DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS

21

SYLLABUS : Fluid Mechanics

Max. Marks : 112 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 28 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 The force required to separate two glass plates of area 10^{-2}m^{-2} with a film of water 0.05 m thick between them, is (Surface tension of water is 70×10^{-3} N/m)

(a) 28 N (b) 14 N (c) 50 N (d) 38 N

Q.2 A thin metal disc of radius r floats on water surface and bends the surface downwards along the perimeter making an angle θ with vertical edge of the disc. If the disc displaces a weight of water W and surface tension of water is T, then the weight of metal disc is

(a) $2\pi rT + W$ (b) $2\pi rT\cos\theta - W$

(c) $2\pi rT\cos\theta + W$ (d) $W - 2\pi rT\cos\theta$

Q.3 The amount of work done in blowing a soap bubble such that its diameter increases from d to D is (T = surface tension of the solution)

(a) $4\pi(D^2 - d^2)T$ (b) $8\pi(D^2 - d^2)T$

(c) $\pi(D^2 - d^2)T$ (d) $2\pi(D^2 - d^2)T$

Q.4 A film of water is formed between two straight parallel wires of length 10 cm each separated by 0.5 cm. If their separation is increased by 1 mm while still maintaining their parallelism, how much work will have to be done (Surface tension of water = 70×10^{-2} N/m)

(a) 7.22×10^{-6} Joule (b) 1.44×10^{-5} Joule

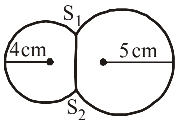
(c) 2.88×10^{-5} Joule (d) 5.76×10^{-5} Joule

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

Space for Rough Work

Q.5 The liquid meniscus in capillary tube will be convex, if the angle of contact is
(a) Greater than 90° (b) Less than 90°
(c) Equal to 90° (d) Equal to 0°

Q.6 Two soap bubbles of radii r_1 and r_2 equal to 4 cm and 5 cm are touching each other over a common surface S_1S_2 (shown in figure). Its radius will be
(a) 4 cm
(b) 20 cm
(c) 5 cm
(d) 4.5 cm



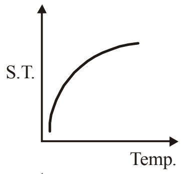
Q.7 The radii of two soap bubbles are r_1 and r_2. In isothermal conditions, two meet together in vaccum. Then the radius R of the resultant bubble is given by
(a) $R=(r_1+r_2)/2$ (b) $R=r_1(r_1r_2+r_2)$
(c) $R^2=r_1^2+r_2^2$ (d) $R=r_1+r_2$

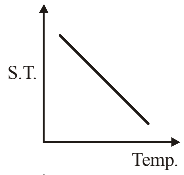
Q.8 Two parallel glass plates are dipped partly in the liquid of density 'd' keeping them vertical. If the distance between the plates is 'x', surface tension for liquids is T and angle of contact is θ, then rise of liquid between the plates due to capillary will be
(a) $\frac{T\cos\theta}{xd}$ (b) $\frac{2T\cos\theta}{xdg}$ (c) $\frac{2T}{xdg\cos\theta}$ (d) $\frac{T\cos\theta}{xdg}$

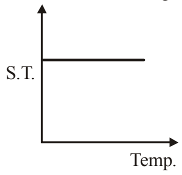
Q.9 A capillary tube of radius R is immersed in water and water rises in it to a height H. Mass of water in the capillary tube is M. If the radius of the tube is doubled, mass of water that will rise in the capillary tube will now be
(a) M (b) $2M$ (c) $M/2$ (d) $4M$

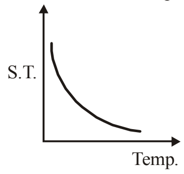
Q.10 In a surface tension experiment with a capillary tube water rises upto 0.1 m. If the same experiment is repeated on an artificial satellite, which is revolving around the earth, water will rise in the capillary tube upto a heights of
(a) 0.1 m
(b) 0.2 m
(c) 0.98 m
(d) Full length of the capillary tube

Q.11 Which graph represents the variation of surface tension with temperature over small temperature ranges for water?

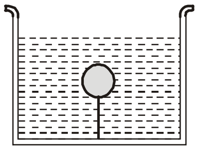
(a)


(b)


(c)


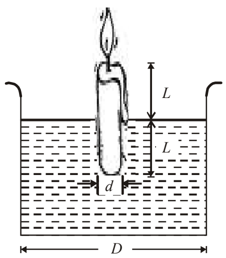
(d)


Q.12 A solid sphere of density $\eta(>1)$ times lighter than water is suspended in a water tank by a string tied to its base as shown in fig. If the mass of the sphere is m then the tension in the string is given by



(a) $\left(\frac{\eta-1}{\eta}\right)mg$
(b) ηmg
(c) $\frac{mg}{\eta-1}$
(d) $(\eta-1)mg$

Q.13 A candle of diameter d is floating on a liquid in a cylindrical container of diameter D $(D>>d)$ as shown in figure. If it is burning at the rate of 2 cm/hour then the top of the candle will

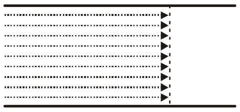


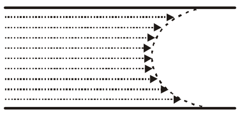
(a) Remain at the same height
(b) Fall at the rate of 1 cm/hour
(c) Fall at the rate of 2 cm/hour
(d) Go up the rate of 1 cm/hour

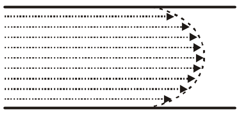
RESPONSE GRID	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	

Space for Rough Work

Q.14 A viscous fluid is flowing through a cylindrical tube. The velocity distribution of the fluid is best represented by the diagram

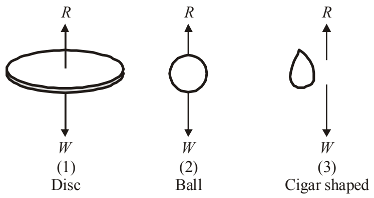
(a) 

(b) 

(c) 

(d) None of these

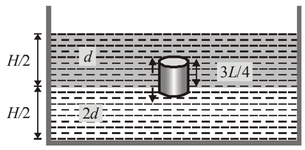
Q.15 When a body falls in air, the resistance of air depends to a great extent on the shape of the body, 3 different shapes are given. Identify the combination of air resistances which truly represents the physical situation. (The cross sectional areas are the same).



(a) $1 < 2 < 3$ (b) $2 < 3 < 1$

(c) $3 < 2 < 1$ (d) $3 < 1 < 2$

Q.16 A homogeneous solid cylinder of length $L(L < H/2)$. Cross-sectional area A/5 is immersed such that it floats with its axis vertical at the liquid-liquid interface with length L/4 in the denser liquid as shown in the fig. The lower density liquid is open to atmosphere having pressure P_0. Then density of solid is given by



(a) $\frac{5}{4}d$ (b) $\frac{4}{5}d$ (c) d (d) $\frac{d}{5}$

Q.17 A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water the quantities of water flowing out per second from both the holes are the same. Then R is equal to

(a) $2\pi L$ (b) $\frac{L}{\sqrt{2\pi}}$ (c) L (d) $\frac{L}{2\pi}$

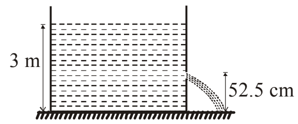
Q.18 Water is filled in a cylindrical container to a height of 3m. The ratio of the cross-sectional area of the orifice and the beaker is 0.1. The square of the speed of the liquid coming out from the orifice is ($g = 10 m/s^2$)

(a) $50\ m^2/s^2$

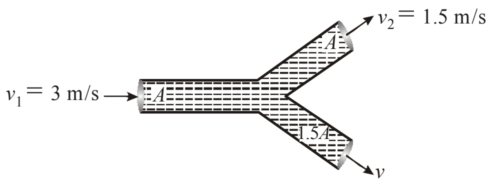
(b) $50.5\ m^2/s^2$

(c) $51\ m^2/s^2$

(d) $52\ m^2/s^2$



Q.19 An incompressible liquid flows through a horizontal tube as shown in the following fig. Then the velocity v of the fluid is



(a) 3.0 m/s (b) 1.5 m/s (c) 1.0 m/s (d) 2.25 m/s

Q.20 Radius of a capillary tube is 2×10^{-3}m. A liquid of weight 6.28×10^{-4} N may remain in the capillary tube then the surface tension of liquid will be

(a) 5×10^{-3} N/m (b) 5×10^{-2} N/m

(c) 5 N/m (d) 50 N/m

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

RESPONSE GRID					
	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ
	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ			

Space for Rough Work

Q.21 The temperature at which the surface tension of water is zero
(1) 370°C
(2) 0°C
(3) Slightly less than 647 K
(4) 277 K

Q.22 Which of the following statements are true in case when two water drops coalesce and make a bigger drop?
(1) Energy is released.
(2) Energy is absorbed.
(3) The surface area of the bigger drop is smaller than the sum of the surface areas of both the drops.
(4) The surface area of the bigger drop is greater than the sum of the surface areas of both the drops.

Q.23 An air bubble in a water tank rises from the bottom to the top. Which of the following statements are true?
(1) Bubble rises upwards because pressure at the bottom is greater than that at the top.
(2) As the bubble rises, its size increases.
(3) Bubble rises upwards because pressure at the bottom is less than that at the top.
(4) As the bubble rises, its size decreases.

DIRECTIONS (Q.24-Q.25) : Read the passage given below and answer the questions that follows :

There is a small mercury drop of radius 4.0mm. A surface P of area 1.0 mm^2 is placed at the top of the drop. Atmospheric pressure = 10^5 Pa. Surface tension of mercury = 0.465 N/m. Gravity effect is negligible.

Q.24 The force exerted by air on surface P is
(a) 0.1 N (b) 1.0023 N (c) 10^5 N (d) 1.0 N

Q.25 The force exerted by mercury drop on the surface P is
(a) 0.1 N (b) 1.0023 N
(c) 0.00023 N (d) 0.10023 N

DIRECTIONS (Qs. 26-Q.28) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.26 **Statement-1 :** A large soap bubble expands while a small bubble shrinks, when they are connected to each other by a capillary tube.
Statement-2: The excess pressure inside bubble (or drop) is inverse ly proportional to the radius.

Q.27 **Statement-1 :** Bernoulli's theorem holds for incompressible, non-viscous fluids.
Statement-2 : The factor $\frac{v^2}{2g}$ is called velocity head.

Q.28 **Statement-1 :** The velocity increases, when water flowing in broader pipe enter a narrow pipe.
Statement-2 : According to equation of continuity, product of area and velocity is constant.

RESPONSE GRID					
	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ
	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ		

DAILY PRACTICE PROBLEM SHEET 21 - PHYSICS			
Total Questions	28	Total Marks	112
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	42
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

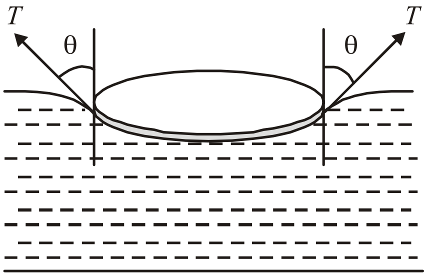
DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS 21

1. (a) Force required to separate the plates

$$F = \frac{2TA}{t} = \frac{2\times 70\times 10^{-3}\times 10^{-2}}{0.05\times 10^{-3}} = 28N$$

2. (c)



Weight of metal disc = total upward force
= upthrust force + force due to surface tension
= weight of displaced water + $T\cos\theta\,(2\pi r)$
$= W + 2\pi r T\cos\theta$

3. (d) $W = T\times 8\pi(r_2^2 - r_1^2) = T\times 8\pi\left(\frac{D^2}{4} - \frac{d^2}{4}\right)$

$= 2\pi(D^2 - d^2)T$

4. (b) Increment in area of soap film $= A_2 - A_1$

$= 2\times[(10\times 0.6) - (10\times 0.5)]\times 10^{-4} = 2\times 10^{-4}\,m^2$

Work done $= T\times\Delta A$

$= 7.2\times 10^{-2}\times 2\times 10^{-4} = 1.44\times 10^{-5}\,J$

5. (a)

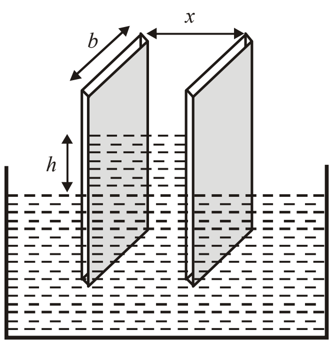
6. (c) Excess pressure inside soap bubble is inversely proportional to the radius of bubble *i.e.* $\Delta P\propto\frac{1}{r}$

This means that bubbles A and C posses greater pressure inside it than B. So the air will move from A and C towards B.

7. (b) $r = \frac{r_1 r_2}{r_1 - r_2} = \frac{5\times 4}{5-4} = 20\ cm$

8. (c) The radius of resultant bubble is given by $R^2 = r_1^2 + r_2^2$.

9. (b)



Let the width of each plate is b and due to surface tension liquid will rise upto height h then upward force due to Surface tension

$= 2Tb\cos\theta$ ....(i)

Weight of the liquid rises in between the plates

$= Vdg = (bxh)dg$ ....(ii)

Equating (i) and (ii) we get, $2T\cos\theta = bxhdg$

$\therefore h = \frac{2T\cos\theta}{xdg}$

10. (b) Mass of liquid in capillary tube

$M = \pi R^2 H\times\rho \therefore M\propto R^2\times\left(\frac{1}{R}\right)$ (As $H\propto 1/R$)

$\therefore\ M\propto R$. If radius becomes double then mass will becomes twice.

11. (d) In the satellite, the weight of the liquid column is zero. So the liquid will rise up to the top of the tube.

12. (b) $T_c = T_0(1 - \propto t)$

i.e. surface tension decreases with increase in temperature.

13. (a)

14. (d) Tension in spring T = upthrust - weight of sphere

$= V\sigma g - V\rho g = V\eta\rho g - V\rho g$ (As $\sigma = \eta\rho$)

$= (\eta - 1)V\rho g = (\eta - 1)\,mg.$

15. (b)

16. (c)

17. (c) A stream lined body has less resistance due to air.

18. (a) Weight of cylinder = upthrust due to both liquids

$$V\times D\times g = \left(\frac{A}{5}\times\frac{3}{4}L\right)\times d\times g + \left(\frac{A}{5}\times\frac{L}{4}\right)\times 2d\times g$$

$$\Rightarrow\left(\frac{A}{5}\times L\right)\times D\times g = \frac{A\times L\times d\times g}{4}$$

$$\Rightarrow\frac{D}{5} = \frac{d}{4}\therefore D = \frac{5}{4}d$$

19. (b) Velocity of efflux when the hole is at depth $h, v = \sqrt{2gh}$

Rate of flow of water from square hole

$Q_1 = a_1 v_1 = L^2\sqrt{2gy}$

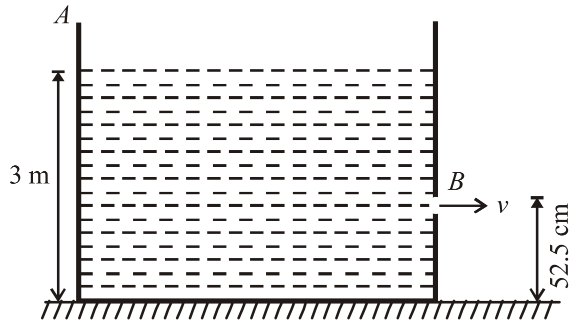
Rate of flow of water from circular hole

$Q_2 = a_2 v_2 = \pi R^2\sqrt{2g(4y)}$

According to problem $Q_1 = Q_2$

$$\Rightarrow L^2\sqrt{2gy} = \pi R^2\sqrt{2g(4y)}\Rightarrow R = \frac{L}{\sqrt{2\pi}}$$

20. **(a)** Let A = cross-section of tank



a = cross-section hole
V = velocity with which level decreases
v = velocity of efflux

From equation of continuity $av = AV \Rightarrow V = \frac{av}{A}$

By using Bernoulli's theorem for energy per unit volume
Energy per unit volume at point A
= Energy per unit volume at point B

$$P + \rho gh + \frac{1}{2}\rho V^2 = P + 0 + \frac{1}{2}\rho v^2$$

$$\Rightarrow v^2 = \frac{2gh}{1-\left(\frac{a}{A}\right)^2} = \frac{2\times10\times(3-0.525)}{1-(0.1)^2} = 50(m/\sec)^2$$

21. **(c)** If the liquid is incompressible then mass of liquid entering through left end, should be equal to mass of liquid coming out from the right end.

$\therefore\ M = m_1 + m_2 \ \Rightarrow Av_1 = Av_2 + 1.5A.v$

$\Rightarrow A\times3 = A\times1.5 + 1.5A.v \Rightarrow v = 1\,m/s$

22. **(b)** $T = \frac{F}{2\pi r} = \frac{6.28\times10^{-4}}{2\times3.14\times2\times10^{-3}} = 5\times10^{-2}\,N/m$

23. **(d)** At critical temperature $\left(T_c = 370^\circ C = 643\,K\right)$, the surface tension of water is zero.

24. **(d)**

25. **(b)**

$P_{Bottom} > P_{Surface}$. So bubble rises upward.

At constant temperature $V \propto \frac{1}{P}$ (Boyle's law)

Since as the bubble rises upward, pressure decreases, then from above law volume of bubble will increase i.e. its size increases.

26. **(a)**

27. **(d).**

$F = P_{atm} \times Area = 10^5 \times 1 \times 10^{-6} = 0.1\,N$

$F = \left(P_{atm} + \frac{2T}{r}\right) \times A = 0.10023\,N$

28. **(a)** Since the excess pressure due to surface tension is inversely proportional to its radius, it follows that smaller the bubble, greater is the excess pressure. Thus when the larger and the smaller bubbles are put in communication, air starts passing from the smaller into the large bubble because excess pressure inside the former is greater than inside the latter. As a result, the smaller bubble shrinks and the larger one swells.

29. **(b)** Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

30. **(a)** In a stream line flow of a liquid, according to equation of continuity,

av = constant

Where a is the area of cross-section and v is the velocity of liquid flow. When water flowing in a broader pipe enters a narrow pipe, the area of cross-section of water decreases therefore the velocity of water increases.