Use the data and formulae from the general handout sheet for any material properties and constants required.

1. Mark the following true or false

F	i	Drag on an aircraft is equal to the summation of the skin friction over its surface
T	ii	Internal stresses in a fluid depends on the rate of deformation, not on total deformation
F	iii	The principle of conservation of energy does not apply to fluid flows
T F	iv	The principle of conservation of energy is not needed to describe constant temperature flows in air.
F	v	Viscous stresses act only in a stationary fluid
F	vi	Pressure acts only in a stationary fluid
T	vii	Pressure is the same at point in all directions but viscous stresses are not
T	viii	“Inviscid” flow is flow with zero or neglible viscosity

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2. The velocity components of a fluid flow are $u=3ms^{-1}$; $v=4ms^{-1}$; $w=12ms^{-1}$. *Show that the resultant speed is* $13ms^{-1}$. An observer now moves in the x-direction at a speed of $5ms^{-1}$ thereby changing the fame of reference of the flow. What is the resultant velocity of the flow in the frame of reference of the observer? **(Ans -2, 4, 12)**

(i) $u_o = \sqrt{v_u^2 + v_v^2 + v_w^2} = \sqrt{169} = 13\ (m/s)$

(ii) $u' = 3 - 5 = -2\ (m/s)$

$v' = 4\ (m/s)$

$w' = 12\ (m/s)$

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3. The speed of an aircraft is 450 Knots. Express this in (i) km/hr (ii) miles/hr (iii) m/s(iv) ft/s **(Ans 834, 518, 232, 760)**

(i) $450 \times 1.853\ \text{km/hr} = 833.85\ \text{km/hr} = 834\ \text{km/hr}$

(ii) $450 \times 1.853\ \text{km/hr} \times \frac{1}{1.61}\ \text{miles/km} = 518\ \text{miles/hr}$

(iii) $450 \times 1.853\ \text{km/hr} \times 1000\ \text{m/km} \times \frac{1}{3600}\ \text{hr/s} = 231.625\ \text{m/s} = 232\ \text{m/s}$

(iv) $231.625\ \text{m/s} \times 3.28\ \text{ft/m} = 759.73\ \text{ft/s} = 760\ \text{ft/s}$

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4. Show that the atmospheric pressure at sea level, 1.013 x 10^5 Nm^{-2}, is equal to the pressure difference between the top and bottom of a water column of height 10.33m. Consider the density of water as 1000 kg/m^3 and g = 9.81m/s^2.

$$\Delta P = \rho g h = 1000\,kg/m^3 \times 9.81\,m/s^2 \times 10.33m = 1.013373 \times 10^5\,N/m^2$$

$$= 1.013 \times 10^5\,N/m^3$$

$$= P_0$$

Use the data and formulae from the general handout sheet for any material properties and constants required.

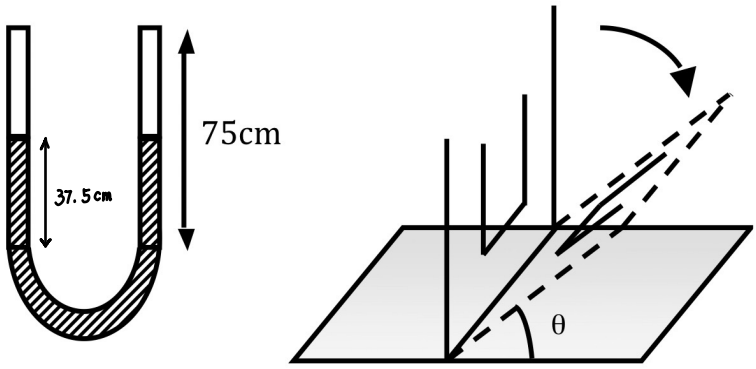

Figure 1

5. As shown in figure 1 a U-tube manometer has two straight sides each of length 75cm and is filled with alcohol of density 800 kg/m^3 to the *half-way* mark on the scale. If it is to be used to measure the pressure rise produced by a centrifugal blower (claimed by the manufacturer to create a pressure equal to 15.3cm of water) what is the smallest angle to the horizontal at which the manometer may be inclined without spilling liquid while in use? **(Ans 14.77°)**

$$\Delta P = \rho g h = 1500.93\ N/m^2$$

$$\Delta h = \frac{\Delta P}{\rho g} = 0.19125\ m = 19.125\ cm$$

$$\therefore \frac{\Delta h}{\sin \theta_{max}} = 75\ cm$$

$$\therefore \theta_{max} = 14.774^\circ = 14.77^\circ$$

Use the data and formulae from the general handout sheet for any material properties and constants required.

6. The pressure at a specific point on the upper surface of an aerofoil is found in a wind tunnel test to be equal to 25cm of water below the value of the atmospheric pressure of 1 bar. What is the pressure in: (i) Pa (N/m^2) (ii) MPa (N/mm^2) (iii) PSI (lb/sq in) **(Ans 97548, 0.0975, 14.14)**

$P = P_0 + \rho g h = 1\,bar - 2452.5\,N/m^2$

$= 100\,kPa - 2452.5\,Pa$

$= 97547.5\,Pa$

$= 97548\,Pa$

$= 0.0975\,MPa$

$= 97548\,Pa \times \frac{1}{6894.76}\,psi/Pa$

$= 14.15\,psi$