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**UNIVERSITI SAINS MALAYSIA**

First Semester Examination  
2010/2011 Academic Session

November 2010

**EAH 221/3 – Fluid Mechanics for Civil Engineers**  
*[Mekanik Bendalir Untuk Jurutera Awam]*

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

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Please check that this examination paper consists of **THIRTEEN (13)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TIGABELAS (13)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions** : This paper contains **SIX (6)** questions. Answer **ALL** questions.

**Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **SEMUA** 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].*

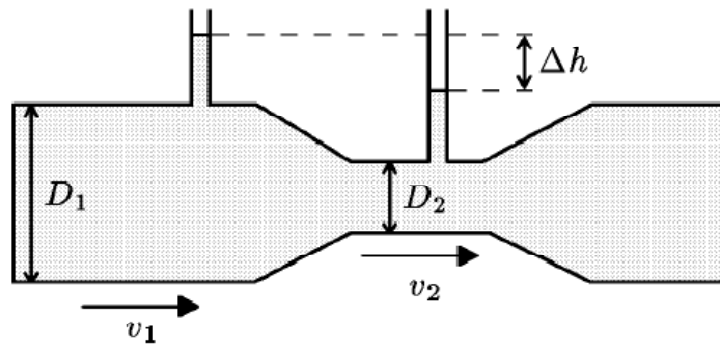
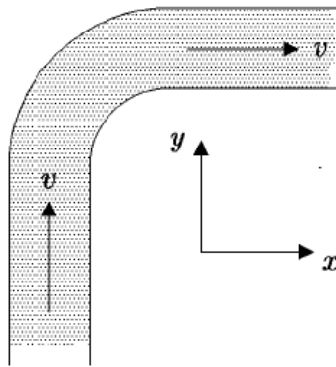


Figure 1

1. A) Figure 1 shows a Venturimeter. The venturi has a diameter  $D_1$  in the first segment and  $D_2$  in the second segment, with  $D_2 < D_1$ . The density of the water is  $\rho$ , and the acceleration due to gravity is  $g$ . If the water in the pipe is flowing at volume flow rate  $Q$  ( $\text{m}^3/\text{s}$ ), what is
- i) the velocity of flow  $v_1$  in the section 1 of pipe (of diameter  $D_1$ ), and the velocity of flow  $v_2$  in the second section of pipe (of diameter  $D_2$ )?  
[5 marks]
  - ii) the difference in the water level ( $\Delta h$ ) in the two tubes?  
[10 marks]
1. B) Describe the characteristic of flow in a pipe during laminar and turbulent flows and their relationship to the Moody Diagram.  
[5 marks]



2. A fire hydrant delivers water at rate  $Q$ , measured as a volume per unit time ( $\text{m}^3/\text{s}$ ). The water travels vertically upwards through the hydrant and then does a  $90^\circ$  turn to emerge horizontally, at speed  $v$ . The pipe and nozzle have uniform cross sections throughout. If  $\rho$  is the density of water of  $980 \text{ kg/m}^3$ , determine the following:

a) If  $Q$  is  $0.150 \text{ m}^3/\text{s}$ , determine the direction force exerted on the corner of the fire hydrant.

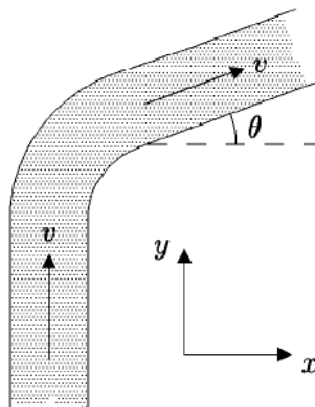
[6 marks]

b) Determine the magnitude of the force exerted by the water on the corner of the hydrant.

[7 marks]

c) Suppose that the nozzle of the hydrant is not horizontal, but instead is a  $15^\circ$  angle above the horizontal, determine the force that the water would exert on the corner of the hydrant.

[7 marks]



3. a) Briefly explain 3 types of devices for measuring fluid velocity and flow rate using principle of Bernoulli.

[5 marks]

- b) An orifice meter is to be installed in a 300 mm ductile iron pipe carrying water at 15 °C . A mercury manometer is used to measure the pressure difference across the orifice when the expected range of the flow rate is from 0.1 m<sup>3</sup>/s to 0.20 m<sup>3</sup>/s. The manometer scale ranges from 0 to 30.5 cm of mercury. Determine an appropriate diameter of the orifice.

[8 marks]

- c) A ship tows an instrument in the form of a 30 ° cone, point first, at velocity of 7.5 m/s in sea water. If the base of the cone has a diameter of 2.20 m, calculate the force in the cable to which the cone is attached.

[7 marks]

4. a) A solid sphere of radius  $R$  and average density  $\rho_s$  is completely submerged in a tank filled with water of density  $\rho_w$  , with  $\rho_s < \rho_w$  . It is held in place by a string attached to the bottom of the tank, as shown. Taking the acceleration of gravity as  $g$ , calculate the tension  $T_h$  of the string as (shown in Figure 2)

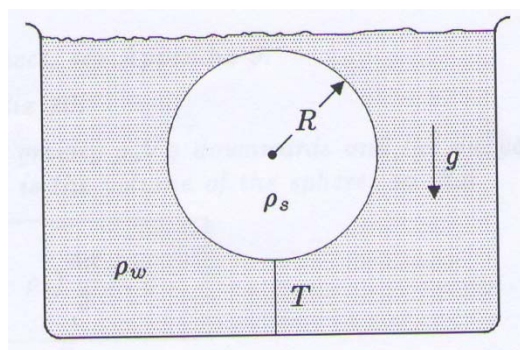


Figure 2

[10 marks]

- b) A timber log is 1.00 m in diameter and 1.25 m long has a specific weight 8.00 kN/m<sup>3</sup>. Will it float in a stable manner in water with its axis vertical ?

[10 marks]

5. a) A cup of cream having a density of  $1005 \text{ kg/m}^3$  and then is turned into 3 cups of whipped cream; determine the specific gravity and specific weight of the whipped cream?

[4 marks]

- b) A parallel plate at a distance of 2mm apart is shown in Figure 3. A shearing stress of 150 Pa develops at the upper plate when it is pulled at a velocity of 1 m/s. Determine the viscosity of the fluid between the plates.

[4 marks]

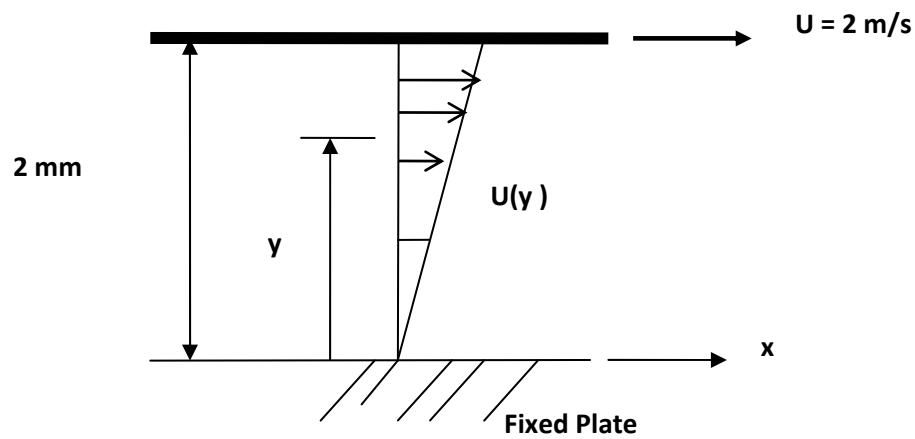


Figure 3

- c) Determine the magnitude and direction of the resultant force acting on the vertical gate 4.0 m and its length is 4.0 m. (Figure 4)

[12 marks]

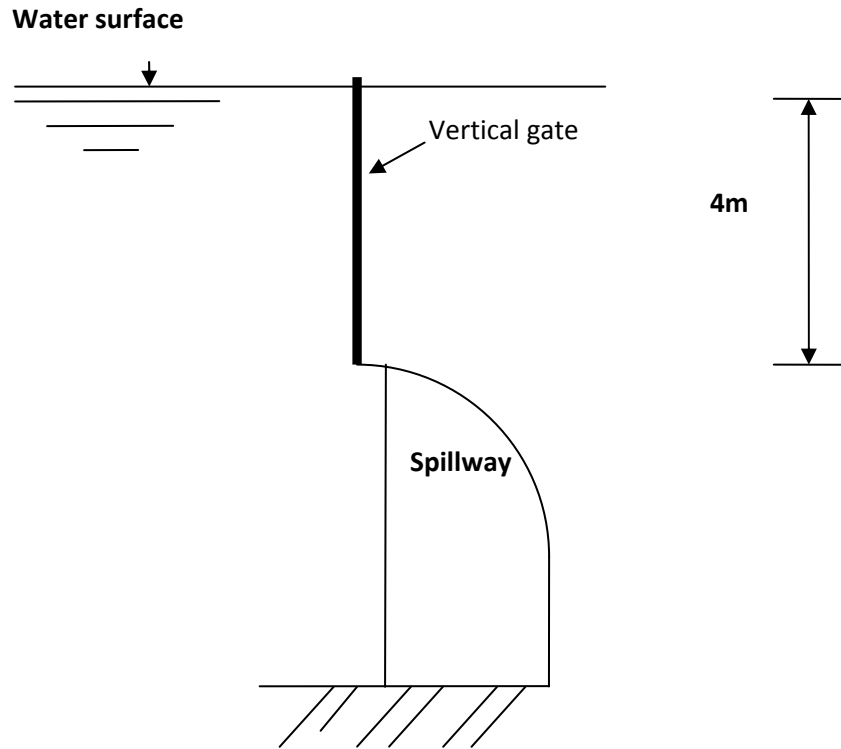


Figure 4

6. a) Determine the pressure ( $P_A$ ) at the bottom of a 30cm tank full with petrol. A similar tank is filled with air, petrol and water as shown in Figure 5. If the pressure at the bottom of the second tank is equal to  $P_A$ , calculate the height of air in the second tank.

Density of water =  $1000 \text{ Kg/m}^3$  Density of air =  $1.2 \text{ Kg/m}^3$  ; Density of petrol =  $680 \text{ Kg/m}^3$

[8 marks]

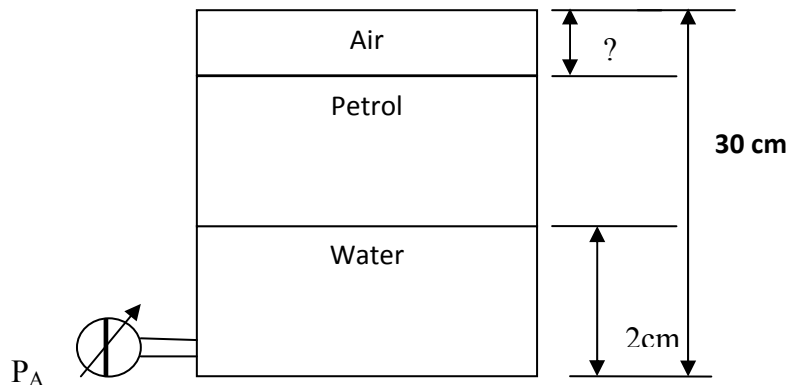


Figure 5

- b) The Figure 6 shown a dam 45 m long that retains 10 m of fresh water and is inclined at an angle of  $\theta = 75^\circ$ . Calculate the magnitude of the resultant force on the dam and the location of the center of pressure?

[12 marks]

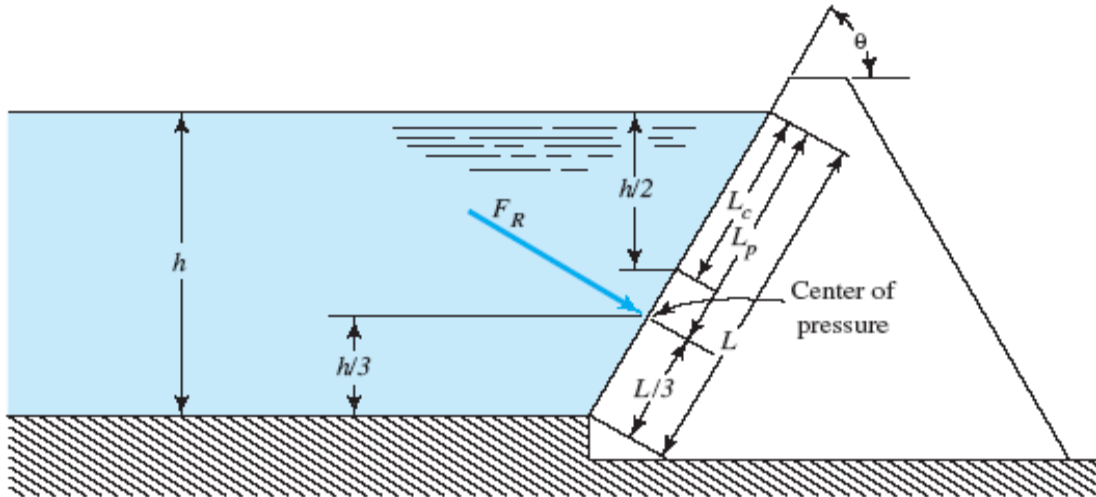
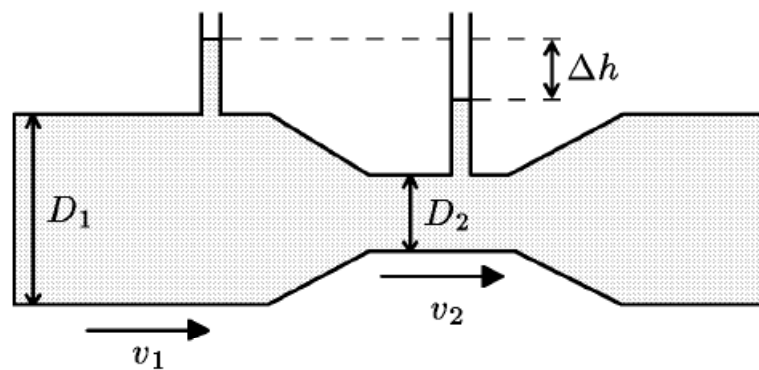


Figure 6



Rajah 1

1. A) Rajah diatas menunjukkan sebuah Venturimeter. Venturimeter tersebut mempunyai diameter  $D_1$  di bahagian awal dan  $D_2$  di bahagian tengah dimana  $D_2 < D_1$ . Sekiranya ketumpatan air adalah  $\rho$  dan tarikan graviti adalah  $g$ . Sekiranya air yang mengalir didalam venturimeter adalah  $Q$  tentukan yang berikut:

i) halaju  $v_1$  di bahagian awal (diameter  $D_1$ ), dan halaju  $v_2$  di bahagian tengah ( diameter  $D_2$ ).

[5 markah]

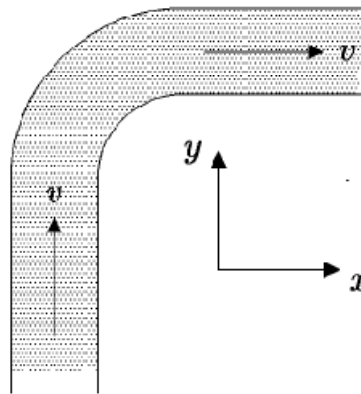
ii) perbezaan aras air  $\Delta h$  dalam dua tiub tersebut.

[10 markah]

1. B) Terangkan ciri-ciri aliran di dalam sebatang paip semasa aliran laminar dan gelora. Kaitkan phenomena ini dengan Diagram Moody

[5 markah]





2. *Sebatang paip bomba mempunyai kadar alir  $L$  ( $m^3/s$ ). Air mengalir secara menegak dan kemudian membengkok  $90^\circ$  serta mengalir secara mendatar pada halaju  $v$ . Paip tersebut mempunyai diameter yang sama. Sekiranya ketumpatan air  $\rho$  adalah  $980\text{kg/m}^3$ , tentukan yang berikut:*

a) *Sekiranya  $Q$  adalah  $0.150\text{ m}^3/\text{s}$ , diarah manakah daya yang dipadukan oleh air tersebut pada lengkung paip bomba?*

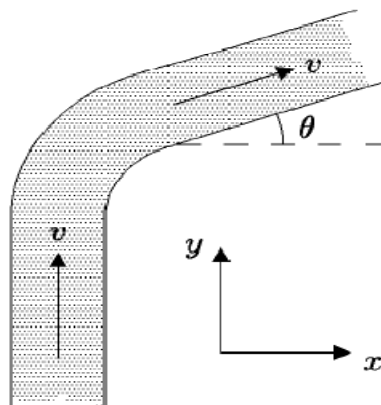
*[6 markah]*

b) *Apakah nilai daya yang dipadukan oleh air ke atas lengkung paip bomba tersebut?*

*[7 markah]*

c) *Sekiranya nosel paip tidak mendatar dan bersudu  $15^\circ$  dari garisan horizontal. Tentukan daya yang dipadukan keatas lengkok paip bomba tersebut.*

*[7 markah]*



3. a) *Jelaskan dengan singkat 3 jenis peranti yang menggunakan prinsip yang terlibat dalam persamaan Bernoulli yang telah dibangunkan untuk mengukur kelajuan bendalir dan debit.*

[5 markah]

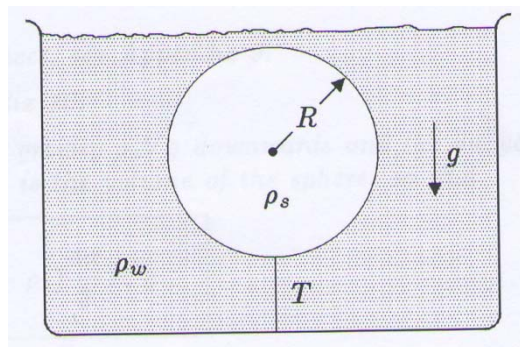
- b) *Sebuah orifis meter akan dipasang pada 12-in paip besi ulet mengalirkan air pada 15°C. Sebuah manometer merkuri akan digunakan untuk mengukur perbezaan tekanan pada orifis ketika rentang yang diharapkan dari laju aliran dari 0.1 m<sup>3</sup> / s sampai 0.20 m<sup>3</sup>/ s. Skala manometer berkisar 0-30.5 cm air raksa. Tentukan diameter sesuai orifis*

[8 markah]

- c) *Kapal menarik suatu instrumen dalam bentuk sebuah kerucut/kon 30°, titik pertama, pada 7.5 m / s dalam air laut. Jika dasar kon mempunyai diameter 2.20 m, hitung gaya pada kabel yang dipasang kon.*

[7 markah]

4. a) *Sebuah bola padat R radius dan massa rata-rata ketumpatan  $\rho_s$  benar-benar tenggelam dalam sebuah tangki diisi dengan air  $\rho_w$  kepadatan massa, dengan  $\rho_s < \rho_w$ . Hal ini di tempatkan dengan sebuah tali yang melekat pada dasar tangki, seperti yang ditunjukkan. Diketahui percepatan gravitasi sebagai g, Tentukan tegangan tali  $T_h$ ? (Lihat Rajah 2)*



Rajah 2

[12 markah]

- b) *Sebatang kayu balak berdiameter 1.00 m dan 1.25 m panjang memiliki berat jenis 8,00 kN/m<sup>3</sup>. Apakah akan mengapung secara stabil di dalam air dengan paksi menegak?.*

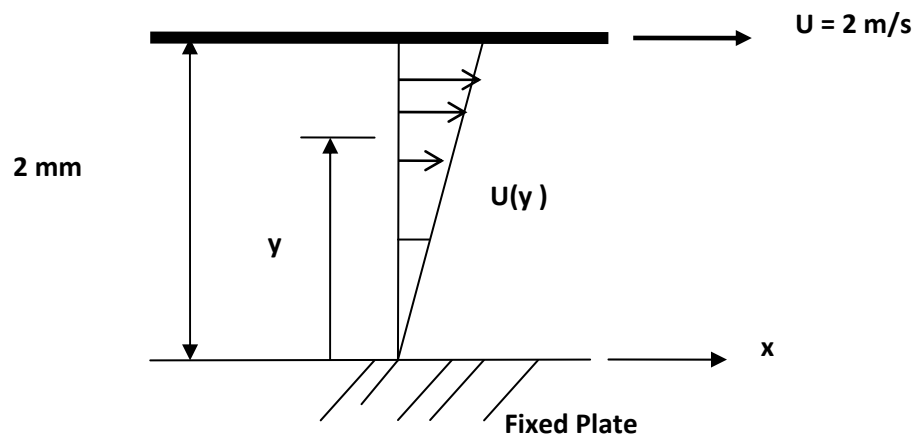
[8 markah]

5. a) *Secawan krim mempunyai ketumpatan 1005 kg/m<sup>3</sup> dan kemudian di pukul untuk menjadi krim putar sebanyak tiga (3) cawan. Tentukan nilai gravity tentu dan berat tentu bagi krim putar tersebut.*

[4 markah]

- b) *Sepasang plat selari berjarak 2 mm, seperti ditunjukkan dalam Rajah 3. Suatu tegasan ricih 150 Pa berkembang di atas plat bila ditarik dengan kelajuan 1 m/s. Tentukan viskositas cecair antara plat.*

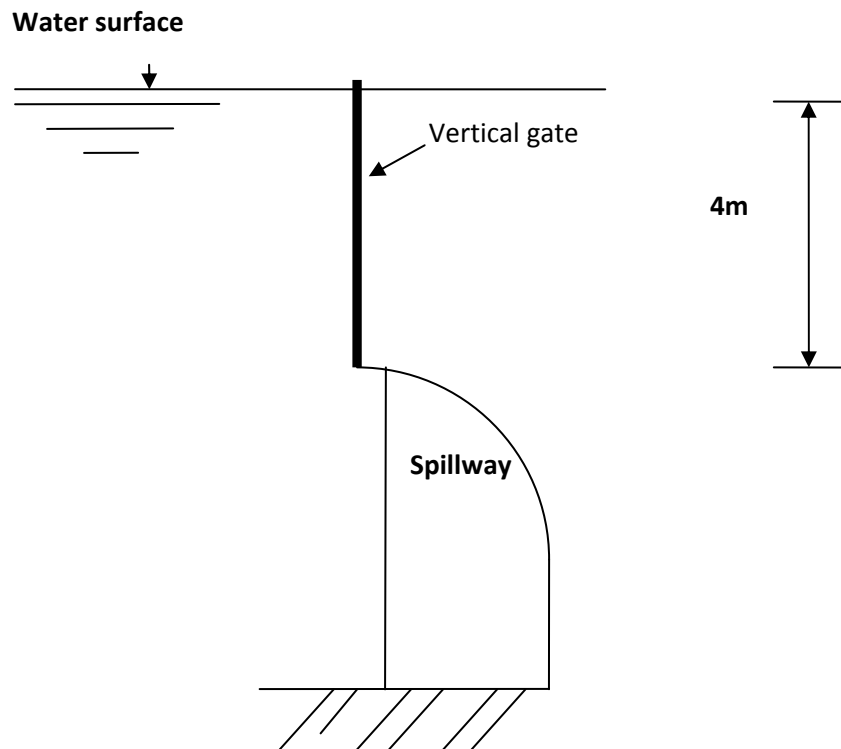
[4 markah]



Rajah 3

- c) *Tentukan nilai dan arah daya tumpuan yang bertindak diatas pintu vertical yang mempunyai 4.0 m tinggi dan 4.0 meter lebar.*

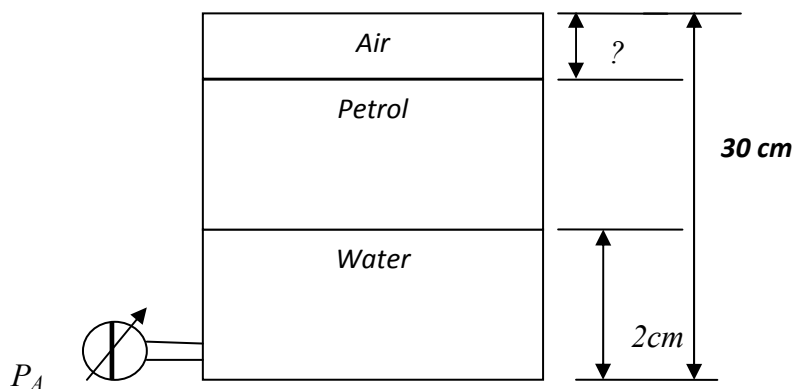
[12 markah]



Rajah 4

6. a) Tentukan tekanan ( $P_A$ ) di dasar sebuah tangki 30 sm tinggi yang di penuhi oleh petrol. Sebuah tangki yang sama tetapi di penuhi oleh udara. Petrol dan air seperti di Rajah 5. Sekiranya tekanan di tangki kedua sama seperti tekanan di ( $P_A$ ). Kira tinggi udara di dalam tangki kedua.

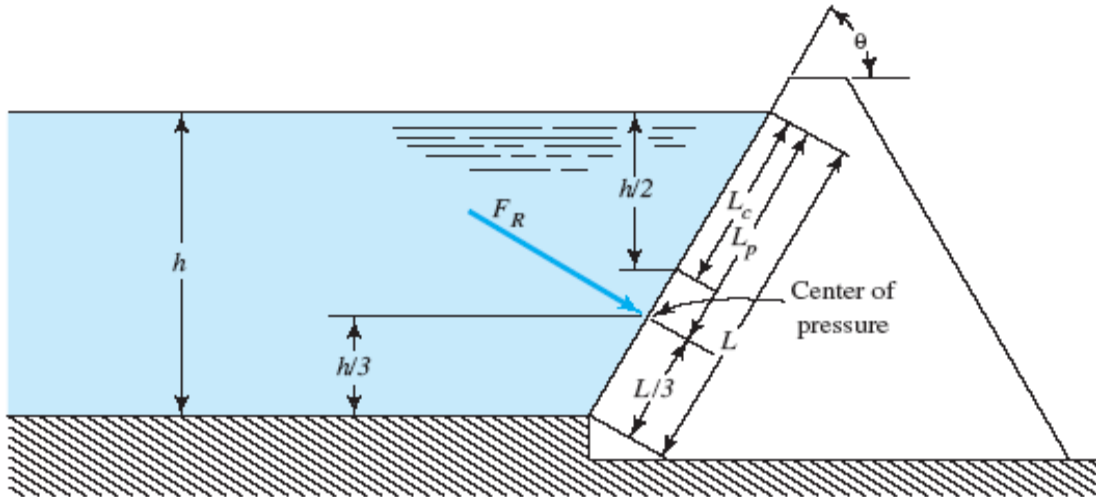
[8 marks]



Rajah 5

- b) Rajah 6 menunjukkan sebuah empangan yang menampung 10 m air dan condong pada  $\theta=75^\circ$ . Kira daya tumpuan pada empangan tersebut dan lokasi pusat tekanan.

[12 markah]



Rajah 6

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