UNIVERSITI SAINS MALAYSIA

First Semester Examination
2012/2013 Academic Session

January 2013

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 **SEVENTEEN (17)** pages of printed material before you begin the examination.

[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***TUJUH BELAS (17)*** *muka surat yang bercetak 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.*

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) Define ideal fluid, Newtonian fluid, capillarity and velocity gradient.

[4 marks]

(b) A gate shown in Figure 1 is 1.5m wide is hinged at point B, and rests against a smooth wall at point A. Compute:

(i) the force on the gate due to seawater pressure

(ii) the horizontal force P exerted by the wall at point A, and

(iii) the reactions at the hinge B.

Assume seawater specific weight = 10035 N/m^3. Use the same units as shown in Figure 1.

[12 marks]

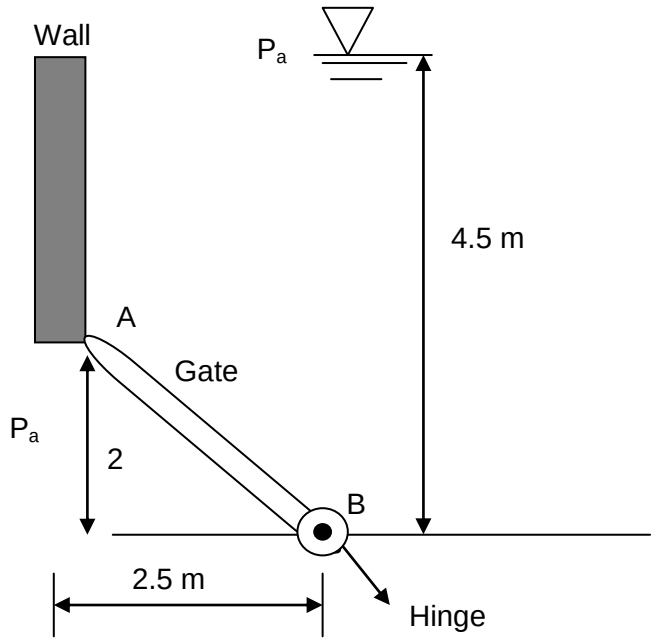


Figure1

(c) Determine the internal diameter of glass tube if the capillary rise of a water in it does not exceed 2. 0 mm. Given surface tension σ = 0.0735 N/m.

[4 marks]

2. (a) Calculate the difference in pressure between points A and B in Figure 2 and express it as $p_B - p_A$.

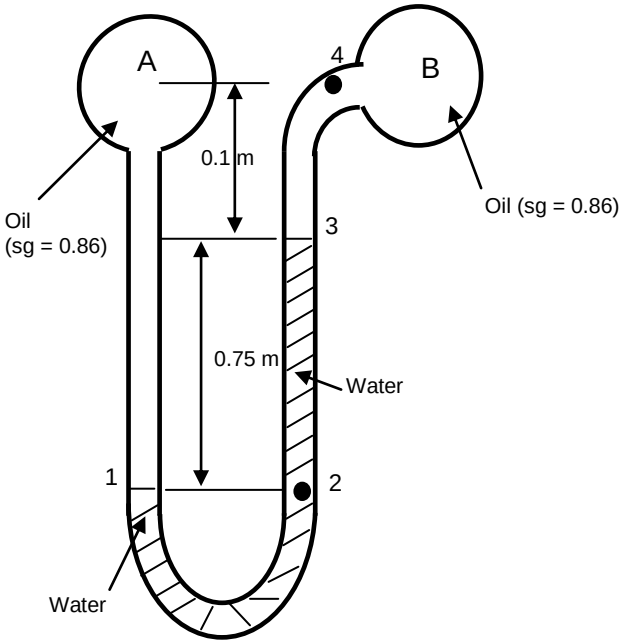


Figure 2

[8 marks]

(b) A brass cube 152.4 mm on a side weighs 298.2 N. If the cube is placed in a equilibrium position under water by attaching a light foam buoy to it. If the foam weight is 707.3 N/m^3, what is the minimum required volume of the buoy?

[8 marks]

(c) Define meta centre and discuss 'degree of stability'.

[4 marks]

3. (a) Referring to Figure 3, prove that the velocity at point C "vena-contracta" is $\underline{\quad\quad}$

[4 marks]

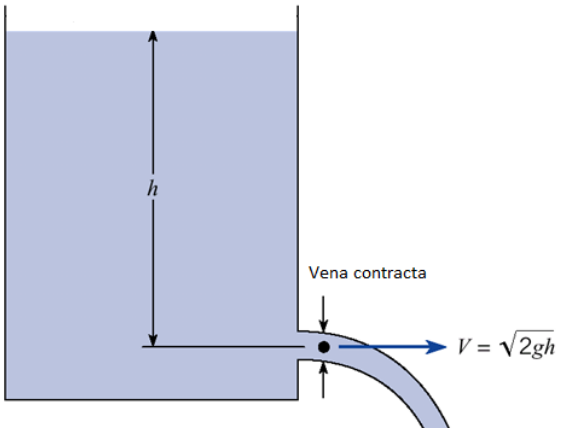


Figure 3

(b) Water is flowing in a horizontal T-pipe in a bathroom as shown in Figure 4. The following conditions are given;Q1 = 0.5 m^3/s, Q2 is 0.3 m^3/s, *p*1 is 100kPa, *p*2 is 70 kPa, *p*3 is 80 kPa, determine the external force that required is to hold the T in the bathroom wall.

[8 marks]

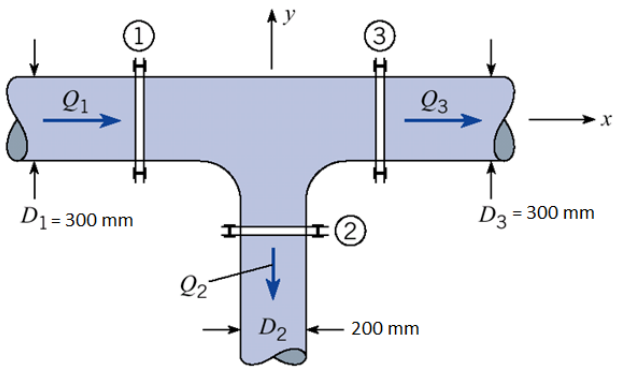


Figure 4

(c) Referring to Figure 5, determine the discharge in the pipe and pressure at Point A. Neglect head losses.

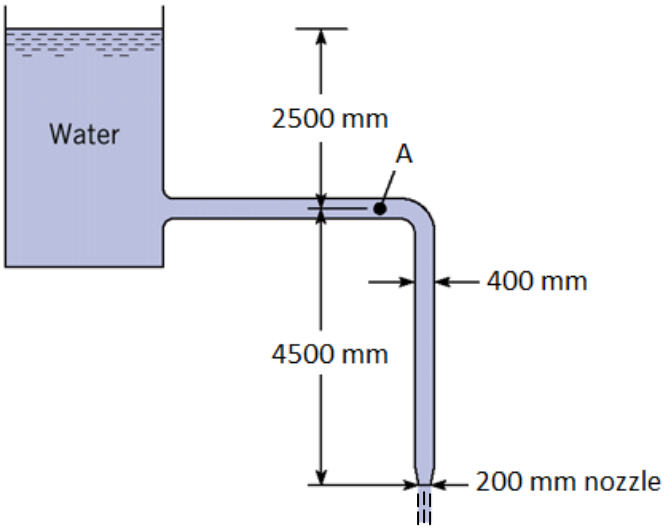


Figure 5

[8 marks]

4. (a) A water jet sprays water vertically from a nozzle as shown in Figure 6. The water velocity exiting the nozzle is 7m/s. Calculate how high 'h' will be.

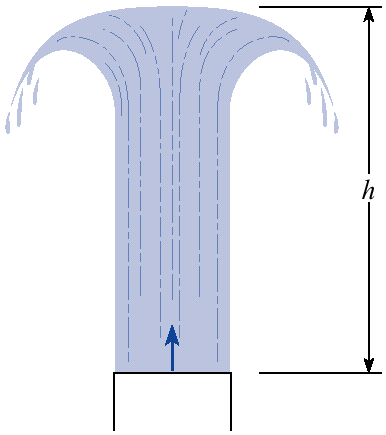


Figure 6

[4 marks]

(b) A piston is driven a water out at a speed 1.5m/s. If “d” is 50mm and “D” is 100mm, determine the speed of the piston. By neglecting friction, determine the force that will required to push the piston.

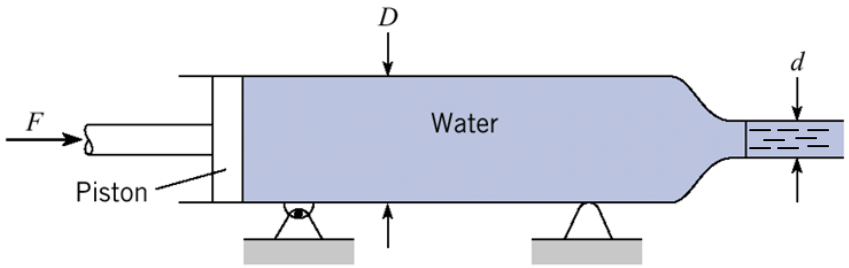


Figure 7

[6 marks]

(c) Determine the magnitude and direction of the force on the double nozzle shown in Figure 8. The pipe and nozzle system weighs 90N. The axes of the pipe and both nozzles all lie in a horizontal plane.

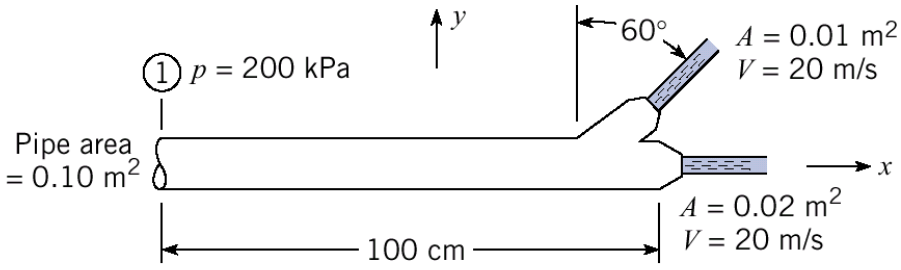


Figure 8

[10 marks]

5. (a) With the aid of diagrams. Describe the following terminologies;

(i) Drag force

[2 marks]

(ii) Lift force

[2 marks]

(b) The water supply to a gas water heater contracts from 10 mm in diameter at A Figure 9 to 7 mm in diameter at B. If the pipe is horizontal, calculate the difference in pressure between A and B when the velocity of the water at A is 4.5m/s. This pressure difference operates the gas control through connections which are taken to the horizontal cylinder in which a piston of 20 mm diameter moves. Ignoring friction and the area of the piston connecting rod, calculate the force on the piston.

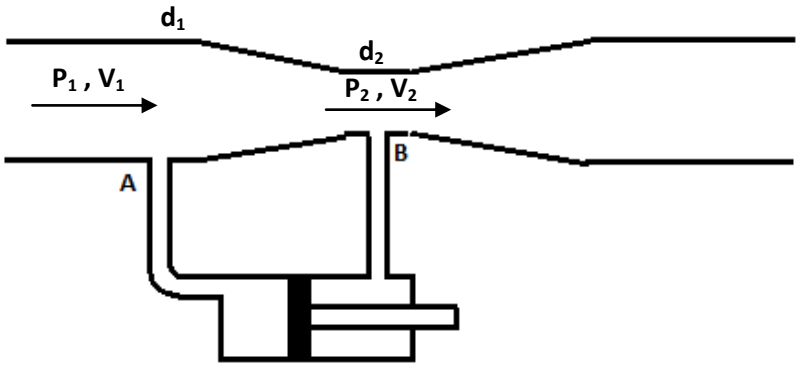


Figure 9

[8 marks]

(c) A kite has a planform area of 0.25 m^2 and is flying in a wind of velocity 25 km/h. The kite has a net weight of 1.2 N. When the string is inclined at an angle of 15° to the vertical, the tension in the string was found to be 3.0 N. Evaluate the coefficients of lift and drag. (ρ_{air} = 1.15 kg/m^3)

[8 marks]

6. (a) With the aid of diagrams. Describe the following terminologies:

(i) Ventury tube

[2 marks]

(ii) Orifice

[2 marks]

(iii) Flow nozzle

[2 marks]

(b) Experiments were conducted in a wind tunnel with a wind speed of 50 km/h on a flat plate of dimensions 2 m long and 1.2 m wide. The density of air is 1.2 kg/m^3. The plate is kept at an angle and the coefficients of lift and drag are 0.75 and 0.15, respectively. Determine

(i) Lift force

[2 marks]

(ii) Drag force

[2 marks]

(iii) Resultant force

[2 marks]

(iv) Direction of resultant force

[2 marks]

(v) Power expended in overcoming resistance of the plate

[2 marks]

(c) A horizontal venturi meter measures the flow of oil of specific gravity 0.9 in a 75 mm diameter pipe line. If the difference pressure between the full bore and the throat tapping is 34.5 kN/m^2 and the area ratio *m* is 4, calculate the rate of flow, assuming a coefficient of discharge of 0.97.

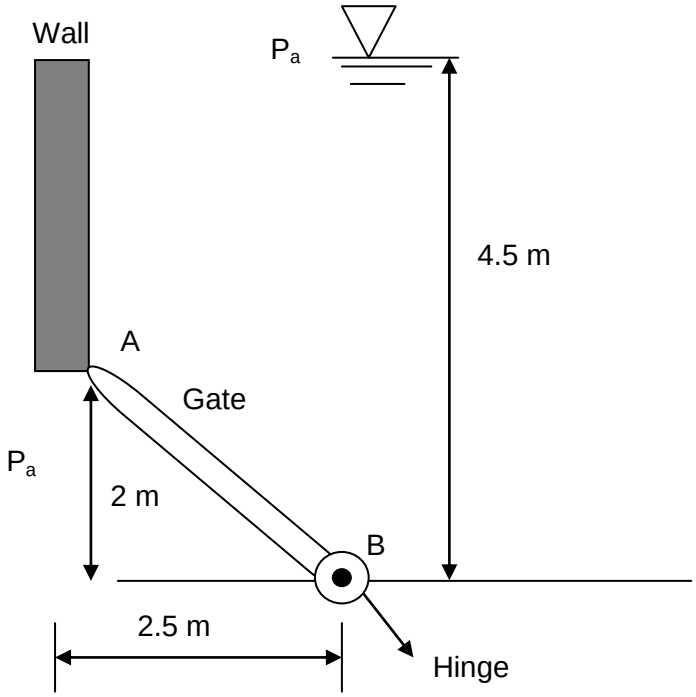
[6 marks]

1. (a) *Takrif cecair unggul, cecair Newtonian, rerambut dan kecerunan halaju?*

[4 markah]

(b) *Sebuah pagar yang ditunjukkan dalam Rajah 1 adalah 1.5m, diengsel di titik B,bersandar pada sebuah dinding di titik A kirakan (i) daya pada pagar oleh kerana tekanan air laut (ii) daya mendatar P yang dikenakan di dinding pada titik A (iii) tindak balas di titik B. (Berat tentu air laut = 10035 N/m^3). Gunakan unit yang sama dalam Rajah 1.*

[12 markah]



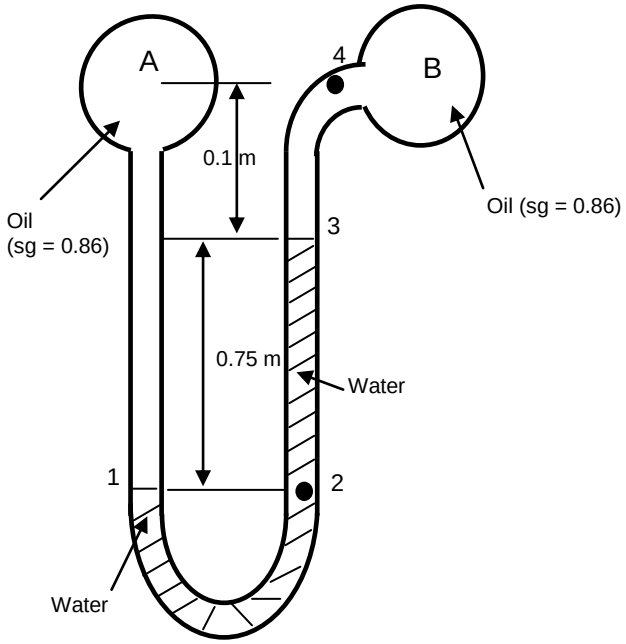
Rajah 1

(c) *Tentukan garis pusat dalam tiub kaca jika kenaikan kapilari air di dalamnya tidak melebihi 2.0 mm. Diberi Tegangan Permukaan σ =0.0735 N/m.*

[4 markah]

2. (a) *Kirakan perbezaan tekanan antara titik-titik A dan B dalam Rajah 2 dan nyatakan dalam $p_B - p_A$.*

[8 markah]



Rajah 2

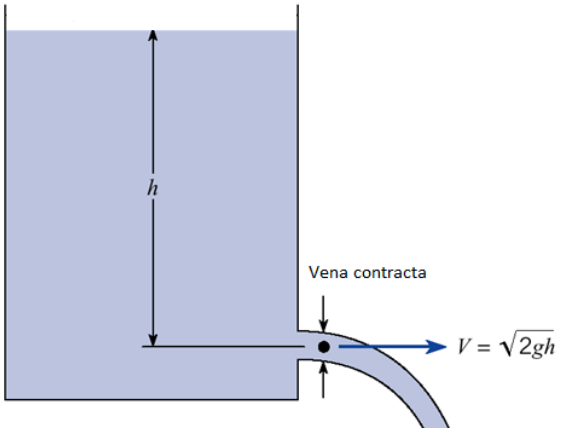
(b) *Sebuah kiub tembaga 152.4 mm panjang dan berat 298.2 N. Jika kiub tersebut diletakkan secara seimbang dalam air dengan memasang sebuah boya gabus gabus yang ringan. Jika gabus adalah 707.3 N/m^3 berat, apakah isipadu minima yang diperlukan untuk boya.*

[10 markah]

(c) *Takrifkan pusat-meta dan bincang istilah 'ketepatan stabiliti'?*

[2 markah]

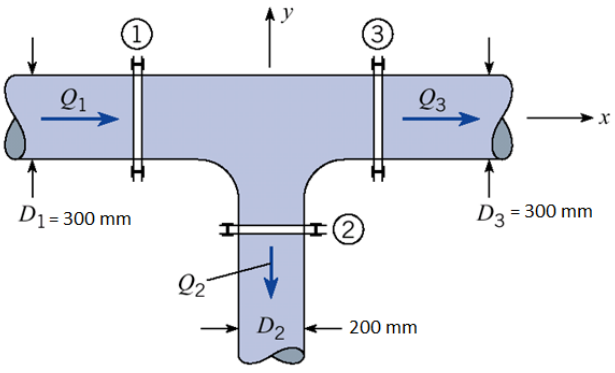
3. (a) *Berpandukan Rajah 3, buktikan bahawa halaju pancutan air di titik C "vena-contracta" adalah* $\underline{\quad}$



Rajah 3

[4 markah]

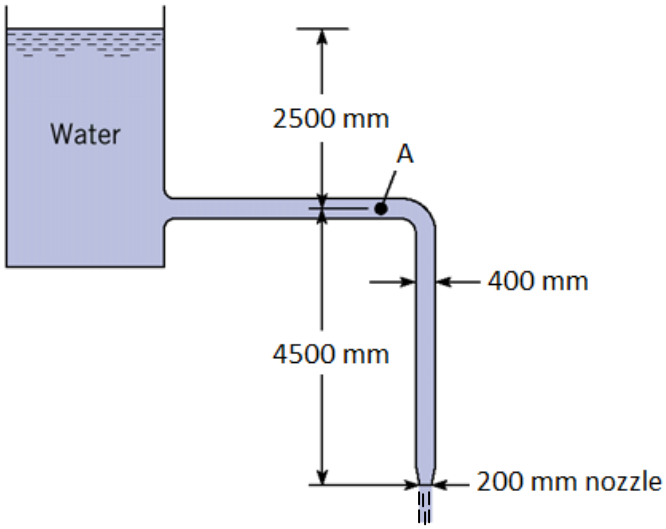
(b) *Air mengalir dalam horizontal T-paip di sebuah bilik air seperti Rajah 4. Diberi ciri-ciri berikut; Q1adalah 0.5 m3/s, Q2adalah 0.3 m3/s, p1 adalah 100kPa, p2 adalah 70 kPa, p3 adalah 80 kPa, tentukan daya yang diperlukan untuk memengang T-paip di dinding bilik air tersebut.*



Rajah 4

[8 markah]

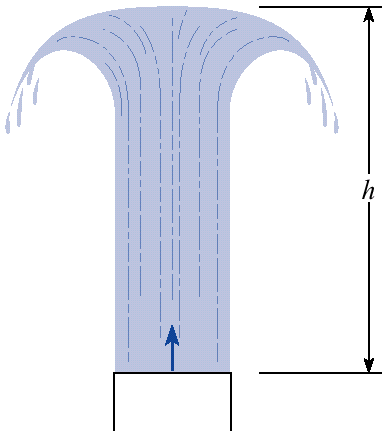
(c) *Berdasarkan Rajah 5, tentukan nilai kadar alir dalam paip dan tekanan di titik A. Abaikan kehilangan turus.*



Rajah 5

[8 markah]

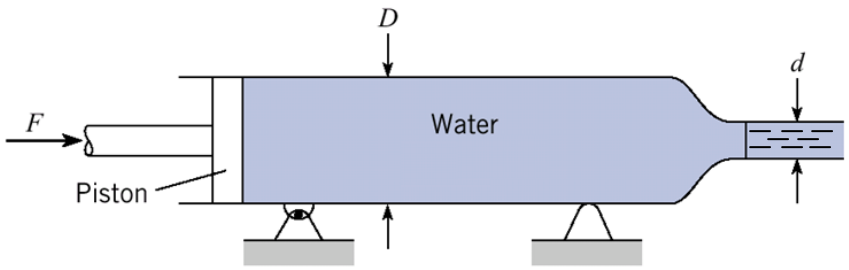
4. (a) *Pancutan air menegak dari sebuah nosel seperti Rajah 6. Halaju air yang keluar dari nosel tersebut adalah 7m/s. Tentukan berapakah ketinggian 'h'.*



Rajah 6

[4 markah]

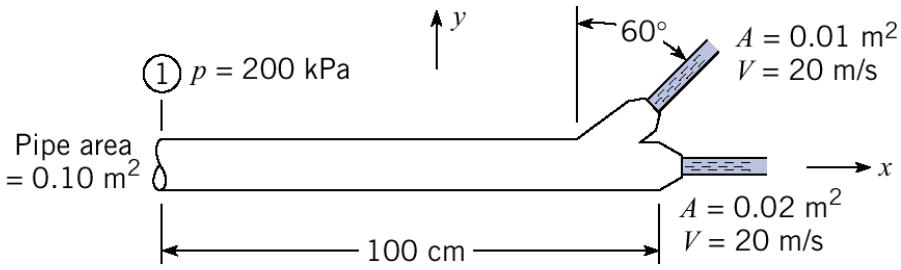
(b) *Sebuah piston memancutkan air keluar selaju 1.5m/s. Sekiranya d adalah 50mm dan D adalah 100mm, tentukan halaju piston tersebut. Dengan abaikan geseran, tentukan daya yang diperlukan untuk menolak piston tersebut.*



Rajah 7

[6 markah]

(c) *Tentukan maknitud dan arah daya yang dikenakan terhadap dua nosel seperti di Rajah 8. Paip dan nosel tersebut seberat 90N. Paip dan nosel itu terletak di paksi horizontal yang sama.*



Rajah 8

[10 markah]

5. (a) *Dengan bantuan rajah, terangkan istilah-istilah berikut;*

(i) Daya seretan

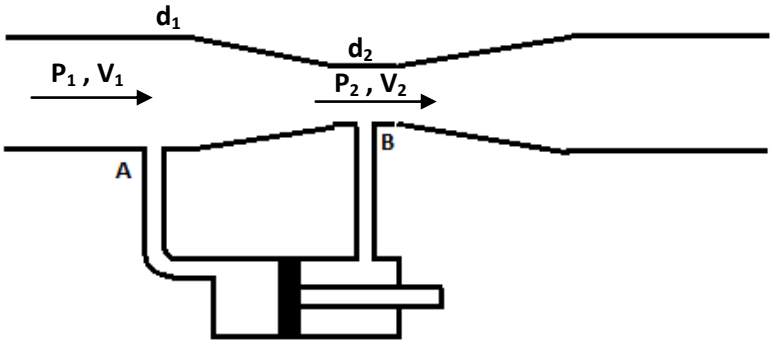
[2 markah]

(ii) Daya angkat

[2 markah]

(b) *Bekalan air ke pemanas air gas menyentuh dari 10 mm diameter pada A Rajah 9 ke 7 mm diameter pada B. Jika paip mendatar, kirakan perbezaan dalam tekanan di antara A dan B apabila halaju air pada A ialah 4.5 m/s. Perbezaan tekanan ini menggerakkan gas melalui penghubung dengan mengambilkira silinder mendatar di mana 20 mm diameter piston bergerak. Abaikan geseran dan luas piston yang menghubungi rod, kira daya pada piston?*

[8 markah]



Rajah 9

(c) *Sebuah layang-layang mempunyai keluasan planform 0.25 m^2 dan ia diterbangkan angin dengan kelajuan 25 km/j. Layang-layang ini mempunyai berat bersih 1.2 N. Apabila tali dinaikkan pada sudut 15° menegak, ketegangan tali didapati menjadi 3.0 N. Nilaikan pekali angkat dan seretan. (ρ_{air} = 1.15 kg/m^3)*

[8 markah]

6. (a) *Terangkan istilah-istilah berikut dengan bantuan rajah;*

(i) Tiub venturi

[2 markah]

(ii) Orifis

[2 markah]

(iii) Kadar alir muncung

[2 markah]

(b) *Eksperimen telah dijalankan dalam terowong angin dengan kelajuan angin 50 km/j di atas plet rata berdimensi 2 m panjang dan 1.2 m lebar. Ketumpatan udara ialah 1.2 kg/m^3. Plet dipasang pada sudut di mana pekali angkat dan seretan masing-masing adalah 0.75 dan 0.15. Dapatkan;*

(i) Daya seretan

[2 markah]

(ii) Daya angkat

[2 markah]

(iii) Daya terhasil

[2 markah]

(iv) Arah daya terhasil

[2 markah]

(v) Kuasa yang dikenakan oleh aliran udara pada plat

[2 markah]

(c) *Meter venturi mendatar digunakan bagi mengukur kadar alir minyak dengan graviti tentu 0.9 di dalam 75 mm garis diameter paip. Jika perbezaan tekanan di antara jara/gerek penuh dan kerongkongan penyadapan ialah 34.5 kN/m^2 dan nisbah luas m ialah 4, kira ukuran kadar alir, dengan mengandaikan pekali kadar alir ialah 0.97.*

[6 markah]

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