Crash Course - Physics

A ship in port is safe, but that's not what ships are built for.

Difficulties are meant to rouse, not discourage. The human spirit is to grow strong by conflict.

Rotational Motion & Fluids.

1. Two particles of masses 1 *kg* and 3 *kg* move towards each other under their mutual force of attraction. No other force acts on them. When the relative velocity of approach of the two particles is 2 *m/s,* their centre of mass has a velocity of 0.5 *m/s.* When the relative velocity of approach becomes 3 *m/s,* the velocity of the centre of mass is

(a) 0.5 *m/s* (b) 0.75 *m/s* (c) 1.25 *m/s* (d) Zero

2. In rotational motion of a rigid body, all particle move with

(a)Same linear and angular velocity

(b)Same linear and different angular velocity

(c)With different linear velocities and same angular velocities

(d)With different linear velocities and different angular velocities

3. A flywheel gains a speed of 540 *r.p.m.* in 6 *sec.* Its angular acceleration will b

(a)3π *rad/sec*^{2} (b)9π *rad/sec*^{2} (c)18π *rad/sec*^{2} (d)54π *rad/sec*^{2}

4. Let F be the force acting on a particle having position vector $\vec{r}$ and $\vec{T}$ be the torque of this force about the origin. Then

(a) $\vec{r}.\vec{T}=0$ and $\vec{F}.\vec{T}=0$ (b) $\vec{r}.\vec{T}=0$ and $\vec{F}.\vec{T}\neq 0$

(c) $\vec{r}.\vec{T}\neq 0$ and $\vec{F}.\vec{T}=0$ (d) $\vec{r}.\vec{T}\neq 0$ and $\vec{F}.\vec{T}\neq 0$

5. A couple produces

(a) Purely linear motion (b) Purely rotational motion

(c) Linear and rotational motion (d) No motion

6. A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point that is directly above the centre of the face, at a height $\frac{3a}{4}$ above the base. The minimum value of F for which the cube begins to tilt about the edge is (assume that the cube does not slide)

(a) $\frac{mg}{4}$ (b) $\frac{2mg}{3}$ (c) $\frac{3mg}{4}$ (d) mg

7. Four particles each of mass m are placed at the corners of a square of side length l. The radius of gyration of the system about an axis perpendicular to the square and passing through its centre is

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

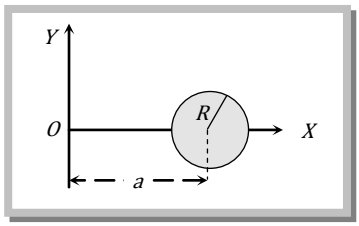
8. The moment of inertia of a rod (length l, mass m) about an axis perpendicular to the length of the rod and passing through a point equidistant from its mid point and one end is

(a) $\frac{ml^2}{12}$ (b) $\frac{7}{48}ml^2$ (c) $\frac{13}{48}ml^2$ (d) $\frac{19}{48}ml^2$

9. Three identical thin rods each of length l and mass M are joined together to form a letter H. What is the moment of inertia of the system about one of the sides of H

(a) $\frac{Ml^2}{3}$ (b) $\frac{Ml^2}{4}$ (c) $\frac{2Ml^2}{3}$ (d) $\frac{4Ml^2}{3}$

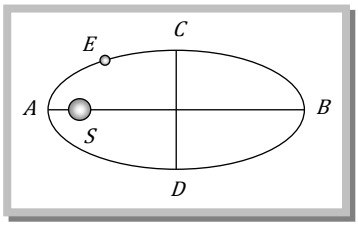
10. The adjoining figure shows a disc of mass M and radius R lying in the X-Y plane with its centre on $X-$axis at a distance a from the origin. Then the moment of inertia of the disc about the X-axis is



(a) $M\left(\frac{R^2}{2}\right)$ (b) $M\left(\frac{R^2}{4}\right)$

(c) $M\left(\frac{R^2}{4}+a^2\right)$ (d) $M\left(\frac{R^2}{2}+a^2\right)$

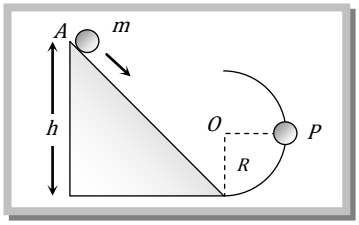
11. The earth E moves in an elliptical orbit with the sun S at one of the foci as shown in the figure. Its speed of motion will be maximum at the point



(a) C (b) A

(c) B (d) D

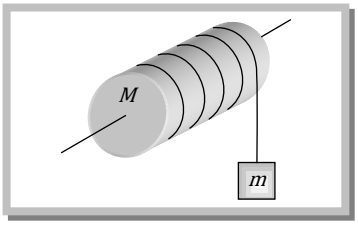
12. A solid ball of mass m and radius r rolls without slipping along the track shown in the fig. The radius of the circular part of the track is R. The ball starts rolling down the track from rest from a height of $8R$ from the ground level. When the ball reaches the point P then its velocity will be



(a) $\sqrt{gR}$ (b) $\sqrt{5gR}$

(c) $\sqrt{10gR}$ (d) $\sqrt{3gR}$

13. A mass M is supported by a mass less string would wound a uniform cylinder of mass M and radius R. On releasing the mass from rest, it will fall with acceleration

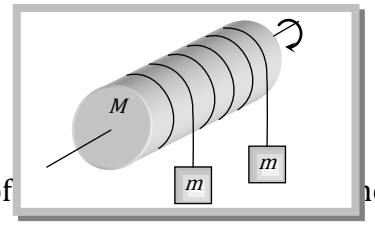


(a) g (b) $\frac{g}{2}$ (c) $\frac{g}{3}$ (d) $\frac{2g}{3}$

14. A uniform solid cylinder of mass M and radius R rotates about a frictionless horizontal axle. Two similar masses suspended with the help two ropes wrapped around the cylinder. If the system is released from rest then the acceleration of each mass will be

(a) $\frac{4mg}{M+2m}$ (b) $\frac{4mg}{M+4m}$

(c) $\frac{2mg}{M+m}$ (d) $\frac{2mg}{M+2m}$



15. The string of a simple pendulum is replaced by a uniform rod of ne mass of the bob of the pendulum is m, then for small oscillations its time period would be (assume radius of bob $r << L$)

(a) $2\pi\sqrt{\frac{2(M+3m)L}{3(M+2m)g}}$ (b) $2\pi\sqrt{\frac{(M+2m)L}{3(M+3m)g}}$

(c) $2\pi\sqrt{\left(\frac{2M}{3m}\right)\frac{L}{g}}$ (d) $2\pi\sqrt{\left(\frac{M+m}{M+3m}\right)\frac{L}{g}}$

16. The pressure at the bottom of a tank containing a liquid does not depend on

(a) Acceleration due to gravity (b) Height of the liquid column

(c) Area of the bottom surface (d) Nature of the liquid

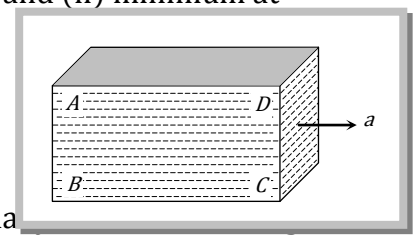
17. When a large bubble rises from the bottom of a lake to the surface. Its radius doubles. If atmospheric pressure is equal to the pressure given by column of water of height H, then the depth of lake is

(a) H (b) $2H$ (c) $7H$ (d) $8H$

18. A closed rectangular tank is completely filled with water and is accelerated horizontally with an acceleration a towards right. Pressure is (i) maximum at, and (ii) minimum at

(a) (i) B (ii) D (b) (i) C (ii) D

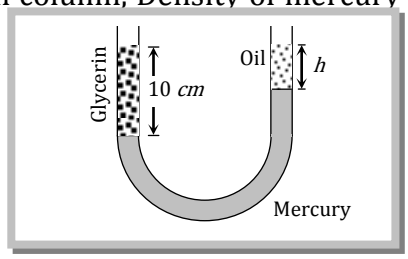
(c) (i) B (ii) C (d) (i) B (ii) A



19. A barometer tube reads 76 cm of mercury. If the tube is gradua with vertical, keeping the open end immersed in the mercury reservoir, the length of the mercury column will be

(a) 152 cm (b) 76 cm (c) 38 cm (d) $38\sqrt{3}cm$

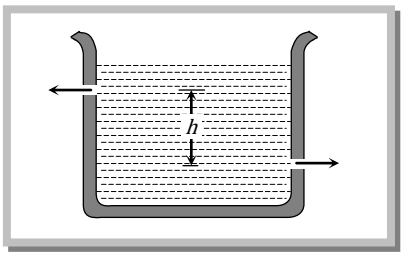
20. A vertical U-tube of uniform inner cross section contains mercury in both sides of its arms. A glycerin (density = 1.3 g/cm^3) column of length 10 cm is introduced into one of its arms. Oil of density 0.8 gm/cm^3 is poured into the other arm until the upper surfaces of the oil and glycerin are in the same horizontal level. Find the length of the oil column, Density of mercury = 13.6 g/cm^3



(a) 10.4 cm (b) 8.2 cm

(c) 7.2 cm (d) 9.6 cm

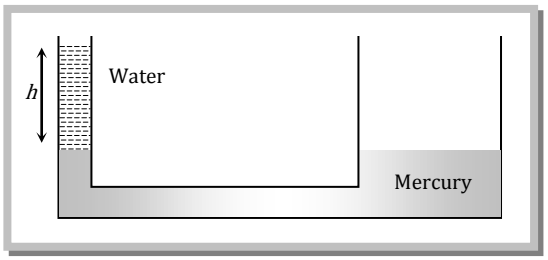
21. There are two identical small holes of area of cross-section a on the opposite sides of a tank containing a liquid of density ρ. The difference in height between the holes is h. Tank is resting on a smooth horizontal surface. Horizontal force which will has to be applied on the tank to keep it in equilibrium is



(a) $gh\rho a$ (b) $\frac{2gh}{\rho a}$

(c) $2\rho agh$ (d) $\frac{\rho gh}{a}$

22. Two communicating vessels contain mercury. The diameter of one vessel is n times larger than the diameter of the other. A column of water of height h is poured into the left vessel. The mercury level will rise in the right-hand vessel (s = relative density of mercury and ρ = density of water) by



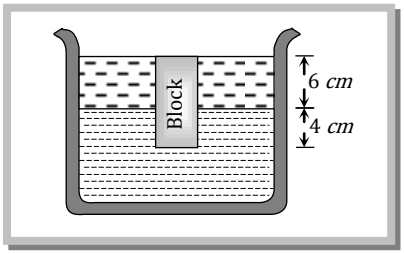
(a) $\frac{n^2h}{(n+1)^2s}$ (b) $\frac{h}{(n^2+1)s}$

(c) $\frac{h}{(n+1)^2s}$ (d) $\frac{h}{n^2s}$

23. A piston of cross-section area 100 cm^2 is used in a hydraulic press to exert a force of 10^7 dynes on the water. The cross-sectional area of the other piston which supports an object having a mass 2000 kg. is

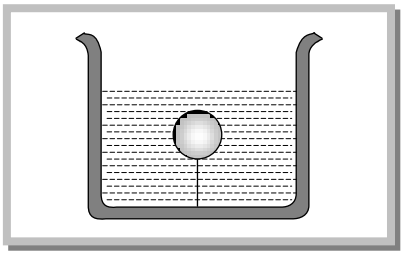
(a) 100 cm^2 (b) $10^9\,cm^2$ (c) $2\times10^4\,cm^2$ (d) $2\times10^{10}\,cm^2$

24. A cubical block of wood 10 cm on a side floats at the interface between oil and water with its lower surface horizontal and 4 cm below the interface. The density of oil is $0.6gcm^{-1}$. The mass of block is



(a) 706 g (b) 607 g (c) 760 g (d) 670 g

25. A solid sphere of density η (> 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) $(\eta-1)mg$

26. If two liquids of same masses but densities ρ_1 and ρ_2 respectively are mixed, then density of mixture is given by

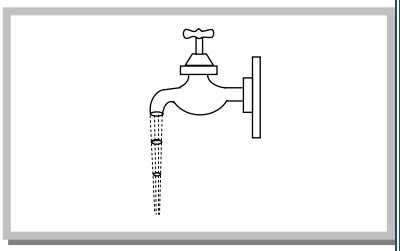
(a) $\rho=\frac{\rho_1+\rho_2}{2}$ (b) $\rho=\frac{\rho_1+\rho_2}{2\rho_1\rho_2}$ (c) $\rho=\frac{2\rho_1\rho_2}{\rho_1+\rho_2}$ (d) $\rho=\frac{\rho_1\rho_2}{\rho_1+\rho_2}$

27. Stream-line flow is more likely for liquids with

(a) Low density and low viscosity (b) High viscosity and high density

(c) High viscosity and low density (d) Low viscosity and high density

28. Water coming out of the mouth of a tap and falling vertically in streamline flow forms a tapering, column, *i.e.,* the area of cross-section of the liquid column decreases as it moves down. Which of the following is the most accurate explanation for this



(a)As the water moves down, its speed increases and hence its pressure decreases. It is then compressed by the atmosphere

(b)Falling water tries to reach a terminal velocity and hence reduces the area of cross-section to balance upward and downward forces

(c)The mass of water flowing past any cross-section must remain constant. Also, water is almost incompressible. Hence, the rate of volume flow must remain constant. As this is equal to velocity × area, the area decreases as velocity increases

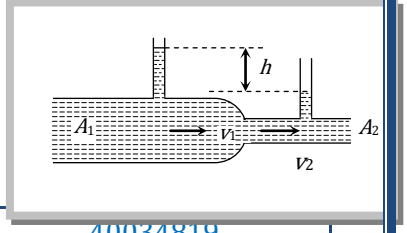
(d)The surface tension causes the exposed surface area of the liquid to decrease continuously

29. An application of Bernoulli's equation for fluid flow is found in

(a)Dynamic lift of an aeroplane (b)Viscosity meter

(c)Capillary rise (d)Hydraulic press

30. A liquid flows through a horizontal tube. The velocities of the liquid in the two sections, which have areas of cross-section A_1 and A_2,



are v_1 and v_2 respectively. The difference in the levels of the liquid in the two vertical tubes is h

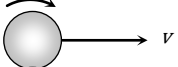
(a)The volume of the liquid flowing through the tube in unit time is A_1v_1 (b) $v_2 - v_1 = \sqrt{2gh}$

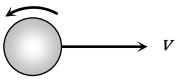
(c) $v_2^2 - v_1^2 = 2gh$ (d) The energy per unit mass of the liquid is same in both sections of the tube

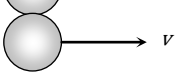
31. A sniper fires a rifle bullet into a gasoline tank making a hole 53.0 m below the surface of gasoline. The tank was sealed at 3.10 atm. The stored gasoline has a density of 660 kgm^{-3}. The velocity with which gasoline begins to shoot out of the hole is

(a) 27.8 ms^{-1} (b) 41.0 ms^{-1} (c) 9.6 ms^{-1} (d) 19.7 ms^{-1}

32. To get the maximum flight, a ball must be thrown as

(a) 

(b) 

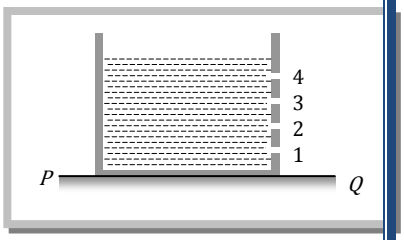
(c) 

(d) Any of (a), (b) and (c)

33. Fig. represents vertical sections of four wings moving horizontally in air. In which case is the force upwards

(a)  (b)  (c)  (d) 

34. A cylindrical vessel of 90 cm height is kept filled upto the brim. It has four holes 1, 2, 3, 4 which are respectively at heights of 20 cm, 30 cm, 45 cm and 50 cm from the horizontal floor PQ. The water falling at the maximum horizontal distance from the vessel comes from



(a) Hole 4 (b) Hole 3 (c) Hole 2 (d) Hole 1

35. Velocity of water in a river is

(a)Same everywhere (b)More in the middle and less near its banks

(c)Less in the middle and more near its banks (d)Increase from one bank to other bank

36. A good lubricant should have

(a)High viscosity (b)Low viscosity (c)Moderate viscosity (d)High density

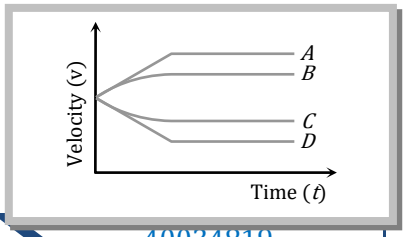
37. The relative velocity of two consecutive layers is 8 cm/s. If the perpendicular distance between the layers is 0.1 cm, then the velocity gradient will be

(a)8sec^{-1} (b)80 sec^{-1} (c)0.8 sec^{-1} (d)0.08 sec^{-1}

38. A small spherical solid ball is dropped from a great height in a viscous liquid. Its journey in the liquid is best described in the diagram given below by the

(a) Curve A (b) Curve B

(c) Curve C (d) Curve D



39. In Poiseuilli's method of determination of coefficient of viscosity, the physical quantity that requires greater accuracy in measurement is

(a) Pressure difference (b) Volume of the liquid collected

(c) Length of the capillary tube (d) Inner radius of the capillary tube

40. Water flows in a streamlined manner through a capillary tube of radius a, the pressure difference being P and the rate of flow Q. If the radius is reduced to $a/2$ and the pressure increased to $2P$, the rate of flow becomes

(a) $4Q$ (b) Q (c) $\frac{Q}{4}$ (d) $\frac{Q}{8}$

Answers

1. A
2. C
3. A
4. A
5. B
6. B
7. A
8. B
9. D
10. B
11. B
12. C
13. D
14. B
15. A
16. C
17. C
18. A

Fluids flow from higher pressure to lower pressure.

19. A

The pressure depends on the height of the highest point of mercury from ground and not the length of liquid column.

20. D

Liquids flow until the pressure at each point is equal to the pressure at all other points at the same level.

21. C

Recite Newton's Second Law Aloud Slowly :)

22. B
23. C

You know Pascal's Law right?

24. C
25. D
26. A

Density = Mass/Volume

27. C

Knowledge based.

28. C

Equation of continuity

29. A

If you could not do this, it is time to give a quick read to the entire chapter from H C Verma. Do it NOW before proceeding.

30. A, C, D

If you did this sum from some formula committed to memory sometime in the past, try to prove the formula NOW without touching any reference material. If you cannot, give a proper reading to H C Verma, Fluids: the entire chapter.

31. B
32. B
33. A
34. B
35. B
36. A
37. B
38. B
39. D
40. D