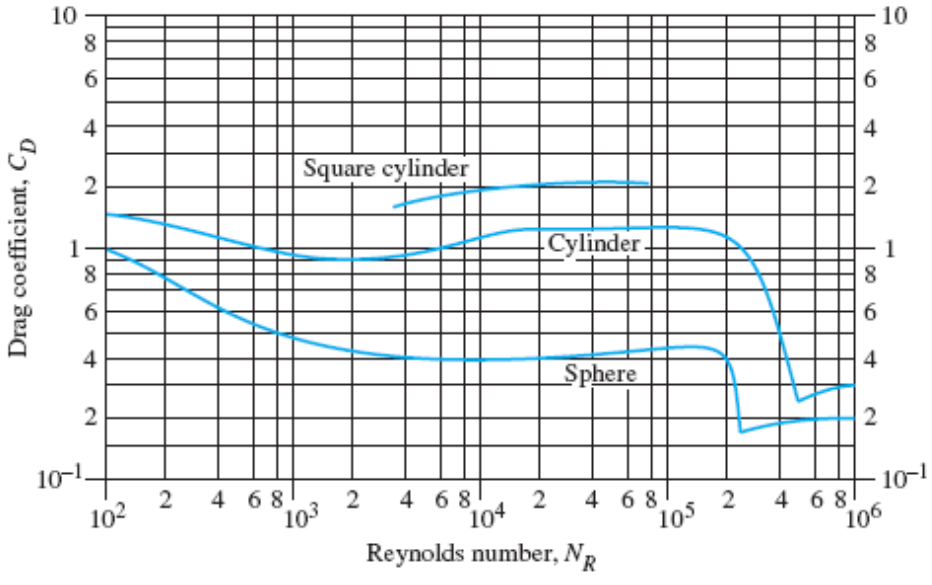



***Rajah 11***

**Appendix 1/ *Lampiran 1***




(a) $C_D$ vs. $N_R$ for lower values of $N_R$




(b) $C_D$ vs. $N_R$ for higher values of $N_R$

**Relationship between Drag coefficient, $C_D$ and Reynold number, $N_R$**

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**Appendix 2/ *Lampiran 2***

Temperature, density, specific heat, thermal conductivity, expansion coefficient, kinematic viscosity and Prandtl's number for temperatures ranging *-150 - 400 °C*



| Temperature - *t* - (°C) | Density - *ρ* - ($kg/m^3$) | Specific heat capacity - $c_p$ - (kJ/kg K) | Thermal conductivity - *l* - (W/m K) | Kinematic viscosity - *v* - ($m^2/s$) x $10^{-6}$ | Expansion coefficient - *b* - (1/K) x $10^{-3}$ | Prandtl's number - $P_r$ - |
|---|---|---|---|---|---|---|
| -150 | 2.793 | 1.026 | 0.0116 | 3.08 | 8.21 | 0.76 |
| -100 | 1.980 | 1.009 | 0.0160 | 5.95 | 5.82 | 0.74 |
| -50 | 1.534 | 1.005 | 0.0204 | 9.55 | 4.51 | 0.725 |
| 0 | 1.293 | 1.005 | 0.0243 | 13.30 | 3.67 | 0.715 |
| 20 | 1.205 | 1.005 | 0.0257 | 15.11 | 3.43 | 0.713 |
| 40 | 1.127 | 1.005 | 0.0271 | 16.97 | 3.20 | 0.711 |
| 60 | 1.067 | 1.009 | 0.0285 | 18.90 | 3.00 | 0.709 |
| 80 | 1.000 | 1.009 | 0.0299 | 20.94 | 2.83 | 0.708 |
| 100 | 0.946 | 1.009 | 0.0314 | 23.06 | 2.68 | 0.703 |
| 120 | 0.898 | 1.013 | 0.0328 | 25.23 | 2.55 | 0.70 |
| 140 | 0.854 | 1.013 | 0.0343 | 27.55 | 2.43 | 0.695 |
| 160 | 0.815 | 1.017 | 0.0358 | 29.85 | 2.32 | 0.69 |
| 180 | 0.779 | 1.022 | 0.0372 | 32.29 | 2.21 | 0.69 |
| 200 | 0.746 | 1.026 | 0.0386 | 34.63 | 2.11 | 0.685 |
| 250 | 0.675 | 1.034 | 0.0421 | 41.17 | 1.91 | 0.68 |
| 300 | 0.616 | 1.047 | 0.0454 | 47.85 | 1.75 | 0.68 |
| 350 | 0.566 | 1.055 | 0.0485 | 55.05 | 1.61 | 0.68 |
| 400 | 0.524 | 1.068 | 0.0515 | 62.53 | 1.49 | 0.68 |

**-oooOooo-**