QB365

Important Questions - Mechanical Properties of Fluids

11th Standard CBSE

Physics Reg.No. :

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) How a raincoat become rainproof? **1**

2) Can two streamlines cross each other, why? **1**

3) Why does the velocity increase when liquid flowing in a wider tube enters a narrow tube? **1**

4) Can Bernoulli's equation be used to describe the flow of water through a rapid in a river? Explain. **1**

5) The height of water level in a tank is H = 96 cm . Find the range of water stream coming out of a hole at depth H / 4 from upper surface of water. **1**

6) Three vessels have same base area and different neck area. Equal volume of liquid is poured into them, which will possess more pressure at the base? **1**

7) A mercury barometer is placed in the mercury through in a way that angle mad with the vertical is 60°.Find the height of mercury column. **1**

8) What is gauge pressure? **1**

9) A liquid drop breaks into 27 small drops. If surface tension of the liquids is S, then find the energy released. **1**

10) Two soap bubble of radii 6 cm and 8 cm coalesce to from a single bubble. Find the radius of the new bubble **1**

Section-B

11) 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. How does the pressure change as the fluid moves along the tube, if dissipative forces are present? **2**

12) 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. Do the dissipative forces become more important as the fluid velocity increases? Discuss qualitatively. **2**

13) At what speed will the velocity head of stream of water be 40 cm? **2**

14) In Millikan's oil drop experiment, what is the terminal speed of an uncharged drop of radius 2.0×10^{-5}m and density 1.2×10^3 kg /m^3? Take the viscosity of air at the temperature of the experiment to be 1.8×10^{-5}Pa-s. How much is the viscous force on the drop at that speed?Neglect buoyancy of the drop due to air. **2**

15) A thin wire is bent in the form of ring of diameter 3.0 cm. The ring is placed horizontally on the surface of soap solution and then raised up slowly. how much upward force is necessary to break the vertical film formed between the ring and the solution? T=3.0×10^{-2} Nm^{-1}. **2**

16) Water flows at a speed of 6 cms^{-1} through a pipe of tube of radius 1 cm. The coefficient of viscosity of water at room temperature is 0.01 poise. What is the nature of flow? **2**

17) Find the critical velocity for air flowing through a tube of 2 cm diameter. For air, $\rho = 1.3 \times 10^{-3} gcm^{-3}$ and $\eta = 181 \times 10^{-6}$ poise. **2**

18) A U-shaped wire is dipped in a soap solution and removed. The thin soap flim formed between the wire and a light slider supports a weight of 1.5×10^{-2} N (which in includes the mall weight of the slider). The length of the slider is 30 cm .What is the surface tension of the film? **2**

19) Two mercury droplets of radii 0.1 cm and 0.2 cm collapse into one single drop. Wha amount of energy is released?The surface tension of mercury S=435.5×10^{-3}N/m Whan two or more droplets collapse to form a bigger drop, then its surface area decrease and energy is released equal to SΔA **2**

20) Water enters a horizontal pipe of non-uniform cross-section with a velocity or 0.6$ms^{-1}$and leaves the other end with a velocity of 0.4ms^{-1}.At the first end, pressure of water is 1200Nm^{-2}.Calcilate the pressure of water at the other end. Density or water is 1000kgm^{-3} **2**

Section-C

21) A capillary tube 1 mm in diameter and 20 cm in length is fitted horizontally to a vessel kept full of alcohol. The depth of the centre of capillary tube below the surface of alcohol is 20 cm. If the viscosity and density of alcohol are 0.012 UGS unit and 08 gcm^{-3} , respectively, find the amount of the alcohol that will flow out in 5 min. Given that g=980 cms^{-2} **5**

22) A liquid is kept in cylindrical vessel which is rotated along its axis. The liquid rises at the sides. If the radius of vessel is 0.05 m and the speed of rotation is 2 rev/s, find the difference in height of the liquid at the centre of the vessel and its sides. **5**

23) Explain why? **5**

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

According to Bernoulli's theorem, for horizontal flow of fluids,

$$\left(p + \frac{1}{2}\rho v^2 = constant\right)$$

Therefore, when velocity of fluid increases, its pressure decreases and vice-versa.

24) Explain why? **5**

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

According to Bernoulli's theorem, for horizontal flow of fluids,

$$\left(p + \frac{1}{2}\rho v^2 = constant\right)$$

Therefore, when velocity of fluid increases, its pressure decreases and vice-versa.

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Section-A

1) 1

If the angle of the content between the water and the material of the raincoat is obtuse, then rainy water does not wet the rain coat. Thus the raincoat becomes waterproof.

2) 1

Two streamlines can never cross each other because if they cross them at the point of intersection, there will be two possible direction of flow of fluid which is impossible for streamlines.

3) This is due to equation of continuity, $a_1 v_1 = a_2 v_2$ $\because$ $a_1 > a_2$ $\therefore$ $v_2 > v_1$ 1

4) No, Bernoulli's equation cannot be used to describe the flow of water through a rapid in a river because Bernoulli's equation can be utilised only for streamline flow. 1

5) 1

The depth of hole below the upper surface of water is h $= \frac{H}{4} = \frac{96}{4}$ = 24 cm The height of hole from ground is, h' = 96 - 24 = 72 cm Horizontal range = 2.$\sqrt{hh'}$

$= 2\sqrt{24 \times 72}$ $= 48\sqrt{3}$ cm

6) 1

If the volumes are same, then height of the liquid will be highest in which the cross-sectional area is least at the top. So, the vessel having least cross-sectional area at the top possess more pressure at the base($\because p = \rho gh$)

7) The height of mercury in the inclined case will be 76cm. 1

8) 1

The difference between absolute pressure and atmospheric p[ressure is known as gauge pressure.

$As, \quad p_{absolute} = p_a + \rho gh So, \quad p_{absolute} - p_a = \rho gh \quad i.e. \quad p_{gauge} = \rho gh$ Here,ρ is the density of a fluid of depth h.

9) Let the radius of large drop =R $\times$ 1

and radius of each small drop =r

Volume of 27 small drops =Volume of the large drop

$= 27 \times \frac{4}{3} \times \pi r^3 = \frac{4}{3}\pi R^3$

So, r=R/3

Surface area of large drop=4π R^2

Surface area of 27 small drops =27 $\times$ 4π r^2

$= 27 \times 4\pi\left(\frac{R}{3}\right)^2 = 12\pi R^2$

$\therefore$ Increase in surface area =$12\pi R^2$-$4\pi R^2$=$8\pi R^2$

Increase in energy = Increase in surface area $\times$ Surface tension

=$8\pi R^2 \times$ S

10) Surface energy of first soap bubble 1

=Surface tension $\times$ Surface area

$= 2 \times 4\pi R_1^2 S = 8\pi R_1^2 S$

Surface energy of second soap bubble $= 8\pi R_1^2 S$

Let the radius of the new soap bubble is R SO, the surface energy of new bubble $= 8\pi R_1^2 S$

By the law of conservation of energy

$8\pi R^2 S = 8\pi R_1^2 S + 8\pi R_1^2 S R^2 = R_1^2 + R_2^2 = 36 + 64 R^2 = 100 cm^2 \Rightarrow R = 10 \quad cm$

Section-B

11) 2

If dissipative forces are present, then a part of pressure energy is utilised in overcoming these forces. Due to which, the pressure decreases as the fluid moves along the tube.

12) Yes, the dissipative forces become more important as the fluid velocity increases. 2

The viscous drag is given by

F =- η A $\frac{dv}{dx}$

As the velocity of fluid increases, the velocity gradient increases and hence, viscous drag increases i.e. dissipative force also increases.

13) Given, h = 40 cm, g = 980 cm/s^2 2

We know that velocity head,

h = $\frac{v^2}{2g}$

v = $\sqrt{2gh}$ = $\sqrt{2 \times 980 \times 40}$

= 280cms^{-1}

14) Given, radius of drop (r) = 2.0 × 10^{-5}m **2**

Density of oil (ρ) = 1.2 × 10^3kg / m^3

Viscosity of air (η) = 1.8 × 10^{-5}Pa-s

Terminal velocity, v = $\frac{2}{9}\frac{(\rho-\rho_0)g}{\eta}$

$$= \frac{2}{9}\frac{(2\times10^{-5})^2\times(1.2\times10^3-O)\times9.8}{1.8\times10^{-5}}$$

= 5.8 × 10^{-2}m/s

∴ Viscous force on the drop, (According to Stoke's law)

F = 6 $\pi\eta$rv

= 6 × 3.14 × 1.8 × 10^{-5} × 2 × 10^{-5} × 5.8 × 10^{-2}

= 3.93 × 10^{-10}N

15) 5.66 x 10^{-3} N **2**

16) R_e = 1200 < 2000 so, flow is laminar. **2**

17) 140 cms^{-1} **2**

18) Length pf the slider (i) =30 cm **2**

As a soap film has two free surfaces, therefore, total length of the film to be supported

l'=2l=2 × 30

=60 cm=0.06m

Let S be the surface tension of te soap solution

Total force on the slider due to surface tension.

F=S × 2l

F=S × 0.060N

Weight (w) supported by the slider =1.5 × 10^{-2} N

In equilibrium,

Force on the slider due to surface tension =weight supported by the slider

∴ F=w

S × 0.06=1.5 × 10^{-2}

or $S = \frac{1.5\times10^{-2}}{0.06} = 2.5\times10^{-2}N/m$

19) **2**

Radii of mercury droplets, r_1=0.1 cm =1 × 10^{-3} m

r_2=0.2 cm =2 × 10^{-3}m

Surface tension (S)=435.5 × 10^{-3}N/m

Let the radius of the big drop formed by collapsing be R

∴ Volume of big drop =Volume of small droplets

$\frac{4}{3}\pi R^3 = \frac{4}{3}\pi r_1^3 + \frac{4}{3}\pi r_1^3 R^3 r_1^3 + r_2^3 = (0.1)^3 + (0.2)^3 = 0.001 + 0.008 = 0.009 or R = 0.21cm = 2.1\times10^{-3}m \therefore Change \quad in \quad surface \quad area \Delta A = 4\pi r^2 - (4\pi r_1^3 + 4\pi r_2^2) \therefore Energy \quad released$

20) 1300N/m^2 **2**

Section-C

21) 38.4 g **5**

22) 0.02m **5**

23) **5**

When we blow over a piece of paper, the velocity of air above the paper increases. So, in accordance with Bernoulli's theorem $\left(p + \frac{1}{2}\rho v^2 = constant\right)$, the pressure of air decreases above the paper. Due to the pressure difference of air between below and above the paper a lifting force acts on paper and hence, it remain horizontal.

24) **5**

A fluid flowing out of small hole in vessel have a large velocity and therefore, a large momentum. As no external force is acting, therefore according to law of conservation of momentum equal momentum in attained by the vessel. Therefore, a backward thrust $\left(F = \frac{dp}{dt}\right)$ acts on the vessel.