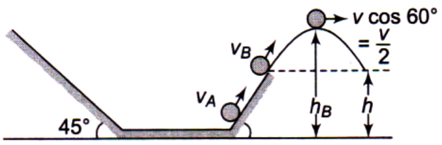
WEEKLY TEST MEDICAL PLUS -01 TEST - 13 BALLIWALA SOLUTION Date 11-08-2019

[PHYSICS]

1.

After collision the balls exchange their velocities, i.e.,

$$v_A = \sqrt{2gh} \text{ and } v_B = \sqrt{2g(4h)} = 2\sqrt{2gh}$$

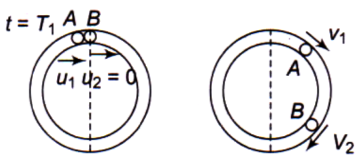


Height attained by A will be: $h_A = \dfrac{v_A^2}{2g} = h$

But path of B will be first straight line and then parabolic as shown in figure. After calculations we can show that: $h_B = \dfrac{13}{4}h$ and $\dfrac{h_A}{h_B} = \dfrac{4}{13}$

2.

$$T_1 = \frac{\pi R}{u_1} \qquad (1)$$



Time taken to collide A and B again:

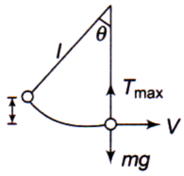
$$T_2 - T_1 = \frac{2\pi R}{v_2 - v_1} \Rightarrow T_2 - T_1 = \frac{2\pi R}{eu_1} \qquad (2)$$

$$(2) \div (1) \Rightarrow \frac{T_2}{T_1} = \frac{2+e}{e}$$

3.

Maximum tension in the string is in its lowest position.

$\therefore$ Speed of mass m in its lowest position is



$$v^2 = 2gh = 2gl(1 - \cos\theta)$$

$$T_{max} - mg = \frac{mv^2}{l}$$

$$T_{max} = mg + 2mg(1 - \cos\theta)$$

$$= mg(3 - \cos\theta)$$

Block of mass 4m does not move.

So $\quad \mu(4mg) \geq T_{max}$

or $\quad 5\mu mg \geq mg(3 - \cos\theta)$ or $\mu \geq \left(\frac{3 - \cos\theta_0}{4}\right)$

4.

Let required angle is θ.

Work done = change in KE

$\Rightarrow \quad Fs\cos\theta = 40 - 0$

$\Rightarrow \quad 20 \times 4\cos\theta = 400 \Rightarrow \theta = 60°$

5.

$KE + PE = \text{constant} \Rightarrow \frac{1}{2}mv^2 + mgh = C$

$\Rightarrow \quad \frac{v^2}{2} + gh = \frac{C}{m} = \text{constant}$

6.

$P = \frac{mgh}{t}$ or $m = \frac{P \times t}{g \times h}$

$m = \frac{3000\text{ W} \times 60\text{ s}}{10\text{ ms}^{-2} \times 10\text{ m}} = 1200\text{ kg} = 1200\text{ litre}$

7.

$F = \frac{-dU}{dx}$ it is clear that slope of $U - x$ curve is zero at point B and C. $\therefore$ $F = 0$ for point B and C

8.

Let tension at lowest point is T_L and at highest point is T_H. Given $\frac{T_L}{T_H} = 4$

We know that $T_L - T_H = 6$ mg

Solve there equation to find T_H and then apply

$T_H = -mg + \frac{mv_H^2}{l}$ to get the value of v_H

9.

Let, M = mass of man, m = mass of boy

V = speed of man, v = speed of boy

Given: $\frac{1}{2}MV^2 = \frac{1}{2}\left(\frac{1}{2}mv^2\right)$, As $m = \frac{M}{2}$

So $\frac{1}{2}MV^2 = \frac{1}{2}\left(\frac{1}{2} \times \frac{M}{2}v^2\right)$

Hence, $v^2 = 4V^2$ or $v = 2$ V

When the man speeds up by 1 m/s, then we get

$$\frac{1}{2}M(V+1)^2 = \frac{1}{2}mv^2 = \frac{1}{2}\frac{M}{2}(4V^2)$$

or $(V+1)^2 = 2V^2$ or $V^2 - 2V - 1 = 0$

Solving we get: $V = 2.4$ ms^{-1} and $v = 2$V $= 4.8$ ms^{-1}

10.

Let v be the velocity with which the bullet will emerge. Now, change in kinetic energy = work done

For first case: $\frac{1}{2}m(100)^2 - \frac{1}{2}m(0)^2 = F \times 1$ (i)

For second case: $\frac{1}{2}m(100)^2 - \frac{1}{2}mv^2 = F \times 0.5$ (ii)

Dividing equation (ii) by (i), we get

$$\frac{(100)^2 - v^2}{(100)^2} = \frac{0.5}{1} = \frac{1}{2} \text{ or } v = \frac{100}{\sqrt{2}} = 50\sqrt{2} \text{ m/s}$$

11.

Suppose F be the resistance force offered by the plank. Let thickness of plank be x.

For first case: $Fx = \frac{1}{2}m[(100)^2 - (80)^2]$ (i)

For second case, let V be the final velocity of bullet;

then $Fx = \frac{1}{2}m[(80)^2 - V^2]$ (ii)

From (i) and (ii) $80^2 - V^2 = 100^2 - 80^2$

or $V = 20\sqrt{7}$ m/s

12.

Let ball rebound with speed v, so

$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20 \text{ m/s}$$

Energy just after rebound

$$E = \frac{1}{2} \times m \times v^2 = 200 \text{ m}$$

50% energy loses in collision means just before collision energy is 400 m

By using energy conservation,

$$\frac{1}{2} mv_0^2 + mgh = 400 \text{ m}$$

$$\Rightarrow \quad \frac{1}{2} mv_0^2 + m \times 10 \times 20 = 400 \Rightarrow v_0 = 20 \text{ m/s}$$

13.

Pressure = 150 mm Hg

Pumping rate $= \frac{dV}{dt} = \frac{5 \times 10^{-3}}{60} \text{ m}^3/\text{s}$

Power of heart $P \cdot \frac{dV}{dt} = \rho gh \times \frac{dV}{dt}$

$$= (13.6 \times 10^3 \text{ kg/m}^3)(10) \times (0.15) \times \frac{5 \times 10^{-3}}{60}$$

$$= \frac{13.6 \times 5 \times 0.15}{6} = 1.70 \text{ watt}$$

14.

When minimum speed of body is $\sqrt{5gR}$, then no matter from where it enters the loop, it will complete full vertical loop.

15.

Both fragments will possess the equal linear momentum

$$m_1 v_1 = m_2 v_2 \Rightarrow 1 \times 80 = 2 \times v_2 \Rightarrow v_2 = 40 \text{ m/s}$$

$\therefore$ Total energy of system

$$= \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

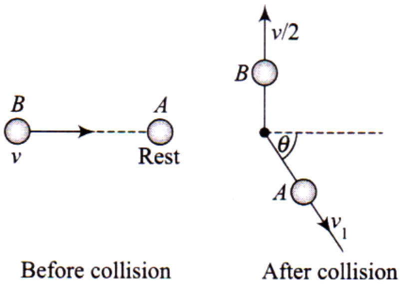
$$= \frac{1}{2} \times 1 \times (80)^2 + \frac{1}{2} \times 2 \times (40)^2$$

$$= 4800 \text{ J} = 4.8 \text{ kJ}$$

16.

17.

Let velocity of A is v_1 at angle θ with initial direction of motion of B.



$m_1 v_1 \cos\theta = m_2 v$ ...(i)

$m_1 v_1 \sin\theta = m_2 v/2$ ...(ii)

Divide: (ii) by (i) $\tan\theta = \frac{1}{2} \Rightarrow \theta = \tan^{-1}\frac{1}{2}$

18.

Applied force $\vec{F} = 3\hat{i} + \hat{j}$

Displacement $\vec{S} = \vec{r}_2 - \vec{r}_1 = 2\hat{i} + 3\hat{j} - 2\hat{k}$

Hence work done $W = \vec{F}\cdot\vec{S} = 6 + 3 + 0 = 9$ J

19.

Initial linear momentum $= P_i = 0$

Final momentum $P_f = 0 = m\upsilon\hat{i} + m\upsilon\hat{j} + \vec{P}_3$

$\Rightarrow \quad P_3 = m\upsilon\sqrt{2}$

Total KE $= \frac{P_3^2}{2\times 2m} + \frac{1}{2}m\upsilon^2 + \frac{1}{2}m\upsilon^2$

$= \frac{2\,m^2\upsilon^2}{4m} + m\upsilon^2 = \frac{3\,m\upsilon^2}{2}$

20.

Power $k = F\cdot v = (ma)v = m\frac{dv}{dt}v = mv\frac{dv}{dt}$

Rearranging we get, $vdv = \frac{k}{m}dt$

Integrating both side,

$$\int_0^v vdv = \frac{k}{m}\int_0^t dt \Rightarrow \frac{v^2}{2} = \frac{k}{m}t$$

$\Rightarrow \quad v = \sqrt{\frac{2\,kt}{m}}$ (i)

Force acting on particle $F = m\dfrac{dv}{dt}$ (ii)

Differentiating equation (i) w.r.t time

$$\frac{dv}{dt} = \left(\sqrt{\frac{2k}{m}}\right)\frac{dt^{1/2}}{dt} = \left(\sqrt{\frac{2k}{m}}\right)\frac{1}{2}t^{-1/2}$$

$$= \left(\sqrt{\frac{k}{2m}}\right)t^{-1/2}$$

Subsituting the value of $\dfrac{dv}{dt}$ in equation (ii) we get

$$F = m\frac{dv}{dt} = m\left(\sqrt{\frac{k}{2m}}\right)t^{-1/2} = \left(\sqrt{\frac{mk}{2}}\right)t^{-1/2}$$

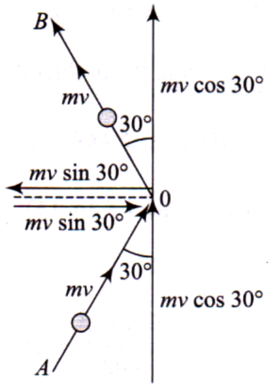
21.

The vector $\vec{OA}$ represents the momentum of the object before the collision, and the vector $\vec{OB}$ that after the collision. The vector $\vec{AB}$ represents the change in momentum of the object $\Delta\vec{P}$. As the magnitudes of $\vec{OA}$ and $\vec{OB}$ are equal, the components of $\vec{OA}$ and $\vec{OB}$ along the wall are equal and in the same direction, while those perpendicular to the wall are equal and opposite. Thus, the change in momentum is due only to the change in direction of the perpendicular components.

Hence, $\Delta p = OB\sin 30° - (-OA\sin 30°)$

$= mv\sin 30° - (-mv\sin 30°)$

$= 2mv\sin 30°$



Its time rate will appear in the form of average force acting on the wall.

$$F \times t = 2\,mv \sin 30°$$

Or $$F = \frac{2\,mv \sin 30°}{t}$$

Given, $m = 0.5$ kg, $v = 12$ m/s, $t = 0.25$ s

$$\theta = 30°$$

Hence, $F = \frac{2 \times 0.5 \times 12 \sin 30°}{0.25} = 24$ N

22.

Net work done in sliding a body up to a height h on inclined plane

= Work done against gravitational force

+ Work done against frictional force

$\Rightarrow$ $W = W_g + W_f$ (i)

but $W = 300$ J

$W_g + mgh = 2 \times 10 \times 10 = 200$ J

Putting in Eq. (i), we get

$$300 = 200 + W_f$$

$$W_f = 300 - 200 = 100 \text{ J}$$

23.

In the given problem, conservation of linear momentum and energy hold good.

Conservation of momentum yields.

$$m_1 v_1 + m_2 v_2 = 0$$

or $4v_1 + 0.2\,v_2 = 0$ (i)

Conservation of energy yields

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = 1050$$

or $\frac{1}{2} \times 4v_1^2 + \frac{1}{2} \times 0.2 \times v_2^2 = 1050$

or $2v_1^2 + 0.1\,v_2^2 = 1050$ (ii)

Solving Eqs. (i) and (ii), we have

$$v_1 = 100 \text{ m/s}$$

24.

Apply law of conservation of linear momentum,

Momentum of first part = $1 \times 12 = 12$ kg ms^{-1}

Momentum of the second part = $2 \times 8 = 16$ kg ms^{-1}

$\therefore$ Resultant momentum

$$= \sqrt{(12)^2 + (16)^2} = 20 \text{ kg ms}^{-1}$$

The third part should also have the same momentum.

Let the mass of the third part be M, then

$$4 \times M = 20$$

$$M = 5 \text{ kg}$$

25.

If two bodies collide head on with coefficient of restitution

$$e = \frac{v_2 - v_1}{u_1 - u_2} \quad \text{...(i)}$$

From the law of conservation of linear momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\Rightarrow \quad v_1 = \left[\frac{m_1 - em_2}{m_1 + m_2}\right]u_1 + \left[\frac{(1+e)\,m_2}{m_1 + m_2}\right]u_2$$

Substiuting $u_1 = 2$ ms^{-1}, $u_2 = 0$, $m_1 = m$ and $m_2 = 2\,m$, $e = 0.5$

We get $v_1 = \dfrac{m - m}{m + 2m} \times 2$

$$\Rightarrow \quad v_1 = 0$$

Similarly, $v_2 = \left[\dfrac{(1+e)\,m_1}{m_1 + m_2}\right]u_1 + \left[\dfrac{m_2 - em_1}{m_1 + m_2}\right]u_2$

$$= \left[\frac{1.5 \times m}{3m}\right] \times 2 = 1 \text{ ms}^{-1}$$

26.

Amount of water flowing per second from the pipe

$$= \frac{m}{\text{time}} = \frac{m}{l} \cdot \frac{l}{t} = \left(\frac{m}{l}\right)v$$

Power = KE of water flowing per second

$$= \frac{1}{2}\left(\frac{m}{l}\right)v \cdot v^2 = \frac{1}{2}\left(\frac{m}{l}\right)v^3$$

$$= \frac{1}{2} \times 100 \times 8 = 400 \text{ W}$$

27.

We know $P = \vec{F} \cdot \vec{v} = Fv \cos \theta$

So just before hitting θ is zero and both F and v are maximum.

28.

$\frac{1}{2} kS^2 = 10$ J (given in the problem)

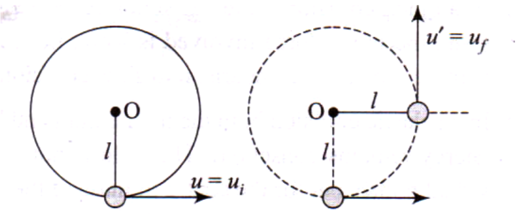
$\frac{1}{2} k[(2S)^2 - (S)^2] = 3 \times \frac{1}{2} kS^2 = 3 \times 10 = 30\ J$

29.

$U \propto x^2$

$\Rightarrow \quad \frac{U_2}{U_1} = \left(\frac{x_2}{x_1}\right)^2 = \left(\frac{0.1}{0.02}\right)^2 = 25 \quad \therefore \quad U_2 = 25\ U$

30 Using conservation of mechanical energy at initial and final position.



$\Delta K + \Delta U = 0$

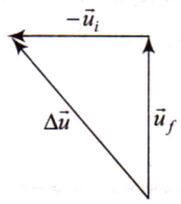
$\left(\frac{1}{2} mu'^2 - \frac{1}{2} mu^2\right) + (mgl) = 0$

or $\quad u'^2 = u^2 - 2gl$

or $\quad u' = \sqrt{u^2 - 2gl} \quad$ (i)

So, the magnitude of change in velocity

$\Delta\vec{u} = \vec{u}_f - \vec{u}_i = \vec{u}_f + (\vec{u}_i)$



$|\Delta\vec{u}| \;=\; \sqrt{u'^2 + u^2} = \sqrt{(u^2 - 2gh) + u^2}$

$= \sqrt{2(u^2 - gl)}$

31.

Work done = Area enclosed by $F - x$ graph

$= \frac{1}{2} \times (3 + 6) \times 3 = 13.5$ J

32.

Work done by the force

= Force × Displacement

or $W = F \times s$ (i)

But from Newton's 2nd law, we have

Force = Mass × Acceleration

i.e., $F = ma$ (ii)

Hence, from Eqs. (i) and (ii), we get

$$W = mas = m\left(\frac{d^2s}{dt^2}\right)s \quad \text{(iii)}$$

$$\left(\therefore\ a = \frac{d^2s}{dt^2}\right)$$

Now, we have, $s = \frac{1}{3}t^2$

$$\frac{d^2s}{dt^2} = \frac{d}{dt}\left[\frac{d}{dt}\left(\frac{1}{3}t^2\right)\right]$$

$$= \frac{d}{dt}\times\left(\frac{1}{3}t\right) = \frac{2}{3}\frac{dt}{dt} = \frac{2}{3}$$

Hence, Eq. (iii) becomes

$$W = \frac{2}{3}ms = \frac{2}{3}m\times\frac{1}{3}t^2 = \frac{2}{9}mt^2$$

We have given $m = 3$ kg, $t = 2s$

$$\therefore \quad W = \frac{2}{9}\times 3\times(2)^2 = \frac{8}{3}\text{ J}$$

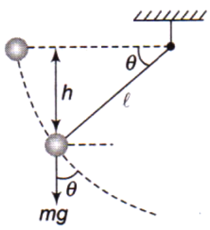
33.

From conservation of energy $\Delta K + \Delta U = 0$

$$mgh = \frac{1}{2}mv^2\ mgl\sin\theta = \frac{1}{2}mv^2$$

$$\Rightarrow \quad a_C = 2g\sin\theta = \frac{v^2}{l} = \text{radial acceleration}$$

$$g\cos\theta = a_t = \text{tangential acceleration}$$



Total acceleration

$$a = \sqrt{a_c^2 + a_t^2} = g\sqrt{\cos^2\theta + (2\sin\theta)^2}$$

$$= g\sqrt{(1-\sin^2\theta) + 4\sin^2\theta} = g\sqrt{1 + 3\sin^2\theta}$$

34.

$$mgl = \frac{1}{2}mu^2 \Rightarrow u^2 = 2g \qquad \text{(i)}$$

$$v^2 = u^2 + 2as \Rightarrow 0 = 2g - 2a(3)$$

$$\Rightarrow \quad a = \frac{g}{3} \Rightarrow \mu_k g = a$$

$$\therefore \quad \mu_k g = \frac{g}{3} \quad \therefore \mu_k = \frac{1}{3}$$

35.

$$W_{\text{spring}} + W_{100\text{ N}} = \Delta k \text{ (on A)}$$

$$W_{\text{spring}} + (100)\left(\frac{10}{100}\right) = \frac{1}{2}(2)(2)^2$$

$$W_{\text{spring}} = 4 - 10 = -6 \text{ J}$$

36.

Total energy at the time of throwing the ball

$$= mgh + \frac{1}{2}mv_0^2$$

Energy after collision with ground

$$= \frac{1}{2}\left(mgh + \frac{1}{2}mv_0^2\right)$$

The ball again rises to height h.

$$\therefore \quad \frac{1}{2}\left(mgh + \frac{1}{2}mv_0^2\right) = mgh$$

or $\quad mgh + \frac{1}{2} = 2mgh$

or $\quad \frac{1}{2}mv_0^2 = mgh \text{ or } v_0 = \sqrt{2gh}$

37.

By energy conservation

$$mgR(1 + \cos 30°) = \frac{1}{2}k\left(\frac{\pi R}{6}\right)^2$$

$$\Rightarrow \quad k = \frac{36mg(2 + \sqrt{3})}{\pi^2 R}$$

38.

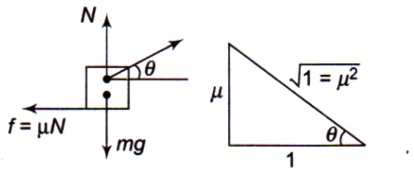
We applying force F therefore tension in string is $T = F$, Hence force acting on weight is $2F$ upward, and displacement is h upward.

Hence $W = 2Fh$ (work done on weight)

39.

The work done by the force F is

$$W = F_{min}\, x \cos\theta \qquad \text{(i)}$$



$$\cos\theta = \frac{1}{\sqrt{1+\mu^2}}, \qquad \sin\theta = \frac{\mu}{\sqrt{1+\mu^2}}$$

F is minimum when $\tan\theta = \mu$ (ii)

$$F_{min} = mg\sin\theta \qquad \text{(iii)}$$

Using equations (i) and (iii),

$$W = (mg\sin\theta)\times\cos\theta$$

$$= mg\cdot\frac{\mu}{\sqrt{1+\mu^2}}\, x\, \frac{1}{\sqrt{1+\mu^2}} = \frac{\mu mgx}{1+\mu^2}$$

40.

Initial velocity of the particle, $v_1 = 20$ m/s
Final velocity of the particle, $v_f = 0$

From work energy theorem

$$W_{net} = \Delta\text{K.E.} = K_f - K_i$$

$$= \frac{1}{2}m(v_f^2 - v_i^2) = \frac{1}{2}(2)(0-400) = -400 \text{ J}$$

41.

Let x be the extension in the spring when 2 kg block leaves the contact with ground.

Then, $kx = 2$ g

$$x = \frac{2g}{k} = \frac{2\times 10}{40} = \frac{1}{2}\text{m}$$

Now from conservation of mechanical energy

$$mgx = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 \qquad (m = 5 \text{ kg})$$

$$v = \sqrt{2gx - \frac{kx^2}{m}}$$

Substituting the values

$$v = \sqrt{2\times 10\times\frac{1}{2} - \frac{(40)}{4\times 5}} = 2\sqrt{2} \text{ m/s}$$

42.

Increase in height of block, $h = a \sin \theta$

Increase in length of spring, $x = a\theta$

Work done by $p = mgh + \; p = mgh + \frac{1}{2}kx^2$

$$= Wa \sin\theta + \frac{1}{2}ka^2\theta^2$$

43.

44.

$$m_1 V = m_2 V_2 - m_1 \frac{V}{10} \quad \text{(i)}$$

$$e = 1 = \frac{V_2 - (-V/10)}{V - 0}$$

or $V_2 + \frac{V}{10} = V$ (ii)

From eqn. (i), $\frac{m_1}{m_2}V = V_2 - \frac{V}{10}\frac{m_1}{m_2}$

From eqn. (ii), $\frac{m_1}{m_2}V = \left(V - \frac{V}{10}\right) - \frac{V}{10}\frac{m_1}{m_2}$

or $11m_1 = 9m_2 \Rightarrow m_2 > m_1$

45.

Fraction of KE lost in collision

$$\Delta K\% = \frac{\frac{1}{2}mu^2 - \frac{1}{2}mv^2}{\frac{1}{2}mu^2} = 1 - \left(\frac{v}{u}\right)^2 = \frac{1}{4}\text{(given)}$$

$$v = u\sqrt{\frac{3}{4}} \quad \text{(i)}$$

The ball strikes at 45°. Component of velocity parallel to wall ($u \cos 45°$) will not change while component of velocity normal to wall will change.

$$v_x = u \cos 45° = \frac{u}{\sqrt{2}}$$

$$v_y = eu \cos 45° = \frac{eu}{\sqrt{2}}$$

$$v = \sqrt{v_x^2 + v_y^2} = \left[\left(\frac{u}{\sqrt{2}}\right)^2 + \left(\frac{eu}{\sqrt{2}}\right)^2\right]^{\frac{1}{2}}$$

$$\Rightarrow \quad v = u\left[\frac{1}{2} + \frac{e^2}{2}\right]^{\frac{1}{2}} \quad \text{(ii)}$$

Solving (i) and (ii), we get

$$e = \frac{1}{\sqrt{2}}$$

46. In an adiabatic change, no heat is exchanged between the system and the surroundings.

47. : State function

48. Based on the first law of thermodynamics,
$\Delta U = q + w$
Change in internal energy for a cyclic process is zero, *i.e.*
$\Delta U = 0$.
$\therefore \quad q = -w$

49.

50. $\Delta E = q + W$, ΔE is a state function.

51. Since vessel is thermally insulated, i.e., the process is the process is adibatic hence, q = 0
Also, $P_{ext} = 0$, hence w = 0
From 1st law of thermodynamics, $\Delta E = q + w$
$\therefore \quad \Delta E = 0$ (for ideal gas)
$\therefore \quad \Delta T = 0$ or $T_2 = T_1$

[$\because$ Internal energy of an ideal gas is a function of temperature.]
Applying ideal gas equation, $PV = nRT$
where n, R and T are constant.
then $P_1V_1 = P_2V_2$
Equation, PV^{γ} = constant, is applicable only for ideal gas in reversible adiabatic process.
Hence, $P_2V_2^{\gamma} = P_1V_1^{\gamma}$ equation is not applicable.

52. As it absorbs heat, $q = +\,208$ J

$$w_{rev} = -2.303\,nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$w_{rev} = -2.303\times(0.04)\times8.314\times310\ \log_{10}\left(\frac{375}{50}\right)$$

$$\therefore \quad w_{rev} = -\,207.76 \approx -\,208\text{ J}$$

53. For isothermal reversible expansion of an ideal gas volume V_1 to V_2 the work done is given as :

54. $T_3 < T_1$ because cooling takes place on adibatic expansion. Hence, (b) is incorrect.

55. For adiabatic expansion, $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$

Here, for CO_2 (triatomic gas), $\gamma = 1.33$

$$\therefore \quad \left(\frac{150}{300}\right) = \left(\frac{10}{V_2}\right)^{0.33}$$

$$\text{or} \quad \left(\frac{1}{2}\right) = \left(\frac{10}{V_2}\right)^{0.33} \Rightarrow \left(\frac{1}{2}\right)^3 = \frac{10}{V_2} \Rightarrow \frac{1}{8} = \frac{10}{V_2} \Rightarrow V_2 = 80\text{ L}$$

56 $W = -2.303nRT\log\frac{V_2}{V_1}$

$= -2.303 \times 1 \times 8.314 \times 300 \times \log\frac{20}{10}$

$= -2.303 \times 8.314 \times 300 \times 0.3010 = -1729$ joules

Work done = – 1729 joules

57. Volume depends on the mass of the system.

58. Given : Standard heat of vaporisation,

$\Delta H_v^\circ = 40.79$ kJ mol^{-1}; Mass of water = 80 g

No. of moles of water $= \frac{80 \text{ g}}{18 \text{ g mol}^{-1}} = 4.44$ mol

Now, heat required to vaporise one mole of water = 40.79 kJ

∴ Heat required to vaporise 4.44 moles of water

$= 4.44 \times 40.79 = 1.81 \times 10^2$ kJ

59.

60. No work is done along the path AB because this process is isochoric (for isochoric process V = 0

∴ work done = PdV = 0).

Thus, the work done $dw = P_B(V_D - V_A)$

$= 8\times10^4(5\times10^{-3} - 2\times10^{-3})$

$= 8\times10^4 \times 3\times10^{-3}\text{ J} = 240$ J

The energy absorbed by the system

$= (dq)_{AB} + (dq)_{BC} = 600 + 200 = 800$ J

The change in internal energy $dE = dq - dw$

$dE = 800 - 240 = 560$ J

61. $W = -\Delta 2.303\ \Delta nRT\ \log\frac{P_1}{P_2}$

$W = -2.303 \times 1 \times 0.082 \times 300 \text{lof}\frac{1}{10}$

$W = -1381.9$ cal

62. Latent heat $dQ = dE + P\Delta V$

or $dQ = dE + \Delta n_g RT$

Given, $dQ = 10$ kcal/mole

$dE = ?$

$\Delta n_g = 3$, $T = 227 + 273 = 500K$,

$R = 2\times10^{-3}$ kcal/mole/K

∴ $dE = dQ - \Delta n_g RT$

⇒ $dE = 10 - 3 \times \frac{2}{1000} \times 500 = 7$ kcal

63. From first law of thermodynamics,

we have, $dq = dE + PdV$

or $dE = dq - PdV = 200 - 2\times10^5 \times 500 \times 10^{-6}$

$dE = 200 - 100 = 100$ J

64. As internal energy is a function of temperature, therefore $\Delta U = 0$

65.

66. For an adiabatic process neither heat enters or leaves the system

$\therefore \quad q = 0$.

67.

ΔE and ΔH both are zero in case of cyclic process. [Also, for isothermal free or reversible expansion of ideal gas, ΔE and ΔH both are zero].

68.

69.

In case of thermodynamic equilibrium $\Delta V, \Delta P, \Delta T$ and Δn all have to be zero.

70.

71.

1 litre-atm = 24.2 calorie

1 calorie = 4.1868 joule

1 joule = 10^7 erg

72.

The minimum extra energy supplied to reactants to make their energy equal to threshold energy is called **activation energy.**

73.

$$W_{\text{expansion}} = -P\Delta V$$

$$= -(1\times 10^5 \text{Nm}^{-2})[(1\times 10^{-2} - 1\times 10^{-3})\text{m}^3]$$

$$= -10^5 \times (10\times 10^{-3} - 1\times 10^{-3})\text{Nm}$$

$$= -10^5 \times 9\times 10^{-3}\text{J} = -9\times 10^2\text{J} = \mathbf{-900\ J}$$

74.

$q = 300$ calorie

$W = -P\,\Delta V = -1\times 10$ litre-atm $= -10\times 24.2$ cal $= -242$ cal

$\Delta E = q + W = 300 - 242 = \mathbf{58\ cal}$

75.

$W_{\text{rev}} > W_{\text{irrev}}$; Thus, there will be more cooling in reversible process.

76.

For isothermal reversible expansion $W = -2.303\, nRT \log \dfrac{P_1}{P_2}$

For all factors being same, $W \propto \dfrac{1}{\text{Molecular weight}}$

NO and $\mathbf{C_2H_6}$ both have equal molecular weights 30 g mol^{-1}.

77.

$q = \mathbf{+200\ J}$

$W = -P\Delta V = -1\times(20-10) = -10$ atm L

$= -10\times 101.3\text{ J} = \mathbf{-1013\ J}$

$\Delta E = q + W = (200 - 1013)\text{ J} = \mathbf{-813\ J}$

78.

79.

ΔH for isothermal free expansion is **zero.**

80.

ΔH for isothermal reversible expansion is **zero.**

81.

$$W = -2.303 nRT \log \frac{V_2}{V_1}$$

$$= -2.303 \times 2 \times 8.314 \times 300 \times \log \frac{50}{5} \text{ joule}$$

$$= -11488.285 \text{ J} \simeq -\mathbf{11.5\ kJ}$$

82.

$$q = +40.65 \text{ kJ mol}^{-1}$$

$$W_{exp.} = -3.1 \text{ kJ}$$

$$\Delta E = q + W$$

$$= 40.65 - 3.1 = \mathbf{37.55\ kJ}$$

83.

In cyclic system, $\Delta E = 0$, $\Delta H = 0$.

Work done by the system = – 550 kJ.

$$\Delta E = q + W$$

$$\Rightarrow \quad 0 = q - 550 \quad \Rightarrow \quad q = \mathbf{550\ kJ}$$

84.

As the system starts from A and reaches to A again, whatever the stages may be net energy change is **zero**.

85.

$$\frac{V_2}{V_1} = \frac{1}{10}$$

$$W \text{ (on the system)} = -2.303 nRT \log \frac{V_2}{V_1} = -2.303 \times 1 \times 2 \times 500 \log \frac{1}{10} \text{ cal}$$

$$= +\frac{2.303 \times 2 \times 500}{1000} \text{ kcal} = \mathbf{+\ 2.303\ kcal}$$

88. (c) During isothermal expansion of an ideal gas against vacuum is zero because expansion is isothermal. The reason, that volume occupied by the molecules of an ideal gas is zero, is false.

89. (a) it is fact that absolute values of internal energy of substances can not be determined. It is also true that to determine exact values of constituent energies of the substance is impossible.

90. (b) Mass and volume are extensive properties. mass/volume is also an extensive parameter. Here, both assertion and reason are true.