SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

SR MPC	GT-2	Date: 10-09-20
Time: 09:00 AM to 12:00 NOON	2013_P1 MODEL	Max.Marks:180

KEY SHEET

PHYSICS

1	**C**	2	**D**	3	**B**	4	**B**	5	**A**
6	**C**	7	**D**	8	**B**	9	**A**	10	**C**
11	**BC**	12	**AC**	13	**BC**	14	**BC**	15	**ACD**
16	**5**	17	**6**	18	**4**	19	**4**	20	**1**

CHEMISTRY

21	**C**	22	**D**	23	**A**	24	**B**	25	**C**
26	**D**	27	**D**	28	**A**	29	**B**	30	**C**
31	**A**	32	**D**	33	**ACD**	34	**ABD**	35	**AB**
36	**6**	37	**4**	38	**4**	39	**2**	40	**8**

MATHS

41	**B**	42	**C**	43	**C**	44	**D**	45	**B**
46	**C**	47	**C**	48	**B**	49	**B**	50	**D**
51	**AB**	52	**ABCD**	53	**BD**	54	**ABC**	55	**ABC**
56	**8**	57	**3**	58	**5**	59	**5**	60	**2**

SOLUTIONS
PHYSICS

1. If block is observed from inclined plane then FBD is shown.

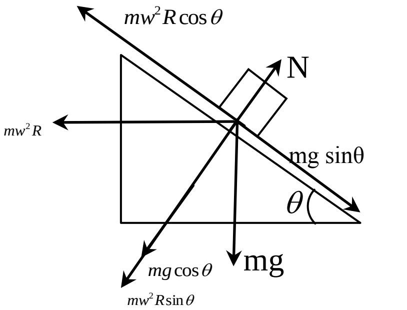
$N = mg\cos\theta + mw^2R\sin\theta$ - (A)

$f_r + mw^2R\cos\theta = mg\sin\theta$

$\mu N = mg\sin\theta - mw^2R\cos\theta$ - (B)

Solving A & B for w

$$w = \sqrt{\frac{g}{R}\left(\frac{\tan\theta - \mu}{1+\mu\tan\theta}\right)} = 3.2\frac{rad}{\sec}$$



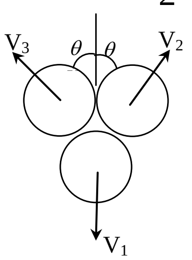
2. By momentum conservation principle

$V_3 = V_2 = V$

$2V\cos\theta = V_1$

$-h = -v_1t_1 - \frac{1}{2}gt_1^2$

$\Rightarrow = \left(2v\cos\theta\right)t_1 + \frac{1}{2}gt_1^2 \ldots$(i)



Now, $-h = (V\cos\theta)t_2 - \frac{1}{2}gt_2^2$

$h = \left(-V\cos\theta\right)t_2 + \frac{1}{2}gt_2^2 \ldots$(i)

From (I) & (II)

$$\frac{h - \frac{1}{2}gt_1^2}{h - \frac{1}{2}gt_2^2} = \frac{2t_1}{-t_2}$$

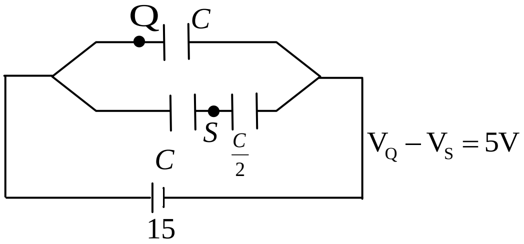
$$h = \frac{1}{2}gt_1t_2\frac{(t_1+2t_2)}{(2t_1+t_2)}$$

3. $\frac{g}{2} = g - w^2R \quad v = wR$

$\Rightarrow \frac{g}{2} = g - \frac{V^2}{R}$

$\Rightarrow \frac{g}{2} = \frac{V^2}{R}$ $\qquad (V_e)_p = \sqrt{2gR}$ $\sqrt{\frac{4V^2}{R} \times R} = 2V$

4. Equivalent circuit is

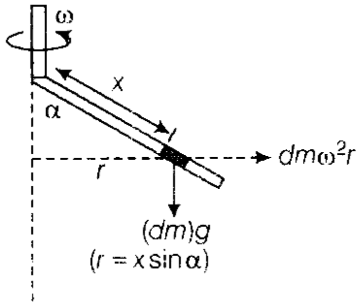


5. Induced emf $\int_a^b B\,v\,dx = \int_a^b \frac{\mu_0 I}{2\pi x} v\,dx$

$\Rightarrow$ Induced emf $= \frac{\mu_0 Iv}{2\pi} \ell n\left(\frac{b}{a}\right) \Rightarrow$ Power dissipated $= \frac{E^2}{R}$ Also, power = F.V $\Rightarrow F = \frac{E^2}{VR}$

$\Rightarrow F = \frac{1}{VR}\left[\frac{\mu_0 IV}{2\pi} \ell n\left(\frac{b}{a}\right)\right]^2$

6. The problem is based on concept of equilibrium, net torque on the system must be zero. So, net torque due to mg and torque due to centrifugal force must be zero.
For equilibrium of rigid body net torque acting on body should be zero. Here only two forces, one is gravity force and other is centrifugal force (if rod is considered as frame of reference). Here notice that centrifugal force is variable because distance of mass from axis is variable that's why radius is variable and because of that centrifugal force is variable.



Torque due to centrifugal force = Torque due to weight

$(dm\omega^2 r)\ (x\cos\alpha) = (dm)g \times \sin\alpha$

$\cos\alpha\left(\omega^2 \int_0^L x^2 dx\right) = g\int_0^L x\,dx$

$\cos\alpha \frac{\omega^2 L^3}{3} = \frac{gL^2}{2} \Rightarrow \cos\alpha = \frac{3g}{2\omega^2 L}$

7. $\Delta\phi = 2n\pi$

$\frac{\pi}{2} + \frac{2\pi}{\lambda} d\sin\theta = 2n\pi$

$\frac{2\pi}{\lambda} d\sin\theta = \left(2n - \frac{1}{2}\right)\pi\ \pi$

$\sin\theta = \left(2n - \frac{1}{2}\right)\frac{\lambda}{2d} = \frac{1}{2} \times \frac{\lambda}{2 \times 3\lambda} = \frac{1}{12}$

$\Rightarrow \frac{y}{\sqrt{(100\lambda)^2}} = \frac{1}{12}$

$144y^2 = (100l)^2$

$y \approx \frac{100\lambda}{12} = \frac{25\lambda}{3}$

8. The basis of the problem in frequency dependence of photoelectric emission. The problem based on emission of electron when incident light with certain frequency (greater than on the threshold frequency) is focused on a metal surface then some electrons are emitted from the metal with substantial initial speed.

Initial energy of electrons = 2 eV

Energy of electron in 1st excited state

(i.e. n = 2) $(i.e., n = 2) = -13.6 \times \frac{1^2}{2^2} = -3.4 eV$

Photon of energy = 2 – (-3.4) = 5.4 eV will be emitted.

$\Rightarrow KE_{max} = E_{photon} - W_0 = 5.4 - \frac{12400}{4600}$

= 5.4 – 2.7 = 2.7 eV.

9. From figure

$OP = 2r \sin\theta = vt$

$\sin\theta = \frac{vt}{2r}$

$\cos\theta \frac{d\theta}{dt} = \frac{V}{2r}$

$\frac{d\theta}{dt} = \frac{v}{2r\sqrt{1-\sin^2\theta}} = \frac{v}{2r\sqrt{1-\frac{v^2t^2}{4r^2}}}$

$= \frac{v}{\sqrt{4r^2 - v^2t^2}}$

10. This problem is based on least count of measuring instrument and rounding off the digits upto significant figures.

Given that 1 MSD = 1 mm

9 MSD = 10 VSD

LC = 1 MSD – 1 VSD $= 1mm - \frac{9}{10}mm$

$= \frac{1}{10}mm$

Measuring reading of edge = MSR + VSR (LC)

$= 10 + 1' \frac{1}{10}$

= 10.1 mm

Volume of cube $V = (1.01)^3 = 1.03 \text{ cm}^3$

\ Density of cube $= \frac{2.736}{1.03}$

$= 2.6563 g/cm^3$

$= 2.66 \ g/cm^3$

Section B: Multiple correct

11. (B) For maximum power across R, we can take two batteries as parallel combinations of cell and then Rext. = R in

(C) $V = \dfrac{\frac{V_1}{R_1} - \frac{V_2}{R_2}}{\frac{1}{R} - \frac{1}{R}}$

For no current across R v = 0 so, $\dfrac{V_1}{R_1} = \dfrac{V_2}{R_2}$

12. Initial state is same for all three processes (say initial internal energy $= E_0$)

In the final state, $V_A = V_B = V_C$

and $P_A > P_B > P_C$

$\Rightarrow P_A V_A > P_B V_B > P_C V_C \Rightarrow E_A > E_B > E_C$

if $T_1 > T_2$

then $E_0 > E_f$ for all three processes

and hence $(E_0 - E_A) < (E_0 - E_B) < (E_0 - E_C) \Rightarrow |\Delta E_A| < |\Delta E_B| < |\Delta E_C|$

If $T_1 < T_2$, then $E_0 < E_f$ for all three processes

and hence $(E_A - E_0) > (E_B - E_0) > (E_C - E_0) \Rightarrow |\Delta E_A| > |\Delta E_B| > |\Delta E_C|$

13. The blocks will be performing SHM in CM frame. At the given instant the blocks are at mean position of the SHM in CM frame, hence velocity at this instant in CM frame is equal to ωA. Also the time period will be $2\pi\sqrt{\dfrac{\mu}{k}}$ where μ is reduced mass. Time taken by blocks to reach maximum compression is 3T/4.

14. $\delta = i_1 + i_2 - A$

$45^\circ = i_1 + i_2 - 60^\circ$

$i_1 + i_2 = 105^\circ$

$i_1 - i_2 = 20^\circ$

or $2i_i = 125^\circ$

$i_i = 62^\circ 30'$, $i_2 = 42^\circ 30'$

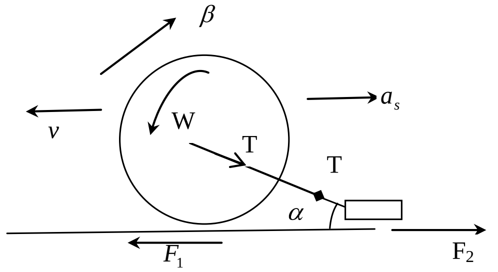
15. $F_2 - F_1 = (m + M)a_s$

$F_1 R = \dfrac{1}{2} MR^2 \dfrac{a_s}{R}$

$F_1 = \dfrac{1}{2} Ma_s$

$F_2 = \mu(mg - T\sin\alpha)$

$T\,Cos\alpha - F_1 = Ma_s$



Solving these equation

$$a_s = \frac{4\mu g}{3(1+\mu\tan\alpha)+4} = 2.08 m/sec^2$$

$$S = \frac{V_0^2}{2a_s} = \frac{4}{2\times 2.08} = 0.96m$$

$$t = \frac{u}{a} = 0.96$$

16. [5]

As the current lags behind the potential difference, the circuit contains resistance and inductance.

Power, $P = v_{rms}\times i_{rms}\times\cos\phi$

Here, $i_{rms} = \frac{V_{rms}}{Z}$, where $Z = \sqrt{[(R^2+(\omega L)^2)]}$

$\therefore\ P = \frac{V_{rms}^2\ \times\cos\phi}{Z}$ or $Z = \frac{v_{rms}^2\ \times\cos\phi}{P}$

So, $Z = \frac{(220)^2\times 0.8}{550} = 70.4\,ohm$

Now, power factor $\cos\theta = \frac{R}{Z}$ or $R = Z\cos\phi$

$R = 70.4\times 0.8 = 56.32$ ohm

Further, $Z^2 = R^2+(\omega L)^2$ or $(\omega L) = \sqrt{(Z^2-R^2)}$

Or $\omega L = \sqrt{(70.4)^2-(56.32)^2}$ = 42.2 ohm

When the capacitor is connected in the circuit,

$$Z = \sqrt{\left[R^2+\left(\omega L-\frac{1}{\omega C}\right)^2\right]}$$

and $\cos\phi = \frac{R}{\sqrt{\left[R^2+\left(\omega L-\frac{1}{\omega C}\right)^2\right]}}$

When $\cos\phi = 1,\ \omega L = \frac{1}{\omega C}$

$$\therefore\quad C = \frac{1}{\omega(\omega L)} = \frac{1}{2\pi f\,(\omega L)}$$

$$= \frac{1}{(2\times 3.14\times 50)\times(42.2)}$$

$$= 75\times 10^{-6} f\ = 75\mu F$$

17. [6]

$$P = 700\times 103\times 1.6\times 10^{-19}\times\frac{dN}{dt} = 10\times 10^{-3}$$

$$\frac{dN}{dt} = \frac{10^{-2}}{10^{-14}} \times \frac{1}{7 \times 16} = \frac{10^{12}}{11.2} = \lambda N_0$$

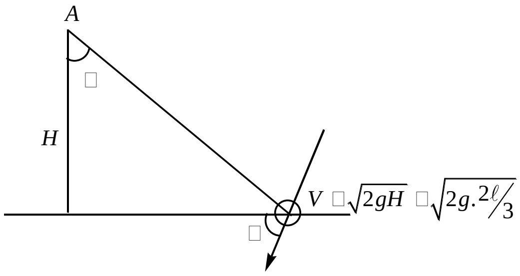
$$\lambda = \frac{ln\ 2}{14 \times 86400} \Rightarrow N_0 = \frac{14 \times 86400 \times 10^{12}}{11.2 \ln 2} = 156 \times 10^{15}$$

18. $B = \int dB = \int_L^{2L} \frac{\mu_0 \left(\frac{2}{\pi} dx\right)\left(\frac{2\pi}{2\pi}\right)}{2x}$

$= \frac{\mu_0}{\pi} \ell n2$

$= \frac{\mu_0}{4\pi} 4\ell n2$ x = 4.

19.



After collision the velocity of the ball $= V \cos q$

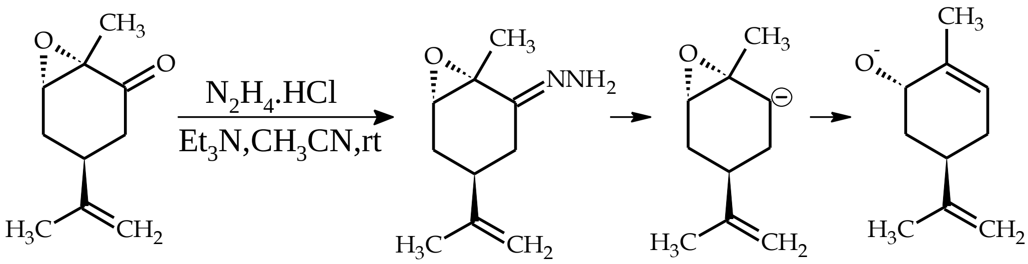
$= 2\sqrt{g\ell/3} \cdot 2/3 = \frac{4}{3}\sqrt{\frac{g\ell}{3}}$

20. $V = \sqrt{gx}$ (x is the hanging distance from the free end) $a = \frac{Vdv}{dx} = \frac{g}{2}$

CHEMISTRY

21. Conceptual

22.



23. Stability of intermediate

24. For the salt bridges, the most advantageous is to use salts in which the cation and the anion have the same mobility which assure the absence of so–called diffusion potential in the half–cell boundary. Thus, the most suitable salts are KNO_3 and NH_4NO_3

25. If HX is strong acid then maximum concentration of conjugate base is 0.033M. Therefore any value higher than this is not possible.

26. Basic definitions

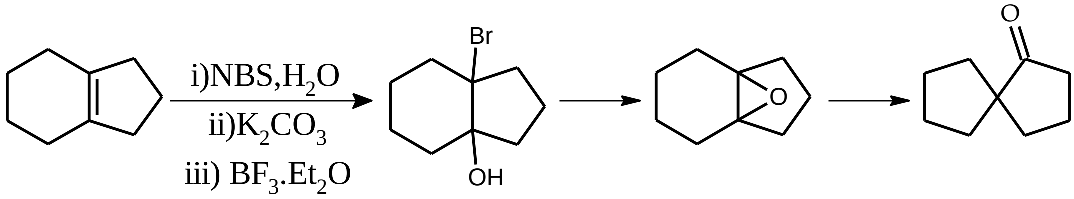
27. The MO electric configuration. Of He^{2+} is $\sigma 1s^2$. It is diamagnetic with bond order 1.

28. XeO_3 having 3 BP and 1 LP have trigonal pyramidal structure. XeF_4 with 4 BP and 2 LP have octahedral electron pair geometry with occupying lone pairs at the opposite corners get square planar structure.

29. Iron with HCl gas gives $FeCl_2$. This on heating with chlorine oxidizes to $FeCl_3$. Conc. H_2SO_4 being less volatile substitute more volatile HCl from $FeCl_3$ converting into $Fe_2(SO_4)_3$. Mg being more electropositive than iron reduces $Fe_2(SO_4)_3$ to Fe.

30. $\langle r \rangle_{n,l}$ decreases with increase in "*l*" value.

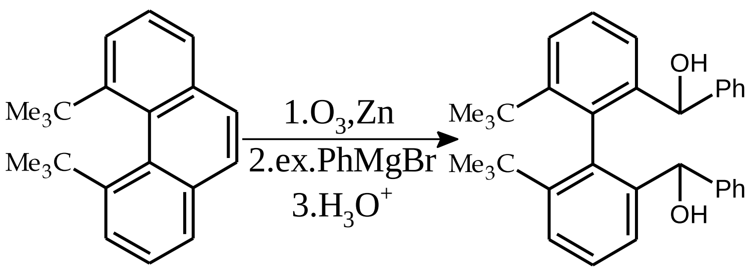
31. Perkin condensation: Carbanion Sandmeyer reaction: Free radical
Cannizaro raection: Oxyanion Hofmann bromamide reaction: Amide anion

32. 

33. AgI is more stable than $\left[Ag(NH_3)_2\right]^+$ HI neutralizes NH_3 forming NH_4^+ ion thus it cannot act as ligand.

34. A) Cu^{2+} first converts $Cu(CN)_2$ which decomposes to insoluble $Cu_2(CN)_2$ and then dissolves in excess KCN due to formation of complex.
B) With ammonia first insoluble $Cu(OH)_2$, then soluble complex in excess ammonia.
C) With KI forms insoluble Cu_2I_2.

35. $$-\frac{\Delta H^o}{R} = \frac{-12-(-9)}{0.001572-0.001412} = \frac{-3}{0.000016} = -18750$$
Substitute the value for $-\frac{\Delta H^o}{R}$ to find ΔS^o: $-12 = -18750 \times 0.001572 + \frac{\Delta S^o}{R}$
$$\frac{\Delta S^o}{R} = 17.475 \cdot$$

36. 

37. For PbF_2 $4.0\times10^{-8} = (0.01)[F^-]^2$ $[F^-]^2 = 4.0\times10.^{-6}$ $[F^-] = 2.0\times10^{-3}M$
For BaF_2 $1.5\times10^{-4} = (0.01)[F^-]^2$ $[F^-]^2 = 1.5\times10.^{-1}$ $[F^-] = 1.2\times10^{-2}M$
The PbF_2 will precipitate first because a lower value for the concentration of fluoride is needed.
From part (i) we known that the BaF_2 precipitates second, when the $[F^-]$ reaches $1.2\times10^{-2}M$
Since PbF_2 (s) is present, then $[Pb^{2+}]\,[F^-]^2 = K_{sp} = 4.0\times10^{-3}$
$[Pb^{2+}]\,(1.2\times10^{-2})^2 = 4.0\times10^{-3}$
$[Pb^{2+}] = 2.8\times10^{-4}M$

38. $a_{max} - \frac{a_{max}}{n} + a = a_{max} \Rightarrow a_{max} = n \times a$

39. $\Delta T = iK_f m$

$(273 - 269.28) = i \times 1.86 \times 1$

$3.72 = i \times 1.86$

i=2

$\alpha = \frac{i-1}{n-1}; (\alpha = 100\% = 1)$

$1 = \frac{2-1}{n-1} \Rightarrow n = 2$

40. Ionic radii $O^{2-}(140\,pm), O_2^{2-}(180\,pm)$ and $O_2^{-}(163\,pm)$. Due to more number of charges on peroxide ion it is bigger than super oxide ion.

Lattice energies (kJ mol^{-1})

	M_2O	M_2O_2	MO_2
Li	2907	2592	878
Na	2518	2309	799
K	2229	2114	741
Rf	2146	2025	706
Cs	2016	1948	679

Standard enthalpies of formation kJ mol^{-1}

	$\Delta_f H^o M_2O$	$\Delta_f HM_2O_2$	$\Delta_f HMO_2$
Li	–596	–640	–
Na	–416	–505	–270
K	–362	–494	–280
Rf	–330	–426	–310
Cs	–318	–402	–315

In the oxides of O_2^{2-} and O_2^{-} ions of oxides, peroxides and super oxides of alkali metals the bond order is 1 and 1.5. Hence O_2^{-} ion is more stable than O_2^{2-}

$L.E \alpha \frac{Z_+ \times Z_-}{R.c + Ra}$.

Among oxides and peroxides, the LE of peroxides are less than oxides due to more size with equal number of charges. Super oxides have less L.Es due to less number of charger (one).

As the size of cations increases the lattice energies of oxides, peroxides and super oxides decreases down the group.

During the formation of oxides, peroxides and super oxides the number of gaseous oxygen molecules converted into solid increases. Thus energy decreases.

Heat of formation of oxides and peroxides decrease down the group. For super oxides the heat of formation increases down the ground. Because of this reason thermal stability of oxides and peroxides decreases down the group while super oxides increases down the group.

When lattice energy is mole while the remaining factors are almost similar heat of formation will become more.

Peroxides and super oxides decompose forming oxides super oxides are less stable than peroxides indicate that. Lattice energy difference between oxide and superoxide is more than oxide and peroxide.

When the oxides, peroxides and super oxides dissolved in water they act as bronsted bases accepting proton from water forming basic solutions.

$O^{2-}+H_2O\rightarrow 2OH^-$

$2O_2^{2-}+2H_2O\rightarrow 4OH^-+O_2$

$2O_2^{-}+2H_2O\rightarrow 2OH^-+H_2O_2+O_2$

MATHS

41. $x-1=a,\ \frac{a^2+a+a+a+1+a^{-5}}{6}\geq 1$

$\therefore\ f(x)\geq 6\ \forall\ x>1$

42. $a>1, b>1, a\neq b$ if α is common root then

$(a-b)(ab-a-b-2)(\alpha-1)=0$

If $\alpha=1$ then $a=b$

If $\alpha\neq 1$ then $a=2\ b=4$ or $a=4, b=2 \Rightarrow ab=8$

43. $1+z+z^2+z^3+4z^4\left(1+z+z^2+z^3+z^4\right)+5z^9=5z^4$

44. $\Delta_1=-2a^2(p-q)(q-r)(r-p)$

$\Delta_2=a^2(p-q)(q-r)(r-p)$

$\Delta_1+2\Delta_2=0$

45. Starting with $1\_\_\_\_ = {}^8C_4=70$

Starting with $23\_\_\_ = {}^6C_3=20$

Starting with $245\_\_ = {}^4C_2=6$

$\therefore$ 97^{th} number is 24678

46. Point of concurrence is $(1,2)$

$\therefore$ required locus is $(x-1)^2+(y-2)^2=(2-1)^2+(3-2)^2$

$\Rightarrow x^2+y^2-2x-4y+3=0$

47. $g^1(x)=x^2\int_1^x f(u)du$

$g^1(1)=0, g^{11}(x)=x^2 f(x)+\int_1^x f(u)du.2x$

$\Rightarrow g^{11}(1)+g^1(1)=f(1)+0=3$

48. $\underset{n\to\infty}{Lt}\sum_{r=1}^{n}\tan^{-1}\frac{2r}{1-r^2+r^4}=\underset{n\to\infty}{Lt}\sum_{r=1}^{n}\tan^{-1}\left(\frac{\left(r^2+r\right)-\left(r^2-r\right)}{1+\left(r^4-r^2\right)}\right)$

$=\underset{n\to\infty}{Lt}\left(\tan^{-1}\left(n^2+n\right)-\tan^{-1}(0)\right)=\frac{\pi}{2}$

49. Clearly $a = 2, b = 3, c = 0$

50. $P\left(\frac{B}{A}\right) = \dfrac{P(B).P\left(\frac{A}{B}\right)}{P(B)P\left(\frac{A}{B}\right) + P(C)P\left(\frac{A}{C}\right)}$

$= \dfrac{\frac{1}{2}.\frac{1}{5}}{\frac{1}{2}.\frac{1}{5} + \frac{1}{2}.\frac{2}{7}} = \dfrac{7}{17}$

51. $A(7,2,4)B(5t-6, 3t-10, 8t-14)$ since angle between AB, BC is $\pi/4$ we get $t = 3,2$

$\therefore$ remaining sides are $\dfrac{x-7}{2} = \dfrac{y-2}{-3} = \dfrac{z-4}{6}$ and $\dfrac{x-7}{3} = \dfrac{y-2}{6} = \dfrac{z-4}{2}$

52. $h(x) = f(x)f(-x) = 9\ \forall x$

53. $f(x)$ is increasing $\forall x \in R$ if $f(0^-) \le f(0^+)$ and $f(1^-) \le f(1^+)$

$\Rightarrow -1 + K \le 1 + 1$ and $e + 1 \le e + l$

$\Rightarrow K \le 3$ and $\Rightarrow l \ge 1$

54. Circle will pass through both the foci of the ellipse

The foci are $\left(2\sqrt{2}, 2\sqrt{2}\right), \left(-2\sqrt{2}, -2\sqrt{2}\right)$

$b^2 = 9, a^2 = 25,\ e^2 = \dfrac{16}{25}$ centre $(0,0)$

55. $a + b + c = 9, ab + bc + ca = 26$

$\Rightarrow |A| = 3abc - a^3 - b^3 - c^3 = -27$

$\therefore |A_1| = |A|^2 = 3^6$

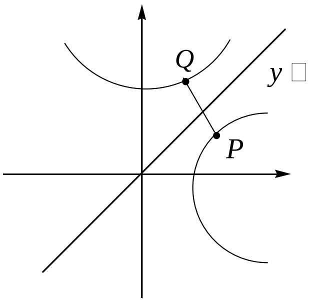
$|A_4| = 3^{48} = \left(3^{24}\right)^2$

Again $3^{48} = \left(3^2\right)^{24} = (1-10)^{24} = 1 - 240 + 27600 + 1000M$

$= 27361 + 1000$ multiple

$\therefore$ Last two digits, $6,1$ and last three are $3,6,1$

56.



$P = \left(\dfrac{3}{4}, \dfrac{1}{2}\right)$

$Q = \left(\dfrac{1}{2}, \dfrac{3}{4}\right)$

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

57. $\underset{x \to 0}{Lt} \frac{1 - \cos\left(2\sin^2 \frac{x}{4}\right)}{2^m x^n} = 1$

$\underset{x \to 0}{Lt} \frac{4\sin^4 x/4}{2^m x^n} = 2$

$\Rightarrow n = 4, \frac{2}{2^{8+m}} = 1 \Rightarrow m = -7$

$\therefore m + n = -3$

58. After reflection the curve is $12x^2 - 7xy - 12y^2 + 25 = 0$

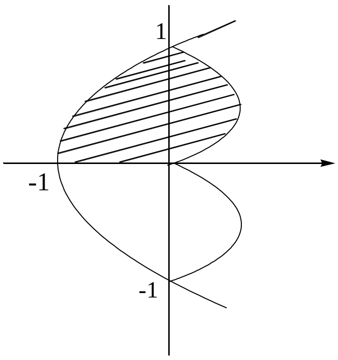
$|r - s| = |-7 + 12| = 5$

59. $\sin 9\theta = 3/5, \cos 9\theta = 4/5$

$\frac{3}{\sin 3\theta} - \frac{4}{\cos 3\theta} = 5\left[\frac{\sin 9\theta}{\sin 3\theta} - \frac{\cos 9\theta}{\cos 3\theta}\right]$

$= 5\left(\frac{\sin 6\theta}{\sin 3\theta \cos 3\theta}\right) = 10$

60.



$A = 2\int_0^1 \left(y\sqrt{1 - y^2} - \left(y^2 - 1\right)\right) dy$

$= 2 sq.units$