PART-A-PHYSICS

SECTION-I(i)

1) In the system shown in figure, the ground is frictionless, the blocks have mass m and 2 m and the string connecting them is massless. If you accelerate the system to the right, as shown, the tension is the same everywhere throughout the string connecting the masses because

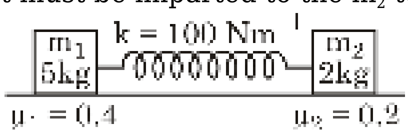
(A) The string is massless

(B) The ground is frictionless

(C) The ratio of the masses is 2 : 1

(D) The acceleration of the system is non-zero.

2) Two blocks m_1 = 5kg and m_2 = 2kg are connected at the two ends of a spring of force constant k = 100 Nm^{-1}. Friction coefficient between m_1 and ground is 0.4, and between m_2 and ground is 0.2. The minimum horizontal velocity v that must be imparted to the m_2 towards right in order to just move m_1 over surface is : (g = 10m/s^2)



(A) $\sqrt{1.4}$ m/s

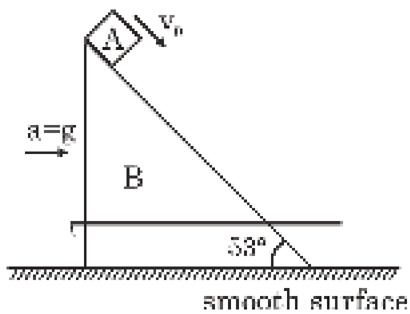
(B) $\sqrt{1.8}$ m/s

(C) $\sqrt{2.2}$ m/s

(D) $\sqrt{2.8}$ m/s

3) Block A is placed on a rough wedge B which is placed on a smooth surface. The wedge has angle of inclination of 53° and is imparted a horizontal acceleration g towards right. Block A is given an initial velocity v_0 with respect to wedge. Find the coefficient of friction for which block A moves with

0



constant velocity v with respect to wedge. (g = 10 m/s^2)

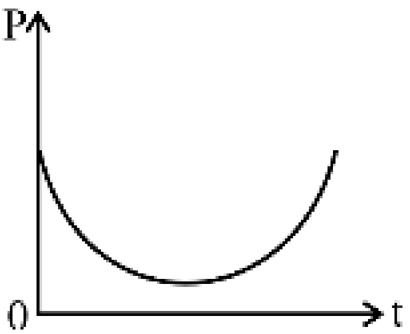
(A) 2/7

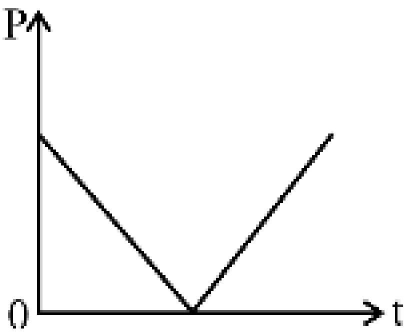
(B) 3/7

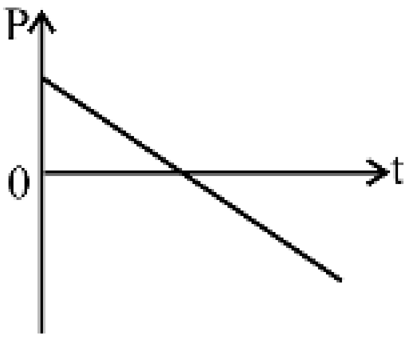
(C) 4/7

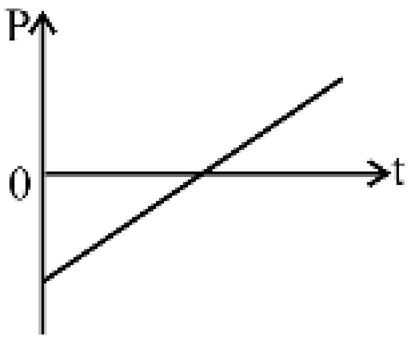
(D) 1/7

4) A stone is projected at time t = 0 with a speed V_0 and an angle θ with the horizontal in a uniform gravitational field. The rate of work done (P) by the gravitational force plotted against time (t) will be :

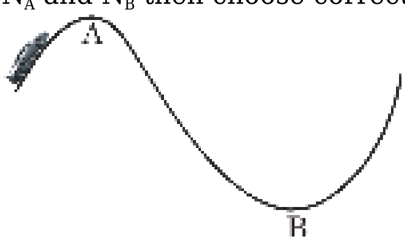
(A)


(B)


(C)


(D)


5) A car of mass m moves in vertical plane with constant speed v. Normal force on car at A and B are N_A and N_B then choose correct option. Radius of curvature at A and B are R_A and R_B :-



(A) $\frac{v^2}{R_A}$ must be greater than or equal to g

(B) $\frac{v^2}{R_A}$ must be less than g.

(C) $\frac{v^2}{R_B}$ must be greater than g.

(D) $\frac{v^2}{R_B}$ must be less than g.

6) A particle is projected with a speed u at an angle θ with the horizontal, Consider a small part of its path near the highest position and take it approximately to be a circular arc, What is the radius of this circle? (This radius is called the radius of curvature of the curve at the point) :

(A) $\frac{u^2\sin^2\theta}{g}$

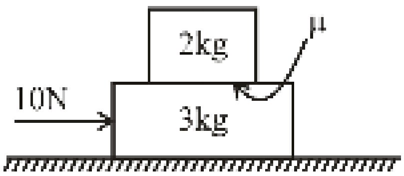
(B) $\frac{u^2\cos^2\theta}{g}$

(C) $\frac{u^2\tan^2\theta}{g}$

(D) $\frac{u^2}{g}$

SECTION-I(ii)

1) A block of mass 3 kg is placed on a smooth horizontal surface. A small block of mass 2 kg is placed over the 3 kg block. Now a force of 10 N is acted upon 3 kg blocks. For both blocks to move together let friction cofficient between block have minimum value of $\mu = \mu_0$. Then choose **CORRECT** statement :



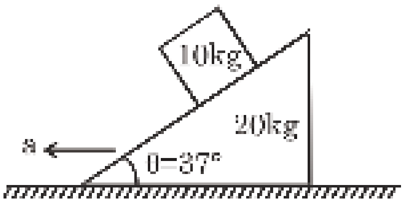
(A) $\mu_0 = 0.1$

(B) $\mu_0 = 0.2$

(C) If same force acted upon 2 kg block instead of 3 kg block and μ_0 exists between 2 kg and 3 kg block then acceleration of 2 kg block is 3 m/sec^2

(D) If same force acted upon 2 kg block instead of 3 kg block and μ_0 exists between 2kg and 3 kg block then acceleration of 3 kg block is $\frac{3}{4}$ m/sec^2.

2) A block of mass 10 kg is at rest on a frictionless wedge. Angle of inclination of wedge is 37°. Wedge is moved towards left with a constant acceleration so that 10kg block remains in equilibrium as shown in diagram. Mass of wedge is 20 kg. Select the **CORRECT** statement(s):



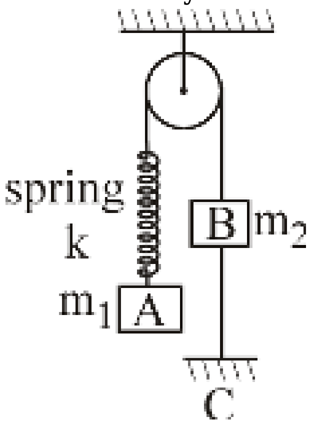
(A) Rate of change of momentum of system (block + wedge) is equal to 215N

(B) a = 7.5 m/s^2

(C) kinetic energy of block is increasing with rate 562.5t, where t is time in sec.

(D) Work done by normal of block on the wedge is negative.

3) In the system shown in the figure $m_1 > m_2$. System is held at rest by thread BC. Just after the thread BC is burnt : Which of the following is incorrect.



(A) initial acceleration of m_2 will be upwards

(B) magnitude of initial acceleration of both blocks will be equal to $\left(\frac{m_1 - m_2}{m_1 + m_2}\right)g$.

(C) initial acceleration of m_1 will be equal to zero

(D) magnitude of initial acceleration of two blocks will be non-zero and unequal.

4) A particle is revolving around a circle of fixed radius r, centre of circle is at point O and position vector of particle w.r.t O is $\vec{r}$, where $\vec{v}$ is velocity, $\vec{a}$ is acceleration and $\vec{\omega}$ is angular velocity.

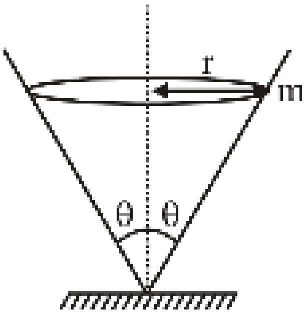
(A) $\vec{r} \cdot \vec{\omega} = 0$

(B) $\frac{\vec{v} \times \vec{\omega}}{|\vec{v} \times \vec{\omega}|} = \hat{r}$

(C) $\vec{a} \cdot \vec{\omega} = 0$

(D) $\vec{r} \cdot \vec{v} = 0$

5) A ball of mass 'm' is rotating in a circle of radius 'r' with speed v inside a smooth cone as shown in figure. Let N be the normal reaction on the ball by the cone, then choose the correct option.



(A) N = mgcosθ

(B) $g\cos\theta = \frac{v^2}{r}\sin\theta$

(C) $N\cos\theta = \frac{mv^2}{r}$

(D) N = mgsinθ

6) Position vector of a particle is given as $\vec{r} = A\left[\cos(\omega t)\hat{i} + \sin(\omega t)\hat{j}\right]$. $\vec{v}$ and $\vec{a}$ are velocity and acceleration of particle :-

(A) $\vec{r}.\vec{v} = 0$

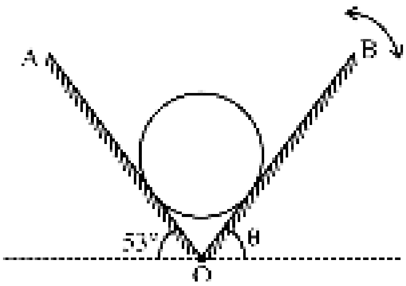
(B) $\vec{r}.\vec{a} = 0$

(C) A is dimensionless

(D) $\hat{r} = -\hat{a}_c$

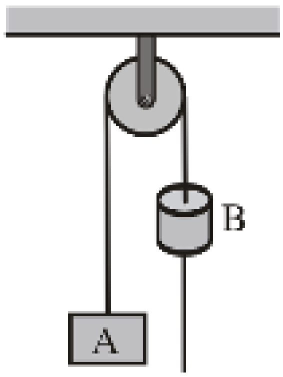
SECTION-III

1) In the arrangement shown in figure, a sphere of mass 1 kg kept at rest with the help of two inclined plane. Plane OA makes fixed angle from horizontal (53°) and plane OB can make a variable angle θ from the horizontal. Value of normal contact force (N) applied by plane OB on sphere depends on angle θ. At some value of θ, value of N will be minimum. Find that minimum value of N in newton ($g = 10\ m/s^2$).

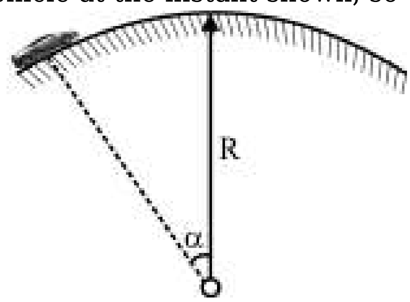


2) A 2 kg block A is attached to one end of a light string that passes over an an ideal pulley and a 1 kg sleeve B slides down the other part of the string with an acceleration of 8 m/s^2 with respect to the

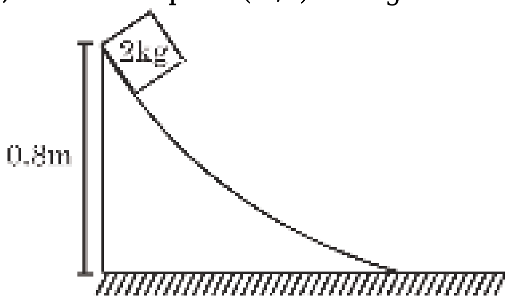
string. Find the tension in the string (in N).



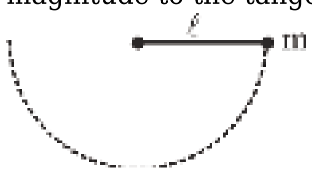
3) The vehicle of mass m = 100 kg moves with speed v of a convex bridge, having a radius of curvature R = 5 m. What should be the speed 'v' (in m/s) of vehicle at the instant shown, so that it leaves the surface immediately? Take $\alpha = 60°$ at this instant.



4) When 2kg mass is released from top of fixed incline plane, then final speed (m/s) of 2kg block when it reaches on ground (Given : All surfaces are smooth)



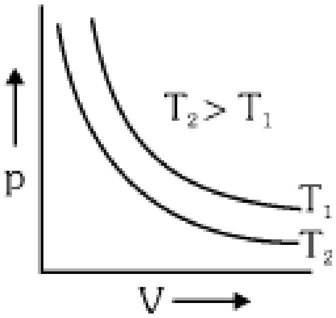
5) A bob is attached to a string of length $\ell = \frac{4}{\sqrt{5}}$ m. The string is held horizontal and the bob is released from this position. At the time when the centripetal acceleration becomes equal in magnitude to the tangential acceleration, find the speed (in m/s) of the bob. ($g = 10\ m/s^2$)

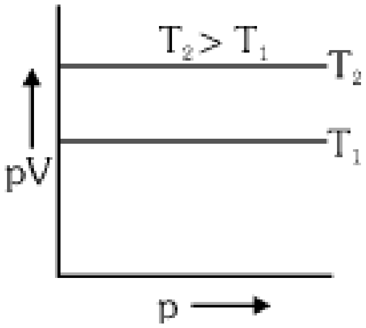


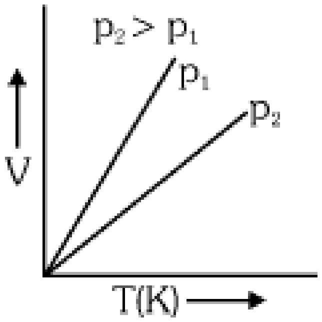
PART-B-CHEMISTRY

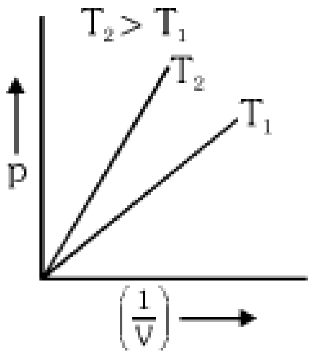
SECTION-I(i)

1) Which of the following graphs is inconsistent with ideal gas behaviour :-

(A) 

(B) 

(C) 

(D) 

2) If pressure of a certain amount of a gas increases by 1% on heating by 1ºC at cosntant volume, then its initial temperature must be -

(A) 100 K
(B) 100°C
(C) 250K
(D) 250°C

3) 80gm of SO_x gas occupies 14 litre at 2atm & 273K. The value of x is :
(Use R = 0.0821L-atm/K-Mole)

(A) 3
(B) 2
(C) 1

(D) None

4) In terms of critical constants, the compressibility factor is :-

(A) 3/8
(B) 8/3
(C) 3/4
(D) 2/3

5)

A system is provided 50 J of heat and work done on the system is 10 J. The change in internal energy during the process is :-

(A) 40 J
(B) 60 J
(C) 80 J
(D) 50 J

6) A system absorbs 20 kJ heat and does 10 kJ of work. The internal energy of the system

(A) increases by 10 kJ
(B) decreases by 10 kJ
(C) increases by 30 kJ
(D) decreases by 30 kJ

SECTION-I(ii)

1) In a closed rigid container of volume 8.21 litre, 4 mol N_2 and 6 mol O_2 present at 400 K temperature. Which is/are correct statements ?

(A) Partial pressure of O_2 is 24 atm.
(B) Partial pressure of N_2 is 16 atm if 2 mol of He added
(C) Partial pressure of O_2 is 24 atm if 2 mol of N_2 removed from container
(D) Total pressure of container increased when 2 mol of He added

2) Indicate the correct statement(s) for equal volumes of N_2(g) and CO_2(g) at 298 K and 1 atm.

(A) The average translational KE per molecule is the same for N_2 and CO_2
(B) The rms speed remains same for both N_2 and CO_2.
(C) The density of N_2 is less than that of CO_2.
(D) The total translational KE of both N_2 and CO_2 is same.

3)

Which of the following statements are correct ?

(A) Helium diffuses at a rate 8.65 times as much as CO does.

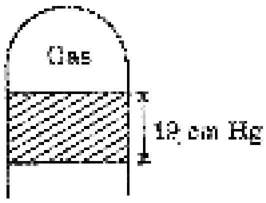
(B) Helium escapes at a rate 2.65 times as fast as CO does.

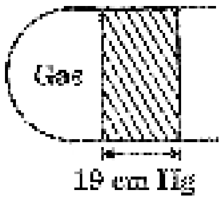
(C) Helium escapes at a rate 4 times as fast as CO_2 does.

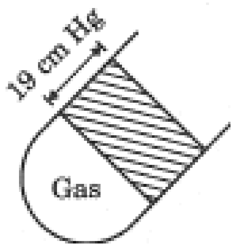
(D) Helium escapes at a rate 4 times as fast as SO_2 does.

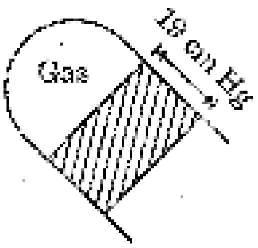
4)

In which of the following case(s) pressure of gas is less or equal to atmospheric pressure?

(A) 

(B) 

(C) 

(D) 

5) Choose intensive properties among given-

(A) Density

(B) Entropy

(C) Boiling point

(D) Heat capacity

6) In isothermal ideal gas compression:

(A) w is +ve

(B) ΔH is zero

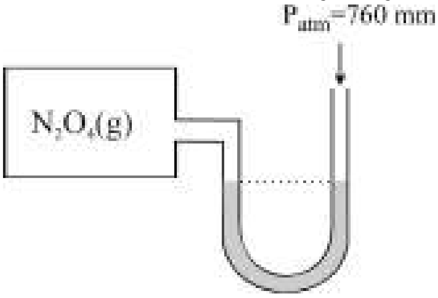
(C) q_{gas} is –ve

(D) ΔH is +ve

SECTION-III

1) A containers contains air above liquid water. Total pressure was 800 torr. What will be the final pressure if volume is doubled. (Aqueous tension = 40 torr)
Fill your answer as sum of digits till you get the single digit answer.

2) In a container initially only N_2O_4 is present. As shown in the diagram

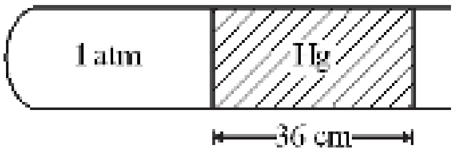


If due to dissociation of N_2O_4 at constant temperature the difference in the column of mercury becomes 7.6 cm then calculate % dissociation of N_2O_4.
Fill your answer as sum of digits (excluding decimal places) till you get the single digit answer.

3) Calculate the enthalpy change (in calorie) when 2 moles of an ideal gas in irreversible adiabatic process change the temperature from 300K to 500K. (C_{v_m} = 3R) & R = 2cal/mol-K
Fill your answer as sum of digits till you get the single digit answer.

4) The Vander Waal's constant for a gas are a = 3.6 atm L^2 mol^{-2}, b = 0.6 L mol^{-1}, if R = 0.08 L atm K^{-1} mol^{-1} and Boyle's temperature is T_B(K) of this gas then what is the value of $\frac{T_B}{15}$?

5) Air is trapped in a horizontal gas tube by 36cm mercury column as shown below :



If the tube is held vertical keeping the open end up, length of air column shrink to 19cm. What is the length (in cm) by which the mercury column shifts down ?

PART-C-MATHEMATICS

SECTION-I(i)

1) If the equation $4x^2 - x + 1 = 0$ and $3x^2 + (\lambda + \mu)x + \lambda - \mu = 0$ have a common root then the value of $\lambda\mu$ is (where λ, μ are rational)

(A) 0

(B) $\frac{-3}{4}$

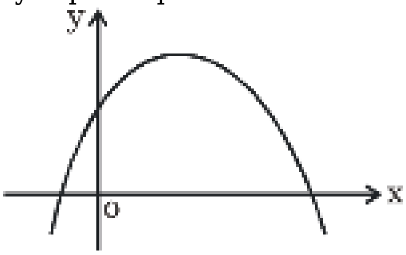
(C) $\frac{3}{4}$

(D) $\frac{4}{3}$

2) Sum of non real roots of equation $(x^2 + x - 2)(x^2 + x - 3) = 12$ is

(A) 1
(B) –1
(C) –6
(D) 6

3) The graph of quadratic polynomial $y = px^2 + qx + r$ is as shown in adjacent figure then which of the following holds good necessarily



(A) $r^2 - 4q < 0$
(B) $r - p + q > 0$
(C) $p + q > 0$
(D) $r^2 - 4p < 0$

4) If α, β are the roots of the equation $x^2 + 2(m - 1)x + m + 5 = 0$ then complete set of values of m for which $\alpha < 1 < \beta$, is

(A) $\left(-\frac{4}{3}, \infty\right)$
(B) $\left(-\infty, -\frac{4}{3}\right)$
(C) $\left(\frac{4}{3}, \infty\right)$
(D) $\left(-\frac{4}{3}, \frac{4}{3}\right)$

5) The general solution of trigonometric equation $4 + 2\sin x + \sin x \sec^2\left(\frac{x}{2}\right) = 0$ is

(A) $x = 2n\pi - \frac{\pi}{2}$, $n \in I$
(B) $x = n\pi - \frac{\pi}{2}$, $n \in I$
(C) $x = n\pi$, $n \in I$
(D) $x = 2n\pi - \frac{\pi}{4}$, $n \in I$

6) Match List-I with List-II and select the correct answer using the code given below the list.

	List-I		List-II
(P)	Number of solution(s) of the equation $e^x + e^{-x} = 2 \sin x$ for $x \in \left[0, \frac{\pi}{2}\right]$, is	(1)	0
(Q)	Number of solution(s) of the equation $x + y = \frac{2\pi}{3}$ and $\cos x + \cos y = \frac{3}{2}$ is	(2)	1
(R)	Number of solution(s) of the equation $\cos x + 2\sin x = 1$, $x \in (0,2\pi]$ is	(3)	2
(S)	Number of solution(s) of the equation $\lvert\tan x\rvert = \sin 2x$ in $(0,2\pi]$ is	(4)	3
		(5)	4

(A) P → 1; Q → 1; R → 3; S → 5

(B) P → 2; Q → 2; R → 4; S → 4

(C) P → 3; Q → 3; R → 2; S → 3

(D) P → 1; Q → 4; R → 1; S → 2

SECTION-I(ii)

1) If one root of the equation $4x^2 + 2x - 1 = 0$ is 'α', then

(A) α can be equal to $\frac{-1 + \sqrt{5}}{4}$

(B) α can be equal to $\frac{1 + \sqrt{5}}{4}$

(C) other root is $4\alpha^3 - 3\alpha$

(D) other root is $4\alpha^3 + 3\alpha$

2) The possible values of expression $E = x^2 + y^2 - 4x - 6y + 15$; $x, y \in \mathbf{R}$ is/are

(A) 1

(B) 2

(C) e

(D) π

3) cos 15 x = sin 5x if

(A) $x = -\frac{\pi}{20} + \frac{n\pi}{5}$, $n \in I$

(B) $x = \frac{\pi}{40} + \frac{n\pi}{10}$, $n \in I$

(C) $x = \frac{3\pi}{20} + \frac{n\pi}{5}$, $n \in I$

(D) $x = -\frac{3\pi}{40} + \frac{n\pi}{10}$, $n \in I$

4)

Let $f(x) = Ax^2 + Bx + C$ where $f(x)$ is an integer when x is an integer, then

(A) $A + B + C$ is an integer
(B) C is not an integer
(C) C is an integer
(D) $A - B + C$ is an integer

5) If one root of the equation $ax^2 + bx + c = 0$ is less than 2 and other root is greater than 2, then for the equation $a(y + 2)^2 + b(y + 2) + c = 0$ (where $a, b, c \in R$ and $a \neq 0$)

(A) both roots real
(B) both roots imaginary
(C) roots are of same sign
(D) roots are of opposite sign

6) The equation $a \cos x - \cos 2x = 2a - 7$ can have a solution, if

(A) $a = 2$
(B) $a = 6$
(C) $a \in (2, 6)$
(D) $a \in [2, 6]$

SECTION-III

1) Number of real solution(s) of equation $(2^x - 1)x^2 + \left(2^{x^2} - 2\right)x = 2^x - 1$

2) Let the sum of all the solutions of the equation $|x-3|^{\log_3^2 x - 5\log_3 x + 8} = |x-3|^2$ is S, then the remainder, when S is divided by 7, is

3) If the equation $x^2\sin^2\theta - (2\sin\theta)x + 1 = 0$ and $a(b - c)x^2 + b(c - a)x + c(a - b) = 0$ have a common root and second equation has equal roots also then the number of possible value(s) of θ in $[0, 2\pi]$ is

4) Number of solution(s) of the equation $27^{\sin^2 x} + 27^{\cos^2 x} = 12$ in the interval $[-\pi, \pi]$ is

5) The number of solution of equation $\sqrt[3]{\sin x - 1} + \sqrt[3]{\sin x} + \sqrt[3]{\sin x + 1} = 0$, lying in $[0, 2\pi]$, is

ANSWER KEYS

PART-A-PHYSICS

SECTION-I(i)

Q.	1	2	3	4	5	6
A.	**A**	**D**	**D**	**D**	**B**	**B**

SECTION-I(ii)

Q.	7	8	9	10	11	12
A.	**B,C**	**B,C,D**	**B,D**	**A,B,C,D**	**B,C**	**A,D**

SECTION-III

Q.	13	14	15	16	17
A.	**8**	**8**	**5**	**4**	**4**

PART-B-CHEMISTRY

SECTION-I(i)

Q.	18	19	20	21	22	23
A.	**A**	**A**	**B**	**A**	**B**	**A**

SECTION-I(ii)

Q.	24	25	26	27	28	29
A.	**A,B,C,D**	**A,C,D**	**B,D**	**A,B,D**	**A,C**	**A,B,C**

SECTION-III

Q.	30	31	32	33	34
A.	**6**	**1**	**5**	**5**	**9**

PART-C-MATHEMATICS

SECTION-I(i)

Q.	35	36	37	38	39	40
A.	**A**	**B**	**B**	**B**	**A**	**A**

SECTION-I(ii)

Q.	41	42	43	44	45	46
A.	**A,C**	**B,C,D**	**A,B,C,D**	**A,B,C,D**	**A,D**	**A,B,C,D**

SECTION-III

Q.	47	48	49	50	51
A.	3	3	1	8	3

SOLUTIONS

PART-A-PHYSICS

1)

If string is massless then tension will be same at each point of string.

2) At the moment m_2 stops, extension in the spring must be able to produce enough force to move m_1 or

$kx = \mu_1 m_1 g \Rightarrow x = \dfrac{.4 \times 5 \times 10}{100} = 20cm.$

As it is equal to displacement of m_2 also, applying work-energy theorem on m_2

$0 - \frac{1}{2}mv^2 = W_s + W_f = -\frac{1}{2}kx^2 - \mu_2 m_2 g.\, x$

$\Rightarrow \frac{1}{2} m_2 v^2$

$= \frac{1}{2} \times 100 \times 0.2 \times 0.2 + 0.2 \times 2 \times 10 \times 0.2$

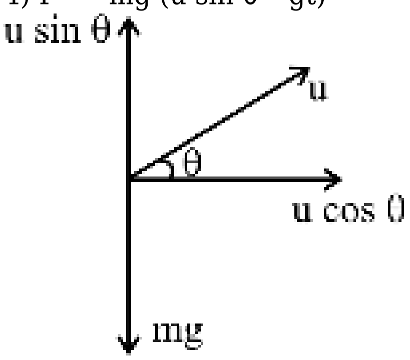
$v^2 = 2 + 0.8 \Rightarrow v = \sqrt{2.8}$ m/s

3)

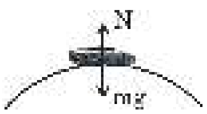
Ans. (4)

m [gsin53° – gcos53°] – μmg cos 53° = 0

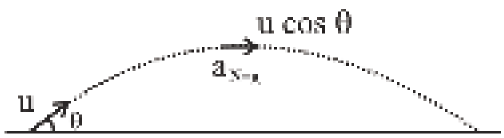
4) P = –mg (u sin θ – gt)



5)

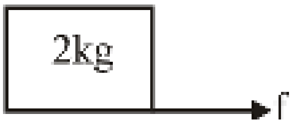
At A 

$mg - N = \dfrac{mv^2}{R_A}$

6) 

at heighest point $a_N = g = \frac{v^2}{R}$

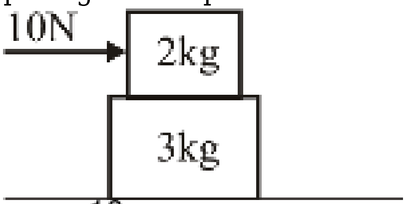
$R_c = \frac{u^2\cos^2\theta}{g}$

7) 

(to move together) $a_{max} = \frac{10}{5} = 2$

f = ma

$\mu \times 2g = 2a \Rightarrow \mu = \frac{a}{g} = \frac{2}{10}$



$a_{max} = \frac{10}{5} = 2$

$f = (\mu 2g) = 3a$

$\mu = \frac{3 \times 2}{20} = 0.3$

8)

Ans. (B,C,D)

Sol. (A) $\frac{\Delta p}{\Delta t} = F = (m + M)a = 30 \times 7.5 = 225N$

(B) $a = g\tan 37 = 10 \times \frac{3}{4} = 7.5$ m/s

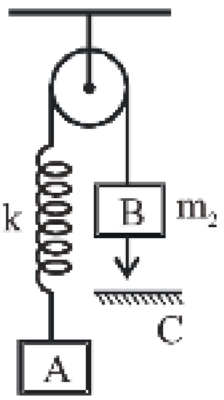
(C) $k = \frac{1}{2} \times 10 \times (7.5t)^2 = \frac{1}{2} \times 10 \times 56.25 \times t^2$

$\therefore \frac{dk}{dt} = 562.5t$

(D) $\theta > 90°$

$w < 0$

9)



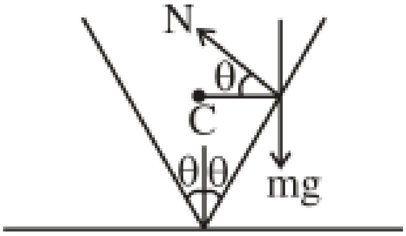
m_1

$a_A = 0$

$a_B = \left(\frac{m_1 - m_2}{m_2}\right) g$ upwards

10)

Angle between $\vec{r}$ and $\vec{\omega}$ is 90°
Angle between $\vec{a}$ and $\vec{\omega}$ is 90°
Angle between $\vec{r}$ and $\vec{v}$ is 90°
Direction of $\vec{r}$ and $\vec{v} \times \vec{\omega}$ is same. We can check it by using right hand thumb rule.

11) 

$N \sin \theta = mg$

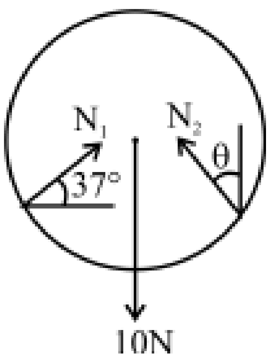
$N\cos\theta = \frac{mv^2}{r}$

12) $\vec{r} = A\left(\cos t\hat{i} + \sin t\hat{j}\right)$

$\vec{v} = \frac{d\vec{r}}{dt} = A\left(-\sin t\hat{i} + \cos t\hat{j}\right)$

$\vec{a} = \frac{d\vec{v}}{dt} = A\left(-\cos t\hat{i} - \sin t\hat{j}\right)$

$[A] = [L]$

13) 

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$$N_1 \frac{4}{5} = N_{23} \sin\theta \quad \ldots (1)$$

$$N_1 \frac{3}{5} + N_2 \cos\theta = 10 \quad \ldots (2)$$

$$\frac{3}{5} \times \frac{5}{4} N_2 \sin\theta + N_2 \cos\theta = 10$$

$$N_2 \left(\cos\theta + \frac{3}{4}\sin\theta\right) = 10$$

$$N_2 = \frac{10}{\frac{3}{4}\sin\theta + \cos\theta}$$

$$N_2 = \frac{8}{\sin(\theta + 53^\circ)}$$

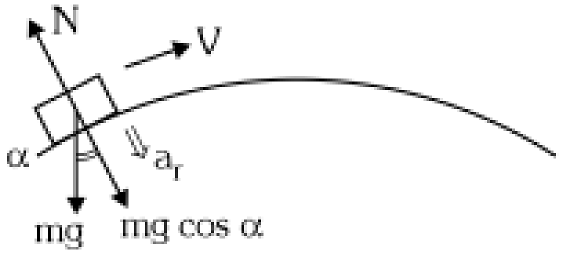
Thus, minimum value of N_2 = 8N

14) $2a_A = 2g - T$

$a_B = g - T$

$a_A + a_B = 8$

$\Rightarrow T = 8N$



15)

$$mg\cos\alpha - N = \frac{mv^2}{R}$$

as $N = 0$

 $v = \sqrt{gR\cos\alpha}$

16) Using work energy theorem

$W_g = \Delta K = K_f - K_i$

$$Mgh = \frac{1}{2}MV^2$$

$$V = \sqrt{2gh}$$

$$= \sqrt{2 \times 10 \times \frac{8}{10}}$$

V = 4 m/s

17)

$$mg\ell\cos\theta = \frac{1}{2}mv^2$$

$v^2 = 2g\ell\cos\theta$

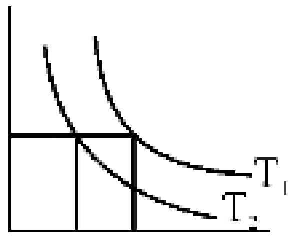
$a_t = g\sin\theta = 2g\cos\theta$

$\tan\theta = 2$

$v = \sqrt{2g \times \frac{1}{\sqrt{5}} \times \frac{4}{\sqrt{5}}}$ = 4 m/sec

PART-B-CHEMISTRY

18)



PV = nRT

Area = PV = nRT

So at greater T, Area will be more

19)

$\frac{1.01P_1}{(T_1 + 1)} \Rightarrow T_1 = 100K$

20)

$2 \times 14 = \frac{80}{(32 + 16x)} \times .0821 \times 273$

x = 2

21) $Z = \frac{P_c \times V_c}{RT_c} = \frac{3}{8}$

24)

(a) $p_{O_2} = \frac{6 \times 0.082 \times 400}{8.21} = 24$ atm

(b) $p_{N_2} = \frac{4 \times 0.0821 \times 400}{8.21} = 16$ atm

(c) $p_{O_2} = 24$ moles of O_2 remains constant

(d) p $\uparrow$ n $\uparrow$

25) PM = dRT

Total K.E. = $\frac{3}{2}$nRT

26) $\frac{r_{He}}{r_{gas}} = \sqrt{\frac{M_{gas}}{M_{He}}}$ gas $\Rightarrow$ CO

$r_{He} = r_{CO} \times \sqrt{\frac{28}{4}}$ $r_{He} = 2.65 \times r_{CO}$

gas $\Rightarrow SO_2$

$r_{He} = r_{SO_2} \times \sqrt{\frac{64}{4}}$

$r_{He} = 4 \times r_{SO_2}$ gas $\Rightarrow CO_2$

$r_{He} = r_{CO_2} \times \sqrt{\frac{44}{4}}$

$r_{He} = 3.32 \times r_{CO_2}$

27) (c) $P_{gas} = 76 + 19\cos\theta > 1\text{ atm}$

30)

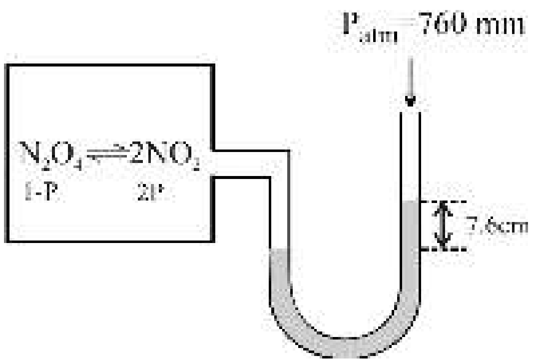
$P_{gas} = 760$

final pressure when volume is doubled $= \frac{760}{2} + 40$

$= 380 + 40$

$= 420$

31)



$N_2O_4 \rightarrow 2NO_2$

1

1 - P 2P

1 - p + 2P = 1.1

P = 0.1

α % = 10

32) $\Delta H = nCp\,[T_f - T_i]$

33) $T_B = \frac{3.6}{0.08 \times 0.6} = 75\,K$

34) P final $= 1 + \frac{36}{76} = \frac{112}{76}$ final height = 19cm

P initial = 1atm, initial length = hi cm

according to Boyle's Law

$P_iv_i = P_fv_f$

$= 1 \times hi.A = \frac{112}{76} \times 19A$

hi = 28cm

The length by which the Hg column shifts down = hi - hf = 28 - 19 = 9cm

PART-C-MATHEMATICS

35)

$\frac{3}{4} = \frac{\lambda + \mu}{-1} = \frac{\lambda - \mu}{-1}$

$\therefore \lambda + \mu = -\frac{3}{4}$ and $\lambda - \mu = -\frac{3}{4}$

$\lambda = -\frac{3}{4}, \mu = 0$

36)

$(x^2 + x - 2)(2 + x - 3) = 12$

Let $x^2 + x = t$

$(t - 2)(t - 3) = 12$

$t^2 - 5t - 6 = 0$

$t = -1, 6$

$\Rightarrow x^2 + x + 1 = 0$ or $x^2 + x - 6 = 0$

37) $p < 0$

SOR = $-\frac{q}{p} > 0 \Rightarrow q > 0$

POR = $\frac{r}{p} < 0 \Rightarrow r > 0$

$\therefore r - p + q > 0$ (Neccessarily)

38)

$f(1) < 0$

$3m + 4 < 0$

$\therefore m < -\frac{4}{3}$

39)

$4 + 2\sin x + \sin x \sec^2\left(\frac{x}{2}\right) = 0$

$4 + 2\sin x + \frac{2\sin x}{1 + \cos x} = 0$

$4 + 4\cos x + 2\sin x + 2\sin x\cos x + 2\sin x = 0$

$4 + 4(\sin x + \cos x) + 2\sin x\cos x = 0$

Let $\sin x + \cos x = t$

$4 + 4t + t^2 - 1 = 0$

$(t + 3)(t + 1) = 0$

$t = -1$
$t = -3$ (Reject)
$\sin x + \cos x = -1$
$\sqrt{2}\cos\left(x - \frac{\pi}{4}\right) = -1$
$\cos\left(x - \frac{\pi}{4}\right) = \cos\left(\frac{3\pi}{4}\right)$
$x = 2n\pi - \frac{\pi}{2}$

40)

Ans. (A)
Sol.
(P) $\sin x = \frac{1}{2}\left[e^{x} + e^{-x}\right] \geqslant 0$
only possiblity is sinx = 1 which is also not possible because $e^x + e^{-x} = 2$ at $x = 0$
(Q) $x + y = \frac{2\pi}{3}$ and $\cos x + \cos y = \frac{3}{2}$
$2\cos\left(\frac{x+y}{2}\right) + \cos\left(\frac{x-y}{2}\right) = \frac{3}{2}$
$2\cos\frac{\pi}{3} + \cos\left(\frac{x-y}{2}\right) = \frac{3}{2}$
$\Rightarrow \cos\left(\frac{x-y}{2}\right) = \frac{3}{2}$ (Not possible)
(R) cosx + 2sinx = 1 □ $2\sin x = 2\sin^2\frac{x}{2}$
$\sin\frac{x}{2}\left[\sin\frac{x}{2} - 2\cos\frac{x}{2}\right] = 0$
□ $\sin\frac{x}{2} = 0, \tan\frac{x}{2} = 2$
$x = 2\pi$ and $\tan\frac{x}{2} = 2$ for two values of x
(S) |tanx| = sin2x at $x = \pi,\ 2\pi,\ \frac{\pi}{4},\ \frac{5\pi}{4}$

41)

$4x^2 + 2x - 1 = 0$
$x = \frac{-2 \pm \sqrt{4+16}}{8} = \frac{-2 \pm 2\sqrt{5}}{8}$
$x = \frac{-1 \pm \sqrt{5}}{4}$

If $\alpha = \frac{-1+\sqrt{5}}{4} \Rightarrow \alpha^3 = \frac{-1 + 5\sqrt{5} - 3\sqrt{5}\left(\sqrt{5}-1\right)}{64}$
$4\alpha^3 = \frac{2\sqrt{5}-4}{4}$
$\Rightarrow 4\alpha^3 - 3\alpha = \frac{-\sqrt{5}-1}{4}$

42)

$E = x^2 - 4x + 4 + y^2 - 6y + 9 + 2$
$E = (x-2)^2 + (y-3)^2 + 2$
By SOS $(x-2)^2 + (y-3)^2 \geq 0$
Add 2 on both sides
$(x-2)^2 + (y-3)^2 + 2 \geq 2$
$E \geq 2$
So E can take values 2, e and π from the options.

43)

$\cos 15x = \sin 5x \Rightarrow \cos 15x = \cos\left(\frac{\pi}{2} - 5x\right)$ or $\cos\left(\frac{3\pi}{2} + 5x\right)$

$15x = 2n\pi \pm \left(\frac{\pi}{2} - 5x\right)$ or $15x = 2n\pi \pm \left(\frac{3\pi}{2} + 5x\right)$

$\Rightarrow x = \frac{n\pi}{10} + \frac{\pi}{40}$, $n \in I$, $\quad x = \frac{n\pi}{5} + \frac{\pi}{20}$, $n \in I$
and $x = \frac{n\pi}{5} - \frac{\pi}{20}$, $n \in I$ and $x = \frac{n\pi}{10} - \frac{3\pi}{40}$ $n \in I$

44)
$f(0) = C = I_1$
$f(1) = A + B + C = I_2 \quad ......(1)$
$f(1) = A + B + C$ is an integer $\quad ......(2)$
$f(-1) = A - B + C$ is an integer

45)
$ax^2 + bx + c = 0$
$\alpha < 2 < \beta$
similarly roots of $a(y+2)^2 + b(y+2) + c = 0$
are of opposite sign because
$\alpha' + 2 < 2 < \beta' + 2$
$\alpha' < 0 < \beta'$

46)

$a \cos x - \cos 2x = 2a - 7$
$a \cos x - (2 \cos^2 x - 1) = 2a - 7$
$a \cos x - 2 \cos^2 x = 2a - 8$
$2 \cos^2 x - a \cos x + 2a - 8 = 0$
$\cos x = \frac{a \pm |a-8|}{4} = \frac{a-4}{2}$ or 2 if $a \geqslant 8$
$-1 \leqslant \cos x \leqslant 1 \Rightarrow -1 \leqslant \frac{a-4}{2} \leqslant 1$
$\Rightarrow 2 \leqslant a \leqslant 6$

47)

Given equation is

$$2^x.x^2 - x^2 + x.2^{x^2} - 2x = 2^x - 1$$

put $x^2 - 1 = t$

 $(2^x - 1)t + 2x(2^t - 1) = 0$

it is possible only when x = 0 or t = 0

 x = 1, –1, 0.

48)

$$|x-3|^{\log_3^2 x - 5\log_3 x + 8} = |x-3|^2$$

$\Rightarrow \log_3^2 x - 5\log_3 x + 8 = 2$

$\Rightarrow$ x = 9, 27

or |x - 3| = 1 $\Rightarrow$ x = 2, 4

or |x - 3| = 0 $\Rightarrow$ x = 3

Sum of solutions = 3 + 2 + 4 + 9 + 27 = 45

49)

$a(b - c)x^2 + b(c - a)x + c(a - b) = 0$ has equal roots

root of above equation is '1'

 $\sin^2\theta - 2\sin\theta + 1 = 0$

$(\sin\theta - 1)^2 = 0 \Rightarrow \sin\theta = 1$

hence no. of values of θ in [0, 2π] is one

50)

Let $27^{\sin^2 x} = t$, then $t^2 - 12t + 27 = 0$

t = 9 or t = 3

$\Rightarrow \sin^2 x = \frac{2}{3}$ or $\sin^2 x = \frac{1}{3}$

No of solutions = 8

51)

Given α + β + γ = 0

$\Rightarrow \alpha^3 + \beta^3 + \gamma^3 = 3\alpha\beta\gamma$

$\Rightarrow 3\sin x = 3\sqrt[3]{(\sin^2 x - 1)\sin x}$

$\Rightarrow \sin x = 0$ or $\sin^2 x = \sin^2 x - 1$

$\Rightarrow \sin x = 0$