Tripura Board
Class XI
Physics
Sample Paper-2 Solution

GROUP-A

1. It is a fundamental unit because it is defined in terms of certain basic, though, arbitrarily chosen standardized reference standard.

2. 1:1, time taken is the same if air resistance is neglected.

3. They are equal if they have the same magnitude and also the same direction.

4. The ratio of their speeds $\frac{v_2}{v_1} = \frac{m_1}{m_2}$

5. Impulse is the change in momentum of a body and it is given by the product of the force and the duration of the force

6. A force for which the work done depends only on the end points is called a conservative force.

7. At 50cm

8. Elasticity and inertia

GROUP-B

9.

$$\frac{\Delta P}{P} = 3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{\Delta d}{d}$$

$$= 3\times 1\% + 2\times 3\% + \frac{1}{2}\times 4\% + 2\%$$

$$= 13\%$$

10.

$$\frac{u^2 \sin^2\theta}{2g} = \frac{u^2 \sin 2\theta}{g}$$

$$Hence\ \sin^2\theta = \sin 2\theta$$

$$\sin^2\theta = 4\sin\theta\cos\theta$$

$$\tan\theta = 4$$

$$\theta = \tan^{-1} 4$$

Or

$$v(t) = \frac{d}{dt}(3.0t\hat{i} + 2.0t^2\hat{j}) = 3.0\hat{i} + 4.0t\hat{j}$$

$$a(t) = 4.0\hat{j}$$

11. Since work done (W) = f s cosθ
Work done by the cycle on the road is zero because the displacement of the road is zero.

12. The angle between these vectors is 180 degrees as they are in opposite direction to each other.
The right hand screw rule gives the direction. Open up your right hand palm and curl the fingers pointing from vector a to vector b. Your outstretched thumb points in the direction of the vector product.

13. The various regions of the spherical shell attract the point mass inside it in various directions. These forces cancel each other out completely so the net force on a point mass inside it is zero.

14.

$$B = \frac{\Delta p}{\Delta V / V}$$

$$\frac{\Delta V}{V} = \frac{0.01}{100}$$

$$\Delta p = 2 atmospheres = 2\times 1.013\times 10^5\ N/m^2$$

$$B = \frac{2\times 1.013\times 10^5}{\frac{0.01}{100}} = 2.026\times 10^9\ N/m^2$$

15. It states that the rate of cooling of a body is proportional to the excess temperature of the body over the surroundings.

$$\frac{dQ}{dt} = k(T_2 - T_1)$$

Where T_1 is the temperature of the surrounding medium and T_2 is the temperature of the body.

GROUP-C

16.

$$v_{rms} = \sqrt{\frac{3RT_1}{M_1}} = \sqrt{\frac{3RT_2}{M_2}}$$

$$\sqrt{\frac{T_1}{M_1}} = \sqrt{\frac{T_2}{M_2}}$$

$$T_1 = \frac{M_1}{M_2}T_2 = \frac{39.9}{4}\times(273-20) = 2.52\times10^3 K$$

17.

i)At maximum height v=0

0 = usinθ-gt

Time of flight T = 2t = $\frac{2u\sin\theta}{g}$

ii) The body falls back to the same height at which it started when it covers its horizontal range. Then derive

$$R = \frac{u^2 \sin 2\theta}{g}$$

18.

The initial kinetic energy of the neutron = $\frac{1}{2}m_1 v^2_{1i}$

The final kinetic energy of the neutron = $\frac{1}{2}m_1 v^2_{1f}$

Use $v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i}$

The fractional kinetic energy lost is

$$f_1 = \frac{K_{1f}}{K_{1i}} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$

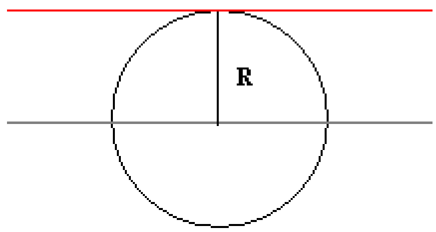
Fractional kinetic energy gained by the nuclei with which it collides is

$$f_2 = 1 - f_1 = 1 - \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \frac{4m_1 m_2}{(m_1 + m_2)^2}$$

If m_1 and m_2 are comparable with each other, the energy transferred is more.

19. The moment of inertia of a rigid body about an axis defined by the formula $I = \sum m_i r_i^2$ where r_i is the perpendicular distance of the i[th] point of the body from the axis.

The moment of inertial about a tangent to the ring in the plane of the ring is the moment of inertia about a diameter parallel to the tangent + Mh^2 where h is the distance between the two parallel axes.



$I = MR^2/2 + MR^2 = 3/2\ MR^2$

20. The change in total energy is

$E_f - E_i$

$$E_i = -\frac{GmM}{2(R+h)} = -\frac{GmM}{2(R+R)} = -\frac{GmM}{4R}$$

$$E_f = -\frac{GmM}{2(R+h)} = -\frac{GmM}{2(R+3R)} = -\frac{GmM}{8R}$$

$$\text{Change in total energy} = \frac{GmM}{8R} = \frac{gmR}{8} = 3.13\times10^9\ \text{J}$$

The kinetic energy of the satellite reduces and it is given by -3.13×10^9 J. The change is potential energy is twice the change in the total energy so change in potential energy is -6.26×10^9 J.

21.

(a) From the given graphs we observe that for a given strain, stress required for A is more than that of B. Hence, Young's Modulus (= Stress/strain) of A is greater than that of B.

(b) Material A is stronger as it can withstand more stress (load) before breaking (fracture) of the material.

Or

Pascal’s law states that whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions.

Pressure = atmospheric pressure + pressure due to the water.

$$P = 1.01\times10^5 + 10(1000)(10) = 2.01\times10^5\,Pa$$

22. In equilibrium, the total energy is equally distributed in all possible energy modes, with each mode having an average energy equal to 1/2kT. This is the law of equipartition of energy.

A diatomic molecule that can be taken as a rigid rotator with 5 degrees of freedom: 3 translational and 2 rotational. Using the law of equipartition of energy the total internal energy of a mole of such a gas is given by

$$U = \frac{5}{2}kT \times N = \frac{5}{2}RT$$

Then molar specific heat at constant volume $C_V = \frac{5}{2}R$

and molar specific heat at constant pressure $C_P = \frac{7}{2}R$

$$Hence\ \frac{C_P}{C_V} = \frac{7}{5}$$

23. If both are travelling towards north then relative velocity of car A w.r.t. B is 60-45 = 15km/h northwards.

If A travels towards north and B travels southwards then velocity of A w.r.t. B is 60-(-45) = 105km/h northwards.

24. Work-energy theorem states that the work done on a particle by a resultant force is equal to the change in its kinetic energy.

$$W = \int F.ds = \int F.\frac{ds}{dt}.dt$$

$$= \int F.v.dt = \int \frac{dK}{dt}.dt = \int dK$$

$$W = K_2 - K_1$$

25. We know that,

$$\vec{F} = \frac{d\vec{P}}{dt} \quad \text{or} \quad \vec{F}dt = d\vec{P}$$

If the impact lasts for a small time dt and the momentum of the body changes from $\vec{P}_1 to \vec{P}_2$ then,

$$\int_0^t \vec{F}dt = \int_{P_1}^{P_2} d\vec{P} = \vec{P}_2 - \vec{P}_1$$

or $\int_0^t \vec{F}dt = \vec{P}_2 - \vec{P}_1$

$\vec{F}$ varies with time and does not remain constant.

$\left(\int_0^t \vec{F}dt\right)$ is a measure of the impulse of the force.

Let $\vec{F}_{av}$ be the constant force during the impact, then $\int_0^t \vec{F}\,dt = \int_0^t \vec{F}_{av}\,dt$

$$= \vec{F}_{av}\int_0^t dt = \vec{F}_{av}\,t$$

$$\therefore \vec{F}_{av}t = \vec{P}_2 - \vec{P}_1$$

Thus, the impulse received during an impact is equal to the total change in momentum produced during the impact.

26.

(a) Padma is responsible, helps her mother in looking after her younger sister.

(b) When small bits of camphor are floated on water, they try to dissolve and reduce surface tension in that region. Consequently the camphor is drawn or pulled aside by the surrounding uncontaminated water of higher surface tension. Due to its irregular shape, camphor dissolves more rapidly at some points than at other points, therefore, the force due to surface tension is not uniform all round, with the result that the camphor pieces dance on the surface of water.

GROUP-D

27. The static frictional force provides the centripetal force. The static friction opposes the impeding motion of the car moving away from the centre of the circle.

The three forces acting on the cyclist are the weight of the cyclist, mg, the normal reaction, N and frictional force, f.

N-mg = 0

So, N = mg.

The maximum permissible speed

$$f \le \mu_s N$$

$$\frac{mv^2}{R} \le \mu_s N$$

$$v^2 \le \frac{\mu_s NR}{m}$$

Put N = mg in above expression

$$v \le \sqrt{\mu_s Rg}$$

Solution for cyclist:

$R = 3m, g = 9.8m/s^2, \mu_s = 0.1$

$\mu_s Rg = 2.94m^2/s^2$

$v = 18km/h = 5m/s$

$v^2 = 25m^2/s^2$

$As\ v^2 is$ not less than $\mu_s Rg$

So the cycle will slip and the cyclist will not be able to negotiate the turn.

Or

(i) Let there be a gas at constant pressure P and volume V. When the pressure increases from P to $P + \triangle p$, the volume decreases from $V to V - \triangle V$.

Bulk modulus, $K = \frac{-V \triangle P}{\triangle V}$

When the gas is impressed isothermally, Boyle's law holds good, i.e.

PV = constant,

Differentiating w. r. t. V, we get

$$P + V\frac{dP}{dV} = 0$$

or $\frac{dP}{-\frac{dV}{V}} = P = K \text{ is} 0$

Thus, the isothermal elasticity of a gas is equal to its pressure.
When the gas is compressed adiabatically, we get

$$PV^\gamma = \text{constant},$$

$$\gamma = \frac{C_P}{C_V}$$

Differentiating w. r. t. V, we get

$$P\gamma V^{\gamma-1} + V^\gamma \frac{dP}{dV} = 0$$

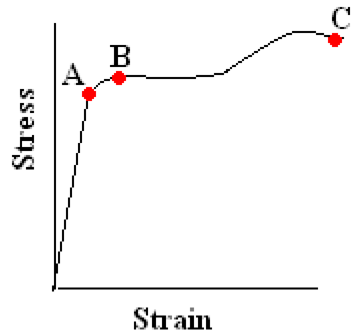
or $\frac{dP}{dV} = -\frac{\gamma P}{V}$

or $\frac{-dP}{\frac{dV}{V}} = \gamma P = k_{adi}$

Thus, the adiabatic elasticity of a gas is γ times the pressure of the gas.

$$\therefore \frac{K_{adi}}{K_{iso}} = \frac{\gamma P}{P} = \gamma$$

28. Hooke's law states that for small deformations, stress is directly proportional to the strain.



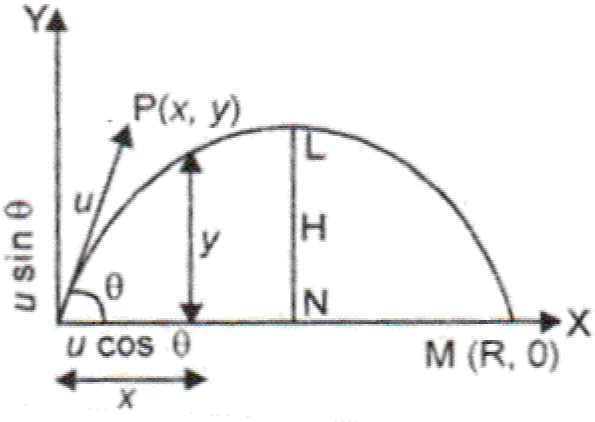
In the region from O to A, the curve is linear. The strain is directly proportional to the stress. Beyond the point A, known as the proportional limit, the relation between stress and strain is not linear.

The point B on the graph is known as the elastic limit. Up to this point stress and strain are not directly proportional but the body returns to its original dimensions if the stress is removed.

Fracture point corresponds to point C on the graph at which the material breaks.

Or

A body thrown up in space and allowed to proceed with effect for gravity alone is called projectile.



Suppose a body is projected with velocity u at an angle θ with the horizontal, P(x, y) is any point on its trajectory at time t. Horizontal component of velocity is unaffected by gravity, but the vertical component (u sin θ) changes due to gravity.

$$x = (u\cos\theta)t$$

$$y = (u\sin\theta)t - \frac{1}{2}gt^2$$

$$= u\sin\theta \times \frac{x}{u\cos\theta} - \frac{1}{2}g\left(\frac{x}{u\cos\theta}\right)^2$$

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

It represents the equation of a parabola, and hence the path followed by a projectile is a parabola.

(i) When the body returns to the same horizontal level y = 0

$$\therefore \quad 0 = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

or $$x\tan\theta = \frac{gx^2}{2u^2\cos^2\theta}$$

or $$x = \frac{2u^2\sin\theta\cos\theta}{g} = \frac{u^2\sin 2\theta}{g}$$

But coordinates of M are (R, 0). Putting x = R,

We have $$R = \frac{u^2\sin 2\theta}{g}$$

(ii) The greatest vertical distance attained by the projectile above the horizontal plane from the point of projection is called maximum height.

Maximum height, LN = H

At maximum, height $v_y = 0$

$$\therefore v_y^2 - u_y^2 = -2gH,$$

where $u_y = u\sin\theta$

or $$(u\sin\theta)^2 = 2gH$$

or $$H = \frac{u^2\sin^2\theta}{2g}$$

29. The equation of displacement of a particle executing SHM at an instant *t* is given as:

$$x = A\sin\omega t$$

Where, *A* = Amplitude of oscillation; *ω* = Angular frequency $\sqrt{\frac{k}{m}}$

The velocity of the particle is:

$$v = \frac{dx}{dt} = A\omega\cos\omega t$$

The kinetic energy of the particle is:

$$E_k = \frac{1}{2}Mv^2 = \frac{1}{2}MA^2\omega^2\cos^2\omega t$$

The potential energy of the particle is:

$$E_p = \frac{1}{2}kx^2 = \frac{1}{2}M\omega^2A^2\sin^2\omega t$$

For time period *T*, the average kinetic energy over a single cycle is given as:

$$\left(E_k\right)_{\text{Avg}} = \frac{1}{T}\int_0^T E_k\ dt$$

$$= \frac{1}{T}\int_0^T \frac{1}{2}MA^2\omega^2\cos^2\omega t\ dt$$

$$= \frac{1}{2T}MA^2\omega^2\int_0^T \frac{\left(1+\cos 2\omega t\right)}{2}dt$$

$$= \frac{1}{4T}MA^2\omega^2\left[t + \frac{\sin 2\omega t}{2\omega}\right]_0^T$$

$$= \frac{1}{4T}MA^2\omega^2\left(T\right)$$

$$= \frac{1}{4}MA^2\omega^2 \qquad \ldots (i)$$

And, average potential energy over one cycle is given as:

$$\left(E_p\right)_{\text{Avg}} = \frac{1}{T}\int_0^T E_p\, dt$$

$$= \frac{1}{T}\int_0^T \frac{1}{2} M\omega^2 A^2 \sin^2 \omega t\, dt$$

$$= \frac{1}{2T} M\omega^2 A^2 \int_0^T \frac{\left(1-\cos 2\omega t\right)}{2}\, dt$$

$$= \frac{1}{4T} M\omega^2 A^2 \left[t - \frac{\sin 2\omega t}{2\omega}\right]_0^T$$

$$= \frac{1}{4T} M\omega^2 A^2 \left(T\right)$$

$$= \frac{M\omega^2 A^2}{4} \qquad \ldots (ii)$$

It can be inferred from equations (*i*) and (*ii*) that the average kinetic energy for a given time period is equal to the average potential energy for the same time period.

Or

For the stationary observer: 400 Hz; 0.875 m; 350 m/s
For the running observer: Not exactly identical

For the stationary observer:
Frequency of the sound produced by the whistle, v = 400 Hz
Speed of sound = 340 m/s
Velocity of the wind, v = 10 m/s

As there is no relative motion between the source and the observer, the frequency of the sound heard by the observer will be the same as that produced by the source, i.e., 400 Hz.

The wind is blowing toward the observer. Hence, the effective speed of the sound increases by 10 units, i.e.,
Effective speed of the sound, v_e = 340 + 10 = 350 m/s

The wavelength (λ) of the sound heard by the observer is given by the relation:

$$\lambda = \frac{v_e}{\nu} - = \frac{350}{400} = 0.875 \text{ m}$$

For the running observer:
Velocity of the observer, v_o = 10 m/s
The observer is moving toward the source. As a result of the relative motions of the source and the observer, there is a change in frequency (ν').

This is given by the relation:

$$\nu' = \left(\frac{v + v_0}{v}\right)\nu$$

$$= \left(\frac{340 + 10}{340}\right) \times 400 = 411.76 \text{ Hz}$$

Since the air is still, the effective speed of sound = 340 + 0 = 340 m/s

The source is at rest. Hence, the wavelength of the sound will not change, i.e., λ remains 0.875 m.
Hence, the given two situations are not exactly identical.