MELUHA INTERNATIONAL SCHOOL

HYDERABAD

SR MPC	JEE ADVANCE	Date: 06-05-2020
Time: 3 Hours	(IIT 2016 PAPER-1 MODEL – 54 BITS)	Max. Marks: 186

PHYSICS

SYLLABUS: ***U.T I + U.T II + U.T III + U.T IV SYLLABUS***

SECTION 1 (Maximum Marks:15)

- This section contains **FIVE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
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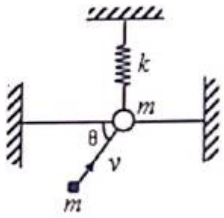
Full Marks	: +3 If only the bubble corresponding to the correct option is darkened
Zero Marks	: 0 If none of the bubbles is darkened.
Negative Marks	: -1 In all other cases.

1. A particle moving in the positive x-direction has initial velocity v_0. The particle undergoes retardation kv^2, where v is its instantaneous velocity. The velocity of the particle as a function of time is given by

A) $v = v_0/(1+kv_0t)$ B) $v = \frac{2v_0}{1+kt}$ C) $v = \frac{v_0}{kt}$ D) $v = \frac{v_0}{(1+k^2v_0^2t)}$

2. An unreformed spring of constant k is connected to a bead of mass m as shown in figure. Bead can move along long rigid rod without friction. A particle of mass m moving with velocity v in the vertical plane containing spring and rod strikes bead at an angle 45^0 with horizontal and sticks to bead. Choose correct alternative representing maximum elongation of spring is, all particles are in same horizontal plane.

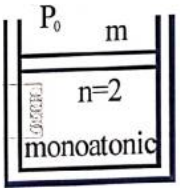


A) $\left(\sqrt{\frac{m}{k}}\right)v$ B) $\frac{1}{2}\left(\sqrt{\frac{m}{k}}\right)v$ C) $2\left(\sqrt{\frac{m}{k}}\right)v$ D) $\frac{1}{4}\left(\sqrt{\frac{m}{k}}\right)v$

3. The gravitational energy of interactions of a system of six identical particles, each of mass m placed at the vertices of a regular hexagon of side 'a' is [PE =0 at infinite separation]

A) $-\frac{Gm^2}{a}\left(1+\frac{1}{\sqrt{3}}+\frac{1}{4}\right)$ B) $\frac{-3Gm^2}{a}\left(1+\frac{1}{\sqrt{3}}+\frac{1}{4}\right)$ C) $\frac{-6Gm^2}{a}\left(1+\frac{1}{\sqrt{3}}+\frac{1}{4}\right)$ D) $\frac{-2Gm^2}{a}\left(1+\frac{1}{\sqrt{3}}+\frac{1}{4}\right)$

4. Two moles of an ideal monatomic gas are contained in a vertical cylinder of cross-sectional area A as shown. The piston is frictionless and has mass m. At a certain instant a heater starts supplying heat to the gas at a rate of q J/s. All the boundaries are thermally insulated. Atmospheric pressure is P_0. The velocity of piston under isobaric condition is



A) $\frac{2}{5}\frac{q}{[p_0A+mg]}$ B) $\frac{3}{5}\frac{q}{(p_0A+mg)}$ C) $\frac{4}{5}\frac{q}{(p_0A+mg)}$ D) $\frac{1}{5}\frac{q}{(p_0A+mg)}$

5. Students I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table.
Least count for length = 0.1cm
Least count for time = 0.1sec

Student	Length of the pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	TimePeriod (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_I, E_{II} and E_{III} are the percentage error in g, i.e., $\left(\frac{\Delta g}{g}\times 100\right)$ for students I, II and III, respectively.

A) $E_I = 0$ B) E_I is minimum C) $E_I = E_{II}$ D) E_{II} is maximum

SECTION 2 (Maximum Marks:32)

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Negative Marks : -2 In all other cases.

- For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks; darkening only (A) and (D) will result in +2 marks: and darkening (A) and (B) will result in -2 marks, as a wrong option is also darkened.

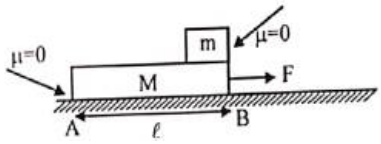
6. A particle is moving in a circular path of radius 1 m such that its speed is varying with time as v = 2t m/s, here t is in sec. Given $\vec{a}$ is the net acceleration and $\vec{v}$ is the velocity of the particle.

A) At $t=\frac{1}{\sqrt{2}}s$, angle between velocity and acceleration is 45^0

B) At $t=\frac{1}{\sqrt{2}}s, \vec{a}.\vec{v}=2\sqrt{2}$ C) At $t=\frac{1}{\sqrt{2}}s, \vec{a}.\vec{v}<0$

D) $\vec{a}.\vec{v}$ magnitude is independent of radial acceleration.

7. In the figure small block is kept on M then

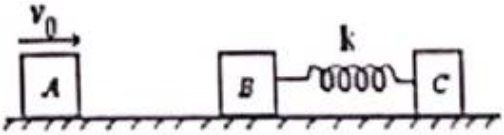


A) the acceleration of m w.r.t. ground is $\frac{F}{m}$ B) the acceleration of m w.r.t. ground is zero

C) the time taken by m to separate from M is $\sqrt{\frac{2lm}{F}}$

D) the time taken by m to separate from M is $\sqrt{\frac{2lm}{F}}$

8. For the given diagram mark the correct option(s). Given that $m_A = m_B = \frac{m_C}{2} = m.$ Neglect any Friction



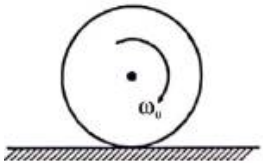
A) for e =1 for collision between blocks A & B maximum Kinetic Energy for block C in subsequent motion is $\frac{4}{9}mv_0^2$

B) for e =1 for collision between block A & B maximum compression in spring $v_0\sqrt{\frac{2m}{3k}}$

C) If A sticks with B after collision then maximum Kinetic energy for block C in subsequent motion is $\frac{1}{3}mv_0^2$

D) If A sticks with B after collision then maximum compression in the spring is subsequent motion is $\sqrt{\frac{m}{k}}\left(\frac{v_0}{2}\right)$

9. A disc is given an initial angular velocity ω_0 and aced on rough horizontal surface as shown. The quantities which will not depend on the coefficient of friction is/are

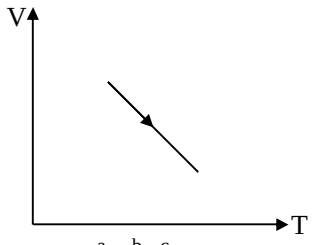


A) The time until rolling begins.
B) The displacement of the disc until rolling begins.
C) The velocity when rolling begins.
D) The work done by the force of friction

10. A bullet of mass 50g and specific heat capacity $800\,J\,kg^{-1}K^{-1}$ is initially at a temperature 20^0C. It is fired vertically upwards with a speed of 200 ms^{-1} and on returning to the starting point strikes a lump of ice at 0^0C and gets embedded in it. Assume that all the energy of the bullet is used up in melting. Neglect the friction of air. Latent heat of fusion of ice $= 3.36\times10^5\,J\,kg^{-1}$.

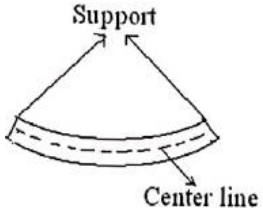
A) kinetic Energy of bullet used in melting is 1000 J.
B) The mass of ice method = 5 g
C) The mass of ice melted is slightly greater than 5 g.
D) The mass of ice melted is less than 5 g.

11. A gas performs a process as shown in V/T diagram. Choose the correct option(s).



A) The process cannot be represented as $P^a V^b T^c$ = constant where a,b,c are non-zero real numbers
B) Specific heat capacity is dependent on temperature
C) Pressure of gas monotonically decreases
D) Pressure of gas monotonically increases

12. A horizontal beam supported at each end sags under its own weight. Then the beam will experience



A) tensile stress B) compressive stress C) shear stress D) bulk stress

13. A lens of focal length f ' is placed in between an object and screen at a distance 'D'. The lens forms two real images of object on the screen for two of its different positions, a distance ' x ' apart. The two real images have magnification M_1 & M_2 respectively (M_1>M_2). Then,

A) $f = \dfrac{x}{M_1 - M_2}$ B) $M_1 M_2 = 1$ C) $f = \dfrac{\left(D^2 - x^2\right)}{4D}$ D) $D \geq 4f$

SECTION 3 (Maximum Marks:15)

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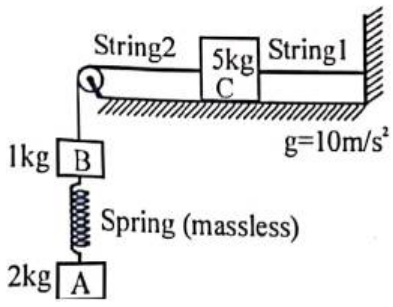
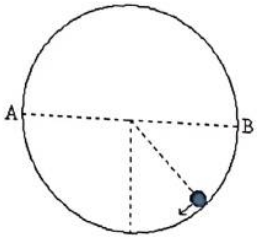
14. The system shown in the figure is in equilibrium and all the blocks are at rest. Assume that the masses of the strings, the pulley and the spring are negligible w.r.t. the masses of the blocks and friction is absent. Find acceleration of the block C (in m/s^2), just after cutting the string 1.



15. A rocket of mass 20,000 kg is blasted upwards with an initial acceleration 5 N $5ms^{-2}$. Find the initial thrust of blast. [in 10^5N Order and answer should be 1 integer] take $\left[g = 10 ms^{-2} \right]$

16. A particle of mass m oscillates along the shell between A and B inside a smooth spherical shell of radius R. At any instant the kinetic energy of the particle is K. Then the force applied by particle on the shell at this instant $\frac{xk}{R}$, where x is number. Find the value of x.



17. The resistances of two metallic wires are $R_1 = (5 \pm 0.2)\Omega$ and $R_2 = (10 \pm 0.1)\Omega$ when these two wires are connected in parallel, the equivalent resistance is found to be 3.3Ω with a maximum percentage error of n%. The value of n is

18. In the Youngs double slit experiment apparatus shown in figure, the ratio of maximum to minimum intensity on the screen is 9. The wavelength of light used is λ, then the value of y is $\frac{\lambda D}{\alpha d}$. Find the value of α

CHEMISTRY

SYLLABUS:- U.T I + U.T II + U.T III + U.T IV SYLLABUS

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19. In which of the following arrangements, the order is NOT according to the property indicated against it?

A) Li < Na < K < Rb : Increasing metallic radius

B) I < Br < F < Cl : Increasing electron gain enthalpy (with negative sign)

C) B < C < N < O Increasing first ionization enthalpy

D) $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$ Increasing ionic size

20. The sequence of ionic mobility in aqueous solution is :

A) $K^{+} > Na^{+} > Rb^{+} > Cs^{+}$ B) $Cs^{+} > Rb^{+} > K^{+} > Na^{+}$

C) $Rb^{+} > K^{+} > Cs^{+} > Na^{+}$ D) $Na^{+} > K^{+} > Rb^{+} > Cs^{+}$

21. Which one of the following statement is not true ?

A) pH of drinking water should be between 5.5 – 9.5.

B) Concentration of DO below 6 ppm is good for the growth of fish.

C) Clean water would have a BOD value of less than 5 ppm.

D) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.

22. The O – O – H bond angle in H_2O_2 is

A) 106^0 B) $109^028'$ C) 120^0 D) 94.8^0

23. Which of the following oxide is amphoteric ?

A) SnO_2 B) CaO C) SiO_2 D) CO_2

Section – 2 : (Maximum Marks : (32)

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24. An isotone of $^{76}_{32}Ge$ is :

A) $^{77}_{32}$Ge B) $^{77}_{33}$As C) $^{77}_{34}$Se D) $^{78}_{34}$Se

25. The compound(s) with TWO lone pairs of electrons on the central atom is (are)

A) BrF_5 B) ClF_3 C) XeF_4 D) SF_4

26. The thermal dissociation equilibrium of $CaCO_3(s)$ is studied under different conditions $CaCO_3(s) \rightleftharpoons CaO(s)+CO_2(g)$. **For this equilibrium, the correct statement (s) is (are)**

A) ΔH is dependent on T

B) K is independent of the initial amount of $CaCO_3$

C) K is dependent on the pressure of CO_2 at a given T

D) ΔH is independent of catalyst, if any

27. Fe^{3+} is reduced to Fe^{2+} by using

A) H_2O_2 in presence of NaOH B) Na_2O_2 in water

C) H_2O_2 in presence of H_2SO_4 D) Na_2O_2 in presence of H_2SO_4

28. In the nuclear transmutation $^9_4Be+X \rightarrow ^9_4Be+Y$ (X, Y) is (are)

A) (γ,n) B) (p,D) C) (n,D) D) (γ,p)

29. Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are

A) CH_3SiCl_3 and $Si(CH_3)_4$ B) $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$

C) $(CH_3)_2SiCl_2$ and CH_3SiCl_3 D) $SiCl_4$ and $(CH_3)_3SiCl$

30. The CORRECT statement(s) for cubic close placed (ccp) three dimensional structure is (are)

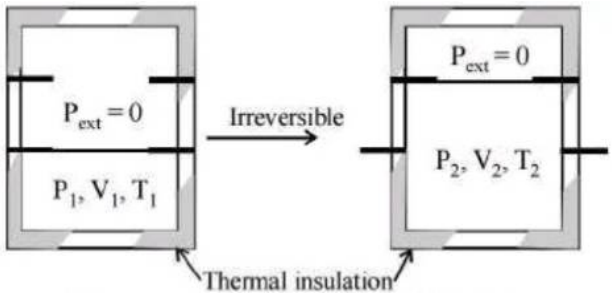
A) The number of the nearest neighbours of an atom present in the topmost layer is 12

B) The efficiency of atom packing is 74%

C) The number of octahedral and tetrahedral voids per atom are 1 and 2, respectively

D) The unit cell edge length is $2\sqrt{2}$ times the radius of the atom

31. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature $= T_1$ expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of the gas are P_2, V_2 and T_2, respectively. For this expansion



A) q=0 B) $T_2 - T_1$ C) $P_2V_2 = P_1V_1$ D) $P_2V_2\gamma = P_1V_1\gamma$

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32. X-rays of wavelength $1.54\overset{0}{A}$ strike a crystal and are observed to be deflected at an angle of 22.5^0. Assuming that n =1. Calculate the placing between the planes of atoms that are responsible for the reflection.

33. A first reaction is 20% complete in 10 minutes. Calculate (I) the rate constant of the reaction (II) time taken for the reaction to go to 75% completion.

34. A photon of wavelength $4000\overset{0}{A}$ strikes a metal surface, the work function of the metal being 2.13 eV. Calculate

(i) the energy of photon in eV

(ii) the kinetic energy of the emitted photoelectron and

(iii) the velocity of the photoelectron

35. If the solubility of iodine in water is 0.8 g/I at 25^0C, Calculate the solubility of I_2 in CCl_4. The k_D of iodine in between CCl_4 and water is 85 in favour of CCl_4 at 25^0C.

36. 2.7 ml H_2 and 3.1 ml I_2 vapour react-at 444^0C to form 4.5 ml HI. Calculate the K_c at this temperature

MATHEMATICS

SYLLABUS:- ***U.T I + U.T II + U.T III + U.T IV SYLLABUS***

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37. **If** $A^{-1}=\begin{bmatrix}\sin^2\alpha & 0 & 0\\ 0 & \sin^2\beta & 0\\ 0 & 0 & \sin^2\gamma\end{bmatrix}$ **and** $B^{-1}=\begin{bmatrix}\cos^2\alpha & 0 & 0\\ 0 & \cos^2\beta & 0\\ 0 & 0 & \cos^2\gamma\end{bmatrix}$ **where** α,β,γ **are any real numbers and** $C=\left(A^{-5}+B^{-5}\right)+5A^{-1}B^{-1}\left(A^{-3}+B^{-3}\right)+10A^{-2}B^{-2}\left(A^{-1}+B^{-1}\right)$ **then find** $|C|$.

A) 0 B) 1 C) 2 D) 3

38. **Two circles of radii** r_1 **and** r_2 **touch the** $x-$**axis at A and B respectively and the line** $y=$**mx, they intersect each other at** $P(9,6)$ **and Q, also** $r_1r_2=68,$ **then**

A) $\frac{12\sqrt{221}}{49}=m$ B) $m=-\frac{12\sqrt{221}}{49}$ C) $m=\frac{221\sqrt{2}}{49}$ D) None of these

39. **If** $|Z-4|+|Z+4|=10,$ **then the difference between the maximum and the minimum values of** $|Z|$ **is:**

A) 2 B) 3 C) $\sqrt{41}-5$ D) 0

40. $\int e^{x\sin x+\cos x}\left(\frac{x^4\cos^3 x-x\sin x+\cos x}{x^2\cos^2 x}\right)dx=$

A) $e^{x\sin x+\cos x}\left(x-\frac{1}{\cos x}\right)+C$ B) $e^{x\sin x+\cos x}\left(x-\frac{1}{x\cos x}\right)+C$

C) $e^{x\sin x+\cos x}\left(1-\frac{1}{x\cos x}\right)+C$ D) $e^{x\sin x+\cos x}\left(1-\frac{1}{\cos x}\right)+C$

41. **A straight line through a point** $(t,2)$ **meets the ellipse** $\frac{x^2}{9}+\frac{y^2}{4}=1$ **at A, D and meet axes at B, C. Such that PA, PB, PC, PD are in G.P. Then range of t**

A) $[6,\infty)$ B) $(-\infty,-6]$ C) Both (a) and (b) D) $[-6,6]$

Section – 2 : (Maximum Marks : (32)

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42. If $A_1, A_3, A_3, ..., A_{1006}$ be independent events such that $P(A_i) = \frac{1}{2i}(i = 1,2,3,....,1006)$ and probability that none of the events occurs be $\frac{\alpha!}{2^{\alpha}(\beta!)^2}$, then :

A) β is of form $4k+2, k \in I$ B) $\alpha = 2\beta$

C) β is a composite number D) α is of form $4k, k \in 1$

43. If $[x]$ denotes the integral part of x for real x, and

$S = \left[\frac{1}{4}\right] + \left[\frac{1}{4} + \frac{1}{200}\right] + \left[\frac{1}{4} + \frac{1}{100}\right] + \left[\frac{1}{4} + \frac{3}{200}\right] .... + \left[\frac{1}{4} + \frac{199}{200}\right]$ **then**

A) S is a composite number B) Exponent of S in $\lfloor\underline{100}$ is 12

C) Number of factors of S is 10 D) $^{25}C_r$ is max when $r = 51$

44. Let $g(x)$ be a cubic polynomial having local maximum at $x = -1$ and $g'(x)$ has a local minimum at $x = 1$. If $g(-1) = 10, g(3) = -22,$ then:

A) perpendicular distance between its two horizontal tangents is 12

B) perpendicular distance between its two horizontal tangents is 32

C) $g(x) = 0$ has atleast one real root lying in interval $(-1,0)$

D) $g(x) = 0$, has 3 distinct real roots

45. If the equation $ax^2 + bx + c = 0; a,b,c \in R$ and $a \neq 0$ has no real roots then which of the following is/are always correct?

A) $(a+b+c)(a-b+c) > 0$ B) $(a+b+c)(a-2b+4c) > 0$

C) $(a-b+c)(4a-2b+c) > 0$ D) $a(b^2 - 4ac) > 0$

46. **The value of x satisfying the equation**

$$\left(\sin^{-1}x\right)^3-\left(\cos^{-1}x\right)^3+\left(\sin^{-1}x\right)\left(\cos^{-1}x\right)\left(\sin^{-1}x-\cos^{-1}x\right)=\frac{\pi^3}{16}$$

Can not be equal to:

A) $\cos\frac{\pi}{5}$ B) $\cos\frac{\pi}{4}$ C) $\cos\frac{\pi}{8}$ D) $\cos\frac{\pi}{12}$

47. **If a differentiable function satisfies** $(x-y)\,f(x+y)-(x+y)\,f(x-y)=2\left(x^2y-y^3\right)\forall x,y\in R$ **and** $f(1)=2,$ **then :**

A) $f(x)$ must be polynomial function B) $f(3)=12$

C) $f(0)=0$ D) $f(3)=13$

48. **If OABC is a tetrahedron with equal edges and p,q,r are unit vectors along bisectors of** $\overrightarrow{OA},\overrightarrow{OB}:\overrightarrow{OB},\overrightarrow{OC}:\overrightarrow{OC},\overrightarrow{OA}$ **respectively and** $\vec{a}=\frac{\overrightarrow{OA}}{|\overrightarrow{OA}|},\vec{b}=\frac{\overrightarrow{OB}}{|\overrightarrow{OB}|},\vec{c}=\frac{\overrightarrow{OC}}{|\overrightarrow{OC}|}$, **then :**

A) $\frac{\left[\hat{a}\hat{b}\hat{c}\right]}{\left[\hat{p}\hat{q}\hat{r}\right]}=\frac{3\sqrt{3}}{2}$ B) $\frac{\left[\hat{a}+\hat{b}\hat{b}+\hat{c}\hat{c}+\hat{a}\right]}{\left[\hat{p}+\hat{q}\hat{q}+\hat{r}\hat{r}+\hat{p}\right]}=\frac{3\sqrt{3}}{4}$

C) $\frac{\left[\hat{a}+\hat{b}\hat{b}+\hat{c}\hat{c}+\hat{a}\right]}{\left[\hat{p}\hat{q}\hat{r}\right]}=\frac{3\sqrt{3}}{2}$ D) $\frac{\left[\hat{a}\hat{b}\hat{c}\right]}{\left[\hat{p}+\hat{q}\hat{q}+\hat{r}\hat{r}+\hat{p}\right]}=\frac{3\sqrt{3}}{4}$

49. **The chord AC of the parabola** $y^2=4ax$ **subtends an angle of** 90^0 **at points B and D on the parabola. If points A, B, C and D are represented by** $\left(at_i^2,2at_i\right),i=1,2,3,4$ **respectively, then find the value of** $\left|\frac{t_2+t_4}{t_1+t_3}\right|$.

A) 1 B) 2 C) 3 D) 4

SECTION 3 (Maximum Marks:15)

- This section contains **FIVE** questions.
- Answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9 both inclusive..
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks: +3 If only the bubble corresponding to the correct option is darkened

Zero Marks : 0 If none of the bubbles is darkened

50. **If** $\sqrt{\underbrace{(1111.....1)}_{2n\text{ times}}-\underbrace{(222.....2)}_{n\text{ times}}}=\underbrace{PPP.....P}_{n\text{ times}}$ **then** $P=$

51. **Let** $A=(-1,0),B=(3,0)$ **and PQ be any line passing through** $(4,1)$. **The range of the slope PQ for which there are two points on PQ at which AB subtends a right angle is** (λ_1,λ_2), **then** $5(\lambda_1+\lambda_2)$ **is equal to**

52. If the system of linear equations

$(\cos\theta)x+(\sin\theta)y+\cos\theta=0$

$(\sin\theta)x+(\cos\theta)y+\sin\theta=0$

$(\cos\theta)x+(\sin\theta)y-\cos\theta=0$

is consistent, then the number of possible values of $\theta,\theta\in[\theta,2\pi]$ **is:**

53. Let OA, OB, OC be conterminous edges of a cuboid. If l,m,n **be the shortest distances between the sides OA, OB, OC and their respective skew body diagonals to them, respectively, then find** $\dfrac{\left(\dfrac{1}{l^2}+\dfrac{1}{m^2}+\dfrac{1}{n^2}\right)}{\left(\dfrac{1}{OA^2}+\dfrac{1}{OB^2}+\dfrac{1}{OC^2}\right)}$.

54. If $|z_1|=2,|z_2|=2,|z_3|=3,|z_3|=4$ **and** $|2z_1+3z_2+4z_3|=9,$ **then value of** $|8z_2z_3+27z_3z_1+64z_1z_2|^{1/3}$ **is:**

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MELUHA INTERNATIONAL SCHOOL

HYDERABAD

JEE ADVANCE **Time: 3 Hours**	**2016 P1 MODEL**	**Date: 06-05-2020** **Max. Marks:186**

KEY SHEET

PHYSICS

01) A	**02) B**	**03) C**	**04) A**	**05) B**
06)ABD	**07) BD**	**08) ABD**	**09) CD**	**10) AC**
11) BD	**12) ABC**	**13) ABCD**	**14) 5**	**15) 3**
16) 3	**17) 3**	**18) 3**		

CHEMISTRY

19) C	**2) B**	**21) B**	**22) D**	**23) A**
24) BD	**25) BC**	**26) ABD**	**27) AB**	**28) AB**
29) B	**30) BCD**	**31) ABC**	**32) 2.01**	**33) 62.18**
34) 3.10	**35) 68**	**36) 52.94**		

MATHEMATICS

37) B	**38) A**	**39) A**	**40) B**	**41) C**
42) ABCD	**43) AB**	**44) BD**	**45) ABD**	**46) ABD**
47) ABC	**48) AD**	**49) A**	**50) 3**	**51) 6**
52) 2	**53) 2**	**54) 6**		

HINTS & SOLUTOINS

PHYSICS

1. $a = -\dfrac{dv}{dt}$

$kv^2 = -\dfrac{dv}{dt}, \int_0^t k\,dt = \int_{v_0}^{v} -\dfrac{dv}{v^2}$

$kt + \dfrac{1}{v_0} = \dfrac{1}{v}$

$v = \dfrac{v_0}{1 + kv_0 t}$

2. Conserving moment of system along rod.

$\Rightarrow mv\cos 45^0 = 2mv_1$

$v_1 = v/2\sqrt{2}$

By work energy theorem:

$-\dfrac{1}{2}kx^2 = -\dfrac{1}{2}(2m)\left(\dfrac{v}{2\sqrt{2}}\right)^2 \Rightarrow x = \dfrac{1}{2}\left(\sqrt{\dfrac{m}{k}}\right)v$

3. Total potential energy is $V = \sum U_{ij}$

$$= \frac{-Gm^2}{a}\left[6\times\left(\frac{1}{a}\right)\right] + g\left(\frac{1}{\sqrt{3a}}\right) + 3\left(\frac{1}{2a}\right) = \frac{-6Gm^2}{a}\left(1+\frac{1}{\sqrt{3}}+\frac{1}{4}\right)$$

4. Pressure under piston

$$p = p_0 + \frac{mg}{A}$$

Also $\Delta Q = \Delta W + \Delta U = pA\Delta x + \frac{3}{2}\times 2R\Delta T \quad ...(i)$

$$p\Delta V = 2R\ \Delta T \qquad ...(ii)$$

From (i) & (ii)

$$\Delta Q = \frac{5}{2}pA\Delta x$$

$$q = \frac{\Delta Q}{\Delta t} = \frac{5}{2}pA\frac{\Delta x}{\Delta t}$$

$$v = \frac{\Delta x}{\Delta t} = \frac{2}{5}\frac{q}{p} = \frac{2}{5}\frac{q}{\left(p_0 + \frac{mg}{A}\right)}$$

$$\Rightarrow \quad v = \frac{\Delta x}{\Delta t} = \frac{2}{5}\frac{q}{PA} = \frac{2q}{2\left(P_0A + mg\right)}$$

5. $$g = 4\pi^2\frac{l}{T^2}$$

$$\frac{\Delta g}{g}\times 100 = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$$

$$\Delta l = 0.1cm, \Delta T = 0.1/n$$

6. Speed $V = 2t$

Tangential acceleration $a_t = \frac{dv}{dt} = 2\,m/s^2$

Radial acceleration $a_r = \frac{(2t)^2}{t} = 4t^2\ m/s^2$

At $t = \frac{1}{\sqrt{2}}, a_r = 2\,m/s^2\ a_t = a_r$

$$\vec{a}.\vec{v} = \left(-a_r\,\hat{e}_r + a_t\,\hat{e}_t\right).v\hat{e}_t = a_t\,v = 4t$$

7. Acceleration of $M, a = \left(\frac{F}{M}\right)$

$$l = \frac{1}{2}\frac{F}{M}t^2$$

$$t = \sqrt{\frac{2Ml}{F}}.$$

8. For $e = 1$

$$v_B = v_{0\text{ after collision}}$$

$\therefore v_c$ has maximum value of $\frac{2v_0}{3}$

$$\therefore \left(KE\right)_{\max} \text{ for } C = \frac{1}{2}.2m\left(\frac{2v_0}{3}\right)^2 = \frac{4}{9}mv_0^2$$

In CM frame

$KE = \frac{1}{2}\frac{2m}{3}.v_0^2 = \frac{1}{2}kx_{\max}^2$

$\therefore l_{\max} = \sqrt{\frac{2mv_0^2}{3k}} = \sqrt{\frac{2m}{3k}}v_0$

If A sticks to B then

$(V_c)_{\max} = \frac{v_0}{2}$ as $m_A + m_B = m_C$

Also

$\frac{1}{2}K.x_{\max}^2 = \frac{1}{2}m\left(\frac{v_0}{2}\right)^2$

$x_{\max} = \sqrt{\frac{m}{k}}\ \frac{v_0}{2}$

9. The velocity of the disc when rolling begins can be obtained using the conservation of angular momentum principle about the point through which the friction force acts. So, the coefficient of friction has no bearing on final velocity. The work done by the force of friction will simply be change in kinetic energy.
$\therefore$ (C) and (D).

10. If the friction offered by air is reflected, the speed of the bullet on returning to be starting point will be equal to its initial speed $v = 200\ ms^{-1}$. The kinetic energy of the bullet is.

$K.E. = \frac{1}{2}mv^2$

$= \frac{1}{2}\left(50\times10^{-3}\right)\times\left(200\right)^3 = 1000J$

Heat lost by bullet for its temperature to fall from 20^0C to $0^0C = \left(50\times10^{-3}\right)\times800\times20 = 800J.$

If $x\,kg$ is the mass of ice melted, then

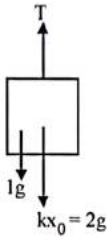
$\Rightarrow x = 5.3\times10^{-3}\,kg = 5.3g$ Hence the correct choices are (1) and (3)

11. $v = k_1 - k_2T$ and $dv = -k_2dt; p\left(k_1 - k_2T\right) = nRT \Rightarrow p = \frac{nRT}{k_1 - k_2T}$

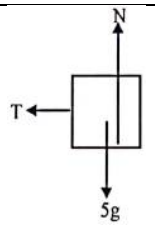
12. Conceptual

13. $V + U = D$
$V - U = x$
$V = \frac{x+D}{2}\ \ U = \frac{D-x}{2}$
$f = \frac{D^2 - x^2}{4D}$
$M_1 = \frac{D+x}{D-x}\ \ M_2 = \frac{D-x}{D+x}$

14. Just after cutting the string 1 the extension of the string will remain same as it was before cutting the string '1', So, we can take string force on block is equal '2g' Now making F.B.D of block 'B'.
$3g - T = 1a$ ...(1)



Making F.B.D of block 'c'



$T = 5a$ ...(2)

From (1) and (2)

$a = g/2 = 5\ m/s^2$.

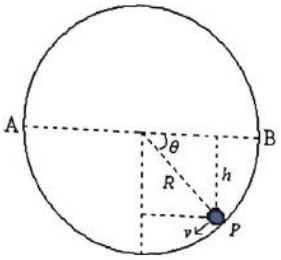
15. $F - Mg = Ma$

$F = M(g + a)$

$= 20,000(10 + 5) \quad = 3 \times 10^5 N = 3$

16. Let velocity of particle at point P is v.

From conservation of mechanical energy



Let N be the normal reaction between the particle and the shell at this instant. Then

$N - mg\sin\theta = \frac{mv^2}{R} \quad \left(\frac{mv^2}{R} = \frac{2K}{R}\right)$

or $N = mg\left(\frac{h}{R}\right) + \frac{2K}{R} = \frac{K}{R} + \frac{2K}{R} \quad (mgh = K)$

17. $\frac{\Delta R_P}{R_P} \times 100 = \left[\frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} + \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2}\right] \times 100$

Where $R_P = \frac{R_1 R_2}{R_1 + R_2}$

18. $\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{l_1/l_2} + 1}{\sqrt{l_1/l_2} - 1}\right)^2 = \frac{9}{1}$

or $\frac{x+1}{x-1} = 3 \quad \left(x = \sqrt{I_1/I_2}\right)$

$\therefore \ x = 2$

$\therefore \ \frac{l_1}{l_2} = 4$

$l_1 = 4l_2$

i.e., if $l_2 = l_0$ then $I_1 = 4I_0$

$I_0 = 4I_0 \cos^2\frac{\phi}{2}$

$\therefore \ \phi = \frac{2\pi}{3}$

$\therefore \left(\frac{2\pi}{\lambda}\right)\left(\frac{yd}{D}\right) = \frac{2\pi}{3} \qquad \therefore y = \frac{\lambda D}{3d}$

CHEMISTRY

19. In a period the value of ionisation potential increases from left to right with breaks where the atoms have some what stable configuration. In this case N has half filled stable orbital. Hence has highest ionisation energy. Thus the correct order is B < C < O < N not B < C < N < O

20. Smaller the ion more is its ionic mobility in aqueous solution. Ionic radii of the given alkali metals is in the order $Na^+ < K^+ < Rb^+ < Cs^+$ and thus expected ionic mobility will be in the order $Cs^+ < Rb^+ < K^+ < Na^+$. However due to high degree of solvation (or hydration) because of lower size or high charge density, the hydrated ion size follows the order $Cs^+ < Rb^+ < K^+ < Na^+$ and thus conductivity order is $Cs^+ > Rb^+ > K^+ > Na^+$ i.e. option (b) is correct answer.

21. COD can be found in a few minutes whereas BOD requires at least 5 days.

22. $O-O-H$ bond angle in H_2O_2 is 94.8^0.

23. SnO_2 is an amphoteric oxide because it reacts with acids as well as with bases to form corresponding salts.

$SnO_2 + 2H_2SO_4\,(conc) \rightarrow Sn(SO_4)_2 + 2H_2O$

$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$

24. ${}^{77}_{33}\text{As}$ and ${}^{78}_{34}\text{Se}$ have same number of neutrons $(=A-Z)$ as ${}^{76}_{32}Ge$

25.

Compound		Number of lone pairs on central atom
BrF_5	$\rightarrow$	1
ClF_3	$\rightarrow$	2
XeF_4	$\rightarrow$	2
SF_4	$\rightarrow$	1

26. (A) $\Delta H = C_{P(rxn)}\Delta T$

Hence enthalpy depends on temperature.

(B) $CaCO_{3(s)} \square\ CaO_{(s)} + CO_{2(g)}\quad K_p = P_{CO_2}$

(C) K_{eq} depends only on temperature and not on pressure.

(D) Enthalpy of reaction is independent of the catalyst.
Catalyst generally changes activation energy.

27. Conceptual

28. The reaction can occur by following two ways.

$^9_4\text{Be} + \gamma \rightarrow {}^8_4\text{Be} + {}^1_0\text{n}\ ;\ {}^9_4\text{Be} + {}^1_1\text{H} \rightarrow {}^2_1\text{H} + {}^8_4\text{Be}$

29. $(CH_3)_2 SiCl_2$ form linear polymer on hydrolysis and $(CH_3)_3 SiCl$ is a chain terminator.

30. CCP is ABC ABC ….. type packing

(A) In topmost layer, each atom is in contact with 6 atoms in same layer and 3 atoms below this layer

(B) Packing fraction $= \dfrac{4\times\frac{4}{3}\pi r^3}{\left(\frac{4r}{\sqrt{2}}\right)^3} = (0.74)$

(C) Each FCC unit has effective no of atoms = 4
Octahedral void = 4
Tetrahedral void = 8

(D) $4r = a\sqrt{2}$

31. Since the vessel is thermally insulated, $q = 0$

Further since, $P_{ext} = 0$, so w=0, hence $\Delta U = 0$

Since $\Delta T = 0, T_2 = T_1$, and $P_2V_2 = P_1V_1$

However, the process is adiabatic irreversible, so we can't apply $P_2V_2\gamma = P_1V_1\gamma$.

32. Bragg's equation is $n\lambda = 2d\sin\theta$

$\therefore\ d = \dfrac{1.54\times 1}{2\sin 22.5^0} = 2.01\overset{0}{A}$

33. (I) For Ist order reaction $k = \dfrac{2.303}{t}\log\dfrac{a}{a-x}$

$k = \dfrac{2.303}{10}\log\dfrac{100}{100-20} = 0.0223\,\text{min}^{-1}$

(II) $t = \dfrac{2.303}{0.0223}\log\dfrac{100}{100-75} = 62.18\,\text{min}$

34. (i)Energy of the photon $E = h\upsilon = \dfrac{hc}{\lambda}$

$E = \dfrac{6.626\times 10^{-34}\,Js\times 3\times 10^{8}\,ms^{-1}}{4000\times 10^{-10}\,m} = 4.97\times 10^{-19}\,J$

$eV = 1.602\times 10^{-19}\,J$

$E = \dfrac{4.97\times 10^{-19}\,J}{1.602\times 10^{-19}\,J} = 3.10\,eV$

35. $k_D = \dfrac{[\text{I}_2]\text{in CCl}_4\text{ layer}}{[\text{I}_2]\text{in water layer}} =$ Let the solubility of I_2 in CCl_4 be a g/litre

$85 = \dfrac{a}{0.8}$

$\text{a} = 68\,\text{g litre}^{-1}$

36.

	H_2	+	I_2	$\rightleftharpoons$	2HI
Initial moles	2.7		3.1		0.0
Moles at equil.	2.7–x		3.1–x		2x

But $2x = 4.5$ (given) $\therefore$ $x = 2.25$

$[H_2] = 2.7 - 2.25 = 0.45,\quad [I_2] = 3.1 - 2.25 = 0.85$

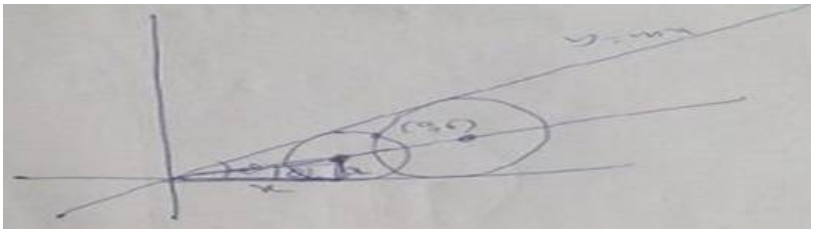
$\text{K}_c = \dfrac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \dfrac{(4.5)^2}{0.45\times 0.85} = 52.94$

MATHS

37. $A^{-1}B^{-1} = B^{-1}A^{-1} \Rightarrow C = \left(A^{-1}+B^{-1}\right)^5 = \left(I\right)^5$

38. $\tan\dfrac{\theta}{2} = \dfrac{r}{x} \Rightarrow x = \dfrac{r}{\tan\dfrac{\theta}{2}} = r.\cot\dfrac{\theta}{2}$

Centre $= r\cot\dfrac{\theta}{2}$ (r), radius = r



So $\left(x - r\cot\dfrac{\theta}{2}\right)^2 + \left(y-r\right)^2 = r^2$

It is passes through $(9,6)$ so

$\left(9 - r\cot\dfrac{\theta}{2}\right)^2 + \left(6-r\right)^2 = r^2$

$\Rightarrow 81-18r\cot\frac{\theta}{2}+r^2\cot^2\frac{\theta}{2}+36+r^2-12r=r^2$

$r^2\left(\cot^2\frac{\theta}{2}\right)+r\left(-12-18\cot\frac{\theta}{2}\right)+117=0$

Let r_1r_2 roots

$r_1r_2=\frac{117}{\cot^2\frac{\theta}{2}}$

G.T $r_1r_2=68$

$\frac{3\times3\times13}{\cot^2\frac{\theta}{2}}=4\times17$

$\tan^2\frac{\theta}{2}(3\times3\times13)=4\times17$

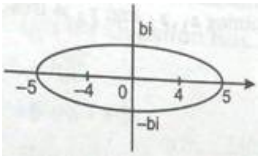
$\tan\frac{\theta}{2}\left(3\times\sqrt{13}\right)=2\times\sqrt{17}$

$\tan\frac{\theta}{2}=\frac{2\sqrt{17}}{3\sqrt{13}}$

$m=\tan\theta=\frac{2\tan\frac{\theta}{2}}{1-\tan\frac{\theta}{2}}=\frac{\frac{2\times2\sqrt{17}}{3\sqrt{13}}}{1-\frac{4(17)}{9(13)}}$

$m=\frac{12\sqrt{221}}{49}$

39. Now, $b^2=25\left(1-e^2\right)=25-(5e)^2$



$=25-16=9$

$\Rightarrow \quad b=3$

Z lies on the ellipse circumference $|Z|$ denotes the distance from the origin. Therofore,

$|Z|_{\max}=5$

$|Z|_{\min}=3$

Thus, the difference between the maximum and the minimum values of $|Z|$ is

$|Z|_{\max}-|Z|_{\min}=5-3=2$

40. $\frac{d}{dx}(x\sin x+\cos x)=x\cos x \quad f'(x)=x\cos x$

Let $f(x)=x\sin x+\cos x \qquad f''(x)=-x\sin x+\cos x$

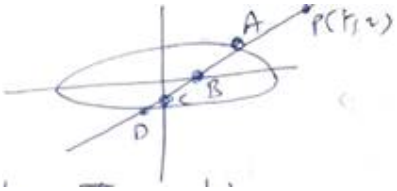
$\int e^{f(x)}\left(xf'(x)+\frac{f''(x)}{\left(f'(x)^2\right)}\right)dx=\int xe^{f(x)}f'(x)dx+\int e^{f(x)}.\frac{f''(x)}{\left(f'(x)^2\right)}dx$

$=xe^{f(x)}-\int e^{f(x)}dx+e^{f(x)}\frac{-1}{f'(x)}-\int e^{f(x)}.f'(x)\left(\frac{-1}{f'(x)}\right)dx$

$$= xe^{f(x)} - \frac{e^{f(x)}}{f'(x)} + C = e^{f(x)}\left(x - \frac{1}{f'(x)}\right) + C$$

$$= e^{x\sin x + \cos x}\left(x - \frac{1}{x\cos x}\right) + C$$

41. Let line



Equation is $y - 2 = \tan d\left(x - t\right)$

At $B \Rightarrow y = 0$ then $x = t - \frac{2}{\tan\theta}$

$$PB = \frac{2}{\sin\theta}$$

At C $\Rightarrow x = 0$ then $y = 2 - t\left(\tan\theta\right)$

$$PC = \frac{t}{\cos\theta}$$

Parametric form of point on line is $\left(x_1 + r\cos\theta_1 y_1 + r\sin\theta\right)$

$\left(t + r\cos\theta, 2 + r\sin\theta\right)$ lies on $\frac{x^2}{a} + \frac{y^2}{b} = 1$

$\Rightarrow 4x^2 + 9y^2 - 36 = 0$

$4\left(t + r\cos\theta\right)^2 + 9\left(2 + r\sin\theta\right)^2 = 36$

$r^2\left(4\cos^2\theta + 9\sin^2\theta\right) + r\left(8t\cos\theta + 36\sin\theta\right) + \left(4t^2\right) = 0$

Let r_1, r_2 are the roots then $r_1 r_2 = \frac{4t^2}{4\cos^2\theta + 9\sin^2\theta}$

Here $r_1 = PA,\ r_2 = PB$

PA, PB, PC, PD are in G.P

$\Rightarrow PA.PD = PB.PC$

$$t = 2\cot\theta + \frac{9}{2}\tan\theta$$

$A.M \geq G.M$

$$t = 2\cot\theta + \frac{9}{2}\tan\theta \geq 2\sqrt{\cot\theta\frac{9}{2}\tan\theta} \quad \geq 2\sqrt{9} \quad \boxed{t \geq 0}$$

$\therefore t \in \left[6, \infty\right)$

If we take $\left(x_1 - r\cos\theta, y_1 - r\sin\theta\right)$ then $t \in \left(-\infty, -6\right]$

So range of t is $\left(-\infty, -6\right] \cup \left[6, \infty\right)$

42. Probability $= \left(1 - \frac{1}{2}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{6}\right)\left(1 - \frac{1}{8}\right).....\left(1 - \frac{1}{2012}\right)$

$$= \frac{1}{2} \times \frac{3}{4} \times \frac{5}{6} \times \frac{7}{8} \times ..... \times \frac{2011}{2012} = \frac{2012!}{2^{2012}\left(1006!\right)^2}$$

43. Conceptual

44. Let $g''(x) = a(x-1)$

$g'(x) = \frac{ax^2}{2} - ax + b$

$g'(-1) = 0 \Rightarrow b = -\frac{3a}{2}$

$g(x) = \frac{ax^3}{6} - \frac{ax^2}{2} + bx + c \Rightarrow g(x) = x^3 - 3x^2 - 9x + 5$

$(\because g(-1) = 10, g(3) = -22)$

45. Conceptual

46. $\left(\sin^{-1}x - \cos^{-1}x\right)\left(\left(\sin^{-1}x\right)^2 + \left(\cos^{-1}x\right)^2 + 2\sin^{-1}x\cos^{-1}x\right) = \frac{\pi^3}{16}$

$\Rightarrow \sin^{-1}x - \cos^{-1}x = \frac{\pi}{4} \Rightarrow \cos^{-1}x = \frac{\pi}{8} \Rightarrow x = \cos\frac{\pi}{8}$

47. Put $x = 1,\ y = 1$

$0f(2) - 2f(0) = 2[1-1] = 0$

$f(0) = 0$

Put $x = 2,\ y = 1$

$f(3) = 12$

$(x-y)f(x+y) - (x+y)f(x-y) = 2\left(x^2y - y^3\right)$

$\frac{(x-y)f(x+y)}{x^2-y^2} - \frac{(x+y)f(x-y)}{x^2-y^2} = 2y$

$\frac{f(x+y)}{x+y} - \frac{f(x-y)}{x-y} = 2y$

$x+y = m,\ x-y = n$

$\frac{f(m)}{m} - \frac{f(n)}{n} = m-n$

Put $n = 1$ $\frac{f(m)}{m} - \frac{f(1)}{1} = m-1$

$f(m) = m^2 + m$

$m \to x$

$f(x) = x^2 + x$

$f(0) = 0$

$f(1) = 2$

$f(3) = 12$

$f(x)$ is polynomial function

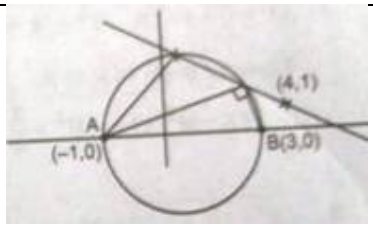
48. Conceptual

49. Conceptual

50. $\sqrt{\frac{10^{2n}-1}{9} - 2\left(\frac{10^n-1}{9}\right)} = P\left(\frac{10^n-1}{9}\right) \Rightarrow P = 3$

51. Describe a circle whose diameter is AB.

$\therefore$ centre $= (1,0)$



Radius =2

Let 'm' the slope of the line passing through $(4,1)$.

$(y,-1)=m(x-4)$ intersect the circle

$\perp$ distance from centre < radius of circle.

$$\left|\frac{-3m+1}{\sqrt{m^2+1}}\right|<2$$

$$9m^2-6m+1<4m^2+4$$

$$\Rightarrow \quad m\in\left(\frac{6-\sqrt{96}}{10},\frac{6+\sqrt{96}}{10}\right)-\left\{\frac{1}{5},1\right\}$$

$$\lambda_1+\lambda_2=\frac{12}{10}=\frac{6}{5}$$

$$5(\lambda_1+\lambda_2)=6$$

52. $$\begin{vmatrix}\cos\theta & \sin\theta & \cos\theta\\ \sin\theta & \cos\theta & \sin\theta\\ \cos\theta & \sin\theta & -\cos\theta\end{vmatrix}=0\Rightarrow -2\cos\theta\cos 2\theta=0$$

53. Let $l=m=n=\frac{1}{\sqrt{2}}$

54. Conceptual