Excel Coaching Classes

Time: 60min | 12th Physics Ch 1,2,9 | Marks: 20

SECTION A

1. Select and write the correct answer for the following multiple choice type of questions: **3**

i. **Bernoulli's principle is true under which of the following assumptions?**

- [ ] (A) The fluid is viscous and streamline.
- [x] (B) The fluid is non-viscous and streamline.
- [ ] (C) The fluid is non-viscous and turbulent.
- [ ] (D) The fluid is viscous and turbulent.

ii. **Kirchhoff's junction law is equivalent to ________.**

- [ ] (A) conservation of energy
- [x] (B) conservation of charge
- [ ] (C) conservation of electric potential
- [ ] (D) conservation of electric flux

iii. **A body is moving in a circular orbit with static friction 0.4. If radius through which the body revolves is 50 m and g = 9.8 m/s^2, then maximum speed with which body revolved is**

- [x] (A) 14 m/s
- [ ] (B) 19 m/s
- [ ] (C) 11 m/s
- [ ] (D) 13 m/s

Ans: Using,

$$v_{max} = \sqrt{\mu r g} = \sqrt{0.4 \times 50 \times 9.8} = 14 \text{ m/s}$$

2. Answer the following questions: **3**

i. **Why is the surface tension of paints and lubricating oils kept low?**

Surface tension of lubricating oils and paints is kept low in order to help them spread over a large area.

ii. **The relative velocity between two layers of fluid, separated by 0.1 mm is 2 cm/s. Calculate the velocity gradient.**

Velocity gradient,

$v_g = \frac{dv}{dx} = \frac{2}{0.01}$ ....(dx = 0.1 mm = 0.01 cm)

$\therefore$ v_g = **200 s^{-1}**

iii. **Define or describe a Potentiometer.**

A potentiometer is a device which does not draw any current from circuit, acting like an ideal voltmeter and measures potential difference accurately.

SECTION B

Attempt any TWO questions of the following: **4**

3. **What is the pressure inside the drop of mercury of radius 3 mm at room temperature? Surface tension of mercury at temperature 20 °C is 4.65×10^{-1} N m^{-1}.**
(1 atm = 1.01×10^{5} Pa)

The pressure inside the drop of mercury is **1.0131×10^{5} Pa**.

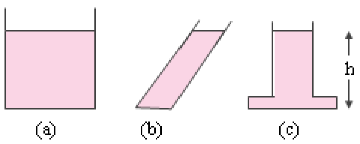
4. **Why does the speed of a liquid increase and its pressure decrease when a liquid passes through constriction in a horizontal pipe?**

i. As per equation of continuity, when the liquid flows through a constriction, the area of cross-section of the liquid decreases, therefore the velocity of the liquid increases.
ii. According to Bernoulli's theorem, the sum of pressure energy, potential energy and kinetic energy per unit mass is constant at all cross-section in the stream line flow of an ideal liquid.
$\therefore$ $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$
iii. If the liquid is flowing through a horizontal tube, the two ends of the tube are at the same level.
iv. Therefore, there is no gravitational head (level difference) i.e., h = 0
$\therefore$ $P + \frac{1}{2}\rho v^2 = \text{constant}$ ….(1)
v. This shows that since the velocity of liquid increases, its pressure decreases when passing through a constriction in a horizontal pipe.

5. **On what factors does the internal resistance of a cell depend?**

Internal resistance of a cell depends upon following factors:
i. Nature of electrolyte,
ii. Nature of electrodes,
iii. Distance between the electrodes,
iv. The area of electrodes dipping in the electrolyte.

6. A. **The figures show three containers filled with the same oil. How will the pressures at the reference line compare?**



The pressure in all the three containers will be the same at the reference line.

B. **On what factors does the potential gradient of the wire depend?**

Potential gradient of the wire depends upon the potential difference between two point on the wire and length of the wire between two points.

SECTION C

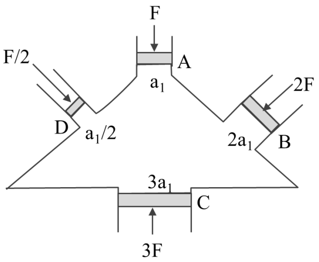
Attempt any TWO questions of the following: **6**

7. **State Pascal's law of fluid pressure. Describe the experimental proof for the same.**

Statement: The pressure applied at any point of an enclosed fluid at rest is transmitted equally and undiminished to every point of the fluid and also on the walls of the container, provided the effect of gravity is neglected.

Explanation:

i. Consider a vessel with four arms A, B, C and D having different cross-sectional areas a_1, $2a_1$, $3a_1$ and $a_1/2$ respectively filled with incompressible fluid and fitted with frictionless, water tight pistons as shown in figure.



Demonstration of Pascal's law

ii. Initially, the enclosed water is at rest. Now suppose that the piston A is pushed down with a force F_1 so that the pressure exerted by it on the fluid is, $P_A = \frac{F_1}{a_1}$.

iii. It is found that the pistons B, C and D can be prevented from moving backwards only if forces $2F_1$, $3F_1$ and $F_1/2$ are exerted on them respectively.

iv. The pressure on the pistons B, C and D are,

piston B: $P_B = \frac{2F_1}{2a_1} = \frac{F_1}{a_1}$

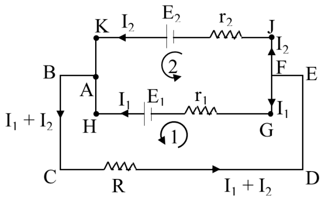
piston C: $P_C = \frac{3F_1}{3a_1} = \frac{F_1}{a_1}$

piston D: $P_D = \frac{F_1/2}{a_1/2} = \frac{F_1}{a_1}$

i.e., $P_A = P_B = P_C = P_D$

v. This shows that the applied pressure on A is transmitted undiminished on pistons B, C and D as required by Pascal's law.

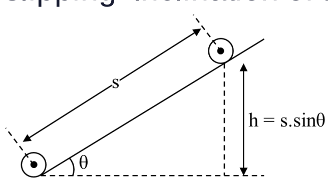
8. **Two cells of emf 1.5 volt and 2 volt having respective internal resistances of 1 Ω and 2 Ω are connected in parallel so as to send current in same direction through an external resistance of 5 Ω. Find the current through the external resistance.**



Current through external resistor is $\frac{5}{17}$ A.

9. **A rigid object is rolling down an inclined plane. Derive expressions for the acceleration along the track and the speed after falling through a certain vertical distance.**

i. Consider a rigid object of mass m and radius R, rolling down an inclined plane, without slipping. Inclination of the plane with the horizontal is θ.



Rolling along an incline

ii. As the objects starts rolling down, its gravitational P.E. is converted into K.E. of rolling.

iii. Starting from rest, let v be the speed of the centre of mass as the object comes down through a vertical distance h.

iv. Total kinetic energy,

$$E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$
$$= \frac{1}{2}mv^2\left(1 + \frac{K^2}{R^2}\right)$$

$\therefore$ E = mgh

$$= \frac{1}{2}mv^2\left(1 + \frac{K^2}{R^2}\right)$$

$$\therefore \quad v = \sqrt{\frac{2gh}{\left(1+\frac{K^2}{R^2}\right)}}$$

v. Linear distance travelled along the plane is

$$s = \frac{h}{\sin\theta}$$

vi. During this distance, the linear velocity has increased from zero to v.

vii. If a is the linear acceleration along the plane,

$$v^2 = u^2 + 2as$$

$$\therefore \quad 2as = v^2 - u^2$$

$$\therefore \quad 2a\left(\frac{h}{\sin\theta}\right) = \frac{2gh}{\left(1+\frac{K^2}{R^2}\right)} - 0$$

$$\therefore \quad a = \frac{g\sin\theta}{\left(1+\frac{K^2}{R^2}\right)}$$

viii. For pure sliding, without friction, the acceleration is g sinθ and final velocity is $\sqrt{2gh}$. Thus, during pure rolling, the factor $\left(1+\frac{K^2}{R^2}\right)$ is effective for both the expressions.

SECTION D

Attempt any ONE question of the following: 4

10. Derive expression for time period of a conical pendulum.

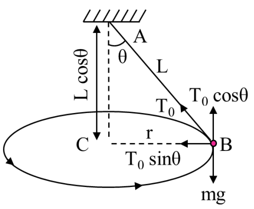
i. Consider the vertical section of a conical pendulum having bob (point mass) of mass m and string of length 'L'.

ii. Here, θ is the angle made by the string with the vertical, at any position (semi-vertical angle of the cone)

iii. In a given position B, the forces acting on the bob are

a. its weight 'mg' directed vertically downwards

b. the force 'T_0' due to the tension in the string, directed along the string, towards the support A.



In an inertial frame

iv. As the motion of the bob is a horizontal circular motion, the resultant force must be horizontal and directed towards the centre C of the circular motion.

v. For this, tension (T_0) in the string is resolved into

a. $T_0 \cos\theta$: vertical component

b. $T_0 \sin\theta$: horizontal component

vi. The vertical component ($T_0 \cos\theta$) balances the weight 'mg'.

∴ $mg = T_0 \cos\theta$ ....(1)

vii. The horizontal component $T_0 \sin\theta$ then becomes the resultant force which is centripetal.

$mr\omega^2 = T_0 \sin\theta$ ....(2)

Dividing equation (2) by equation (1),

$\omega^2 = \frac{g\sin\theta}{r\cos\theta}$ ....(3)

viii. From the figure,

$\sin\theta = \frac{r}{L}$

∴ $r = L\sin\theta$ ....(4)

From equation (3) and (4),

∴ $\omega^2 = \frac{g\sin\theta}{L.\sin\theta.\cos\theta}$

$\omega = \sqrt{\frac{g}{L\cos\theta}}$

ix. If T is the period of revolution of the bob, then

$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{L\cos\theta}}$

∴ Period, $T = 2\pi\sqrt{\frac{L\cos\theta}{g}}$

11. A. **State the applications of Wheatstone bridge.**

i. The Wheatstone bridge is used for measuring the values of very low resistance precisely.

ii. Wheatstone bridge can also measure the quantities such as galvanometer resistance, capacitance, inductance and impedance.

B. **A uniform solid sphere has radius 0.2 m and density 8×10^3 kg/m^3. Find the moment of inertia about the tangent to its surface. ($\pi = 3.142$)**

M.I. of the uniform solid sphere about a tangent to its surface is **15.02 kg m^2.**