PHYSICS

NCERT - NCERT PHYSICS(TELUGU)

MECHANICAL PROPERTIES OF FLUIDS

Example

1. The two thigh bones (femurs), each of cross sectional area $10cm^2$ support the upper part

of a human body of mass 40kg. Estimate the average pressure sustained by the femurs?

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2. What is the pressure on a swimmer 10m below the surface of a lake?

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3. The density of the atmosphere at sea level is $1.29kg/m^3$. Assuming that it does not change

with altitude, Then how high would the atmosphere extend?

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4. At a depth of 1000m in an ocean (a) What is the absolute pressure? (b) what is the gauge pressure? (c) find the force acting on the window of area $20cm \times 20cm$ of a submarine at this depth, the interior of which is maintained at sea level atmospheric pressure.

the density of sea water is $1.03 \times 10^3 kgm^{-3}$.

$g = 10ms^{-2}$

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5. Two syringes of different cross sections filled with water are connected with a tightly fitted rubber tube filled with water . Diameters of the smaller piston and larger piston are 1,0 cm and 3.0 cm respectively. (a) Find the force exerted on the larger piston when a force of 10N is applied to the smaller piston.

(b) If the smaller piston is pushed in through 6.0 cm, how much does the larger piston move out?

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6. In a car lift compressed air exerts a force F F_1 on a small piston having a radius of 5.0 cm, This pressure is transmitted to a second piston of radius 15cm [Fig.10.7]. If the mass of the car to be lifted is 1350 kg. calculate F_1

What is the pressure necessary to accomplish this task?

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7. The flow of blood in a large artery of an anesthetised dog is diverted through a Venturi Meter.The wider part of the meter has a cross-sectional area equal to that of the artery. $A = 8mm^2$. The narrow part has an area $a = 4mm^2$. The pressure drop in the

artery is 24Pa. What is the speed of the blood in the artery?

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8. A fully loaded boeing aircraft has a mass of $3.3 \times 10^5 Kg$. Its total wing area is $500 m^2$. It is in level flight with a speed of $960 km/h$ (a) Estimate the pressure difference between the lower and upper surfaces of the wings (b) Estimate the fractional increase in the speed of the air on the surface of the wing relative to

the lower surface.[The density of air is p= $1.2kgm^{-3}$]

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9. A metal block of area $0.10m^2$ is connected to a 0.010 kg mass via a string that passes over an ideal pulley(considered massless and frictionless) as in Fig 10.15 A liquid with a film thickness of 0.30 mm is placed between the block and the table . When released the block moves to the right with a constant speed of

$0.085ms^{-1}$. FInd the coefficienyt of viscosity of the liquid.

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10. The terminal velocity of a copper ball of radius 2.0 mm falling through a tank of oil at $20^{\circ}C$ is $6.5cms^{-1}$. Compute the viscosity of the oil at $20^{\circ}C$. Density of oil is $1.5 \times 10^{3}kgm^{-3}$.density of copper is $8.9 \times 10^{3}kgm^{-3}$.

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11. The lower end of a capillary tube of diameter 2.00mm is dipped 8.00cm below the surface of water in a beaker. What is the pressure required in the tube in order to blow a hemispherical bubble at its end in water? The surface tension of water at temperature of the experiments is $7.30 \times 10^2 Nm^{-1}$.1 atmospheric pressure $= 1.01 \times 10^5 Pa$ density of water $= 1000 kg/m^3$, $g = 9.80 ms^{-2}$. Also calculate the excess pressure.

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Exercise

1. Explain why

The blood pressure in humans is greater at the feet than at the brain.

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2. Explain why

Atmospheric pressure at a height of about 6km decreases to nearly half to its value at the sea level, through the height of the atmospheric is more than 100 km.

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3. Explain why

Hydrostatic pressure is a scalar quantity even though pressure is force dividing by area.

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4. Explain why

The angle of contact of mercury with glass is obtuse. While that of water with glass is acute

.

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5. Explain why

Water on a clean glass surface tends to spread out while mercury on the same surface tends

to form drops. (Put differently ,water wets glass while mercury does not).

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6. Explain why

Surface tension of a liquid is independent of the area of the surface.

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7. Explain why

Water with detergent disolved in it should have small angles of contact.

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8. Explain why

A drop of liquid under no external forces is always spherical in shape.

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9. Fill in the blanks using the words from the list appended with each statement

Surface tension of liquids generally.....with temperature (increases/decreases)

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10. Fill in the blanks using the words from the list appended with each statement

Viscosity of glass.....with temperature,whereas viscosity of liquids.....with temperature (increases/decreases)

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11. Fill in the blanks using the words from the list appended with each statement

For solid of elastic modulus of rigidity, the shearing force is proportional to.....while for fluids it is proportional to.....(shear strain/ rate of shear strain).

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12. Fill in the blanks using the words from the list appended with each statement

For a fluid in a steady flow,the increase in flow speed at a constriction follows (conservation of mass/ Bernoulli's principle)

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13. Fill in the blanks using the words from the list appended with each statement

For the model of a plane in a wind tunnel.

Turbulence occurs at a .....speed for turbulence for an actual plane (greater/small)

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14. Explain why

To keep a piece of paper horizontal,you should blow over,not under it.

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15. Explain why

When we try to close a water tap with our fingers. Fast jets of water gush through the openings between our fingers

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16. Explain why

The size of the needle of a syringe controls flow rate better than the thumb pressure

exerted by a doctor while administering an injection.

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17. Explain why

A fluid flowing out of a small hole in a vessel results in a backward thrust on the vessel.

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18. Explain why

A spinning cricket ball in air does not follow a parabolic trajectory.

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19. A 50kg girl wearing high heel shoes balances on a single heel.the heel is circular with a diameter 1.0 cm. What is the pressure exerted by the heel on the horizontal floor?

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20. Toricell's barometer and mercury. Pascal duplicated it using French wine of density $984 kgm^{-3}$. Determine the height of the wine column for normal atmospheric pressure.

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21. A vertically-off shore structure is built to withstand a maximum stress of $10^9 Pa$ is the structure suitable for putting up on top of an oil well in the ocean? Take the depth of the

ocean to be roughly 3km. And ignore ocean currents.

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22. A hydraulic automobile life is designed to lift cars with a maximum mass of 3000 kg. The area of cross section of the piston carrying the load is $425cm^2$.What maximum pressure would the smaller piston have to eat?

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23. A U-tube contains water and methylated spirit separated by mercury. The mercury columns in the two arms are in level with 10.0 cm of water in one arm and 12.5cm of spirit to the other. What is the specific gravity of spirit?

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24. In the previous problem, If 15.0 cm of water and spirit each are further poured into the respective arms of the tube, what is the

difference in the levels of mercury in the two arms?

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25. Can Bernoulli's equations be used to describe the flow of water through a rapid in a river? Explain.

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26. Does it matter if one uses gauge instead of absolute pressures in applying Bernoulli's equation Explain?

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27. Glycerine flows steadly through a horizontal tube of length 1.5 m and radius 1.0 cm. IF the amount of glycerine collected per second at one end is $4.0 \times 10^{-3} kgs^{-1}$. What is the pressure difference between the two

ends of the tube?(density of glycerine $= 1.3 \times 10^3 kgm^{-3}$ and viscosity of glycerine =0.83 Pa s).[You may also like to check If the assumption of laminar flow in the tube is correct]

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28. In a test experiment on a model aeroplane in a wind tunnel, the flow speeds on the upper and lower surface of the wing are $70ms^{-1}$ and $63ms^{-1}$ respectively. What is

the lift on the wing if its area is $2.5m^2$? Take the density of air to be $1.3kgm^{-3}$.

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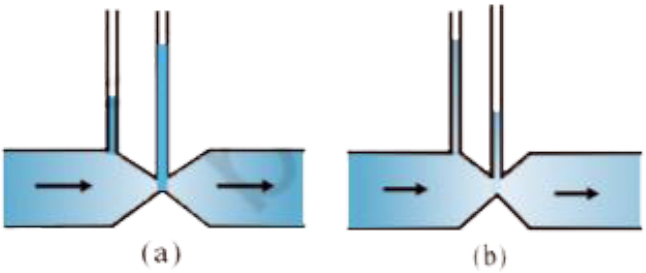
29. Figures 10.23(a) and (b) refer to the steady flow of a (non-viscous) liquid. Which of the two figures is incorrect? Why



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30. The cylindrical tube of a spray pump has a cross section of $8.0 cm^2$ one end of which has 40 fine holes each of diameter 1.0 mm. If the liquid flow inside the tube is $1.5 m \ \text{min}^{-1}$. What is the speed of ejection of the liquid through the holes?

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31. A U-shaped wire is dipped in a soap solution, and removed. The thin soap

filmformed between the wire and the light slider supports a weight of 1.5×10 −2 N(which includes the small weight of the slider). The length of the slider is 30 cm. what is the surface tension of the film?

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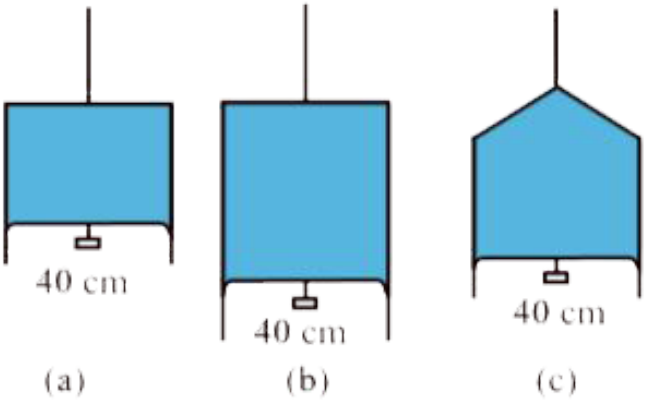
32. Figure 10.24(a) shows a thin liquid film supporting a small weight $= 4.5 \times 10^{-2} N$ What is the weight supported by a film of the same liquid at the same temperature in Fig.(b)

and (c) ? Explain your answer physically.



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33. What is the pressure inside the drop of mercury of radius 3.00mm at room temperature? Surface tension of mercury at that temperature $(20^\circ C)$ is

$4.65 \times 10^{-1} Nm^{-1}$. The atmospheric pressure is $1.01 \times 10^{5} Pa$. Also give the excess pressure inside the drop.

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34. What is the excess pressure inside a bubble of soap solution of radius 5.00 mm. given that the surface tension of soap solution at the temperature $(20^{\circ} C)$ is $2.50 \times 10^{-2} Nm^{-1}$? If an air bubble of the same dimension were formed at depth of 40.0

cm inside a container the soap solution (of relative density 1.20] what would be the pressure inside the bubble?[1 atmospheric pressure is $1.01 \times 10^5 Pa$).

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35. A tank with a square base of area $1.0m^2$ is divided by a vertical position in the middle. The bottom of the partition has a small hinged door of area $20cm^2$ The tank is filled with water in one compartment, and an acid

(of relative density 1.7) in the other. both to the height of 4.0 cm compute the force necessary to keep the door close.

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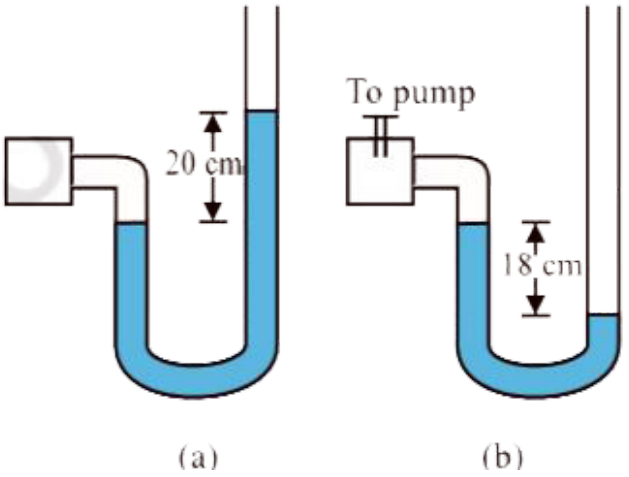
36. A manometer reads the pressure of a gas in an exclosure as shown in fig.10.25(a) When a pump removes some of the gas, the manometer reads as in fig.10.25(b) the liquid used in the manometer is mercury and the atmospheric pressure is 76cm of mercury.

Give the absolute and gauge pressure of the gas in the exclosure for cases (a) and (b) in units of cm of mercury.

How would the levels change in case (b) If 13.6 cm of water (immiscible with mercury) are poured into the right limb of the manometer? (ignore the small change in the volume of the gas).



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37. Two vessels have the same area but different shapes. The first shapes takes twice the volume of water that the second vessel requires to fill up to a particular common height? Is the force exerted by the water on the base of the vessel the same in the two cases? If so, why do the vessels filled with water to that same height give different readings on a weighing scale?

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38. During blood transfusion the needle is inserted in a vein where the gauge pressure is 2000 Pa. At what height must the blood container be placed so that blood may just enter the vein? [Use the density of whole blood from table 10.0]

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39. In deriving Bernoulli's equation, we equated the work done on the fluid in the tube to its change in the potential and kinetic energy. (a) What is the largest average velocity of the blood flow in an artery of diameter $2 \times 10^{-3} m$ if the flow must remain laminar? (b) Do the dissipative forces become more important as the fluid velocity increases? Discuss qualitatively?

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40. What is the largest average velocity of blood flow in an artery of radius $2 \times 10^{-3} m$ if the flow must remain laminar?(b) What is the corresponding flow rate?(take viscosity of blood to be $2.084 \times 10^{-3} Pas$)

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41. A plane is in level fight at constant speed and each of its two wings has an area of $25 m^2$. If the speed of the air is $180 km / h$ over the lower wing and $234 km / h$ over the upper wing

surface, determine the plane 's mass.(Take air density to be 1kg m^{-3})

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42. In Millikan's oil drop experiment. What is the terminal speed of an uncharged drop of radius $2.0 \times 10^{-5} m$ and density $1.2 \times 10^{3} kgm^{-3}$. Take the viscosity of air at the temperature of the experiment to be $1.8 \times 10^{-5} Pas$. How much is the viscosity

force on the drop at that speed? Neglect buoyancy of the drop due to air.

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43. Mercury has an angle of contact equal to 140° with soda lime glass. A narrow tube of radius 1.00mm made of this glass is dipped in a trough containing mercury.By what amount does the mercury at the temperature of the experiment is 0.465 Nm^{-1}. Density of mercury =$13.6 \times 10^3 kgm^{-3}$

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44. Two narrow bores of diameters 3.00mm and 6.0mm are joined together to form a U-tube open at both ends. If the U-tube contains water, what is the difference in its levels in the two limbs of the tube? Surface tension of water at the temperature of the experiment is $7.3 \times 10^{-2} Nm^{-1}$.Take the angle of contact to be zero and density to water to be $1.0 \times 10^{3} kgm^{-3}$

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45. It is known that density ρ of air decreases with height y as

$\rho = \rho_0 e^{-y/y_0}$

where $\rho_0 = 1.25 kgm^{-3}$ is the density at sea level. And y_0 is a constant . This density variation is called the law of atmosphere. Obtain this law assuming that the temperature of atmosphere remains a constant (isothermal conditions). Also assume that the value of g remains constant.

A large He balloon of volume $1425 m^3$ is used

to lift a payload of 400kg.Assume that the balloon maintains constant radius as it rises. How high does it rise?

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