

MODEL SOLUTIONS TO IIT JEE 2011

Paper II – Code 0

PART I

1 2 3 4 5 6 7 8
C D B A D C A B

9	10	11	12
B, C, D	A, B, C, D	A, B, D	A, C, D

13 14 15 16 17 18
8 6 5 7 6 8

19 20

A – r, s, t

B – p, s

C – r, s

D – q, r

A – p, r, s

B – r, s

C – t

D – p, q, r, t

Section I

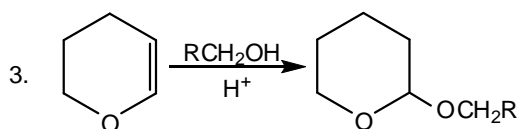
1. $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$, $\text{Na}_3[\text{Co}(\text{ox})_3]$, $[\text{K}_2\text{Pt}(\text{CN})_4]$ & $[\text{Zn}(\text{H}_2\text{O})_6](\text{NO}_3)_2$ are diamagnetic.

$$2. E_{\text{cell}} = E_{\text{cell}}^0 + \frac{0.06}{4} \log \frac{P_{\text{O}_2} \times [\text{H}^+]^4}{[\text{Fe}^{2+}]^2}$$

$$= 1.67 + 0.015 \log \frac{0.1 \times (10^{-3})^4}{(10^{-3})^2}$$

$$= 1.67 - 0.015 \times 7$$

$$= 1.57 \text{ V}$$



4. CuS & HgS are insoluble in dilute mineral acids. Cu^{2+} & Hg^{2+} ions belong to group II of qualitative analysis.
5. Haematite is Fe_2O_3 . Oxidation state of Fe is +3
Magnetite is Fe_3O_4 . Oxidation state of Fe is +2 and +3.

6. Aromatic primary amines form diazonium salt with NaNO_2 and HCl at low temperature which couples with β -naphthol to form coloured azo dye.

$$7. \Delta T_f = i \times K_f \times m$$

$$= 4 \times 1.86 \times \frac{0.1}{329} \times 10$$

$$= 0.023$$

$$\text{F.P} = -2.3 \times 10^{-2} \text{ } ^\circ\text{C}$$

8. The structure given is that of β -D-glucose.

Section II

9. Cu^{+2} is reduced to Cu^{+1} by CN^- & SCN^-
 CuCl_2 in aqueous acidic medium is reduced to CuCl on boiling with metallic Cu
10. In (B), (C) and (D), $\text{X}-(\text{CH}_2)_4-\text{X}$ is converted to a diamine which can form condensation polymer with adipic acid. In (A), $\text{X}-(\text{CH}_2)_4-\text{X}$ is converted to a diol which gives polyester.

$$11. K = \frac{0.693}{t_{1/2}}$$

K increases with increase of temperature and hence half life decreases.

$$t = \frac{t_{1/2}}{0.3} \log \frac{100}{0.4} = 8t_{1/2}$$

$$R = R_0 e^{-kt}$$

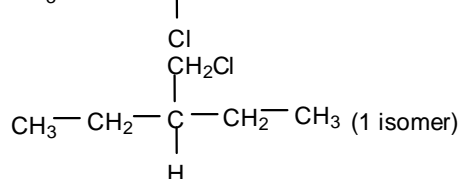
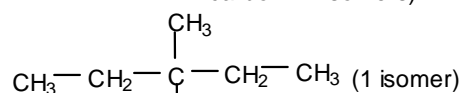
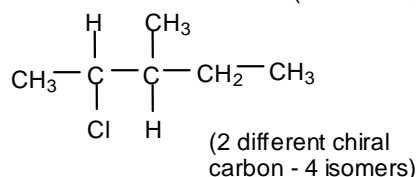
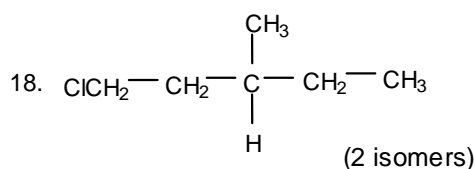
12. $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$ (acid medium)
 $\text{MnO}_4^- \rightarrow \text{MnO}_2$ (Neutral and aqueous mediums)

Section III

13. A truncated octahedron has 8 hexagonal and 6 square faces. (36 edges and 24 vertices)
14. There are six C – H bonds that can involve in hyperconjugation.
15. $\text{PCl}_5 + \text{SO}_2 \rightarrow \text{POCl}_3 + \text{SOCl}_2$
 $\text{PCl}_5 + \text{H}_2\text{O} \rightarrow \text{POCl}_3 + 2\text{HCl}$
 $\text{PCl}_5 + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2\text{Cl}_2 + 2\text{POCl}_3 + 2\text{HCl}$
 $6\text{PCl}_5 + \text{P}_4\text{O}_{10} \rightarrow 10\text{POCl}_3$
 $\text{PCl}_5 \rightarrow \text{PCl}_3 + \text{Cl}_2, 2\text{PCl}_3 + \text{O}_2 \rightarrow 2\text{POCl}_3$

16. $[\text{Cl}^-]$ from $\text{CuCl} = 10^{-3}$
 $K_{sp}(\text{AgCl}) = [\text{Ag}^+][\text{Cl}^-]$
 $[\text{Ag}^+] = \frac{1.6 \times 10^{-10}}{10^{-3}} = 1.6 \times 10^{-7}$

17. Millimoles of $\text{Cl}^- = 30 \times 0.01 \times 2$
 $= 0.6$
 Vol. of 0.1 M $\text{AgNO}_3 = \frac{0.6}{0.1} = 6 \text{ mL}$



Section IV

19. (A) is intramolecular aldol condensation
 (B) involves Grignard reagent addition to carbonyl compound.
 (C) involves nucleophilic addition and dehydration.
 (D) involves dehydration and intramolecular Friedel–Craft reaction.
20. (A) involves transition from solid to gas phase with the absorption of heat.
 (B) is exothermic and a gaseous product is formed from a solid.
 (C) involves association
 (D) white phosphorous is converted to the polymeric red allotropic form on heating. Different solids are considered as different phases.

PART II

21 22 23 24 25 26 27 28
B B C A C D C A

29 30 31 32
B, C C C, D A, B, D

33 34 35 36 37 38
2 7 5 5 4 4

39

A – p, t
B – p, s
C – q, s
D – q, r

40

A – p, r, t
B – p, r
C – q, s
D – r, t

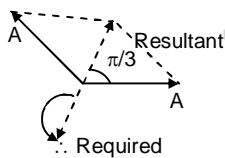
Section I

21. Escape KE = $\frac{GMm}{r}$

and $V = \sqrt{\frac{GM}{r}}$

Eliminate r

22. Phasor:



$A \sin \left(\omega t + \frac{4\pi}{3} \right)$

23. L.C = 0.01 mm
 diameter = 2.70 mm
 % error = $\frac{1}{2.70}$

$\frac{\Delta \rho}{\rho} = \frac{3\Delta \text{dia}}{\text{dia}} + \frac{\Delta m}{m}$

% error = $\frac{3}{2.70} + 2 = 3.1\%$

24. Take dr at r

No. of turns = $\frac{N \cdot dr}{(b-a)}$

$-dB = \frac{\mu_0 N}{(b-a)} dr \cdot \frac{i}{2r}$

$B = \int dB = \frac{\mu_0 Ni}{2(b-a)} \ln \frac{b}{a}$

25. At θ_c , 100% reflected.
 (B or C) But C is correct.
 ∴ At $\theta = 0$, T + R = 100,
 R ≠ 0

26. $0.01 V = 0.01 V' + 0.2 V''$

But time of fall = $\sqrt{\frac{2h}{g}} = 1$

∴ $V' = 100, V'' = 20$

∴ $V = 500$

27. If non-conservative induced electric field this pattern is possible.

28. $T = 2\pi \sqrt{\frac{m}{K}}$ holds.

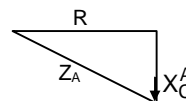
At equilibrium position,

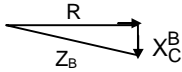
$kx_0 = QE$

∴ Equilibrium shifted.

Section II

29.





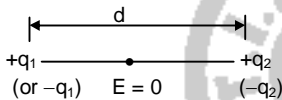
$$X_C^B = \frac{1}{C\omega} < X_C^A$$

$$\Rightarrow Z_B < Z_A$$

$$\Rightarrow I_R^B > I_R^A \text{ and } V_C^A > V_C^B$$

30. During collision, an impulse is exerted on the ring which has a horizontal component (towards right) and a vertical component (downwards). This produces an additional upward normal reaction (by floor on ring) and a horizontal frictional force (towards left) \Rightarrow (C) is correct. Since kinetic frictional force is not a finite force (due to varying N) acting for an infinitesimally small duration, its effect on changing the momentum of ring during collision is not negligible. Hence, conservation of horizontal linear momentum cannot be applied.

31.



$$W_{\text{agent}} = \Delta U = q(V_2 - V_1) \\ = 1 \times (V_B - V_A) \\ = (V_B - V_A)$$

32. $Vd_A + Vd_B = 2Vd_F = 0$

$$\therefore d_A + d_B = 2d_F$$

Obviously $d_A < d_F$ and $d_B > d_F$

Section III

33. $\frac{4}{3} - \frac{1}{-24} = \frac{7}{4} - 1 + \frac{4}{3} - \frac{7}{4}$

$\Rightarrow v = 16$ from top surface of liquid

$\Rightarrow 2$ cm from bottom surface of liquid

34. $h\nu = \frac{1242 \text{ eV nm}}{200\text{nm}} = 6.21 \text{ eV}$

$$KE = 6.21 - 4.7 = 1.51 \text{ eV}$$

$$\frac{kq}{r} = 1.5 \text{ V for stopping electrons.}$$

$$\therefore q = \frac{1.5 \times (10^{-2})}{9 \times 10^9} = Ne$$

$$\therefore N = 1 \times 10^7$$

35. $T = \frac{2u \sin 60^\circ}{g} = \frac{2 \times 10 \times \sqrt{3}}{10 \times 2} = \sqrt{3} \text{ s}$

$$(u \cos \theta) T = \frac{1}{2} aT^2 + 1.15$$

$$(u = 10 \text{ m s}^{-1})$$

$$\Rightarrow a = 5 \text{ m s}^{-2}$$

36. $E_{\text{eff}} = \frac{E_1 r_2 + E_2 r_1}{(r_1 + r_2)}$
 $= \frac{(6 \times 2) + (1 \times 3)}{(1 + 2)}$
 $= 5 \text{ V}$

37. $\frac{1}{2} mv^2 = \mu mg S + \frac{1}{2} kS^2$

$$m = 0.18 \text{ kg}, \mu = 0.1,$$

$$g = 10 \text{ m s}^{-2}, S = 0.06 \text{ m}$$

$$\Rightarrow v^2 = 0.12 + 0.04 = 0.16$$

$$\Rightarrow v = \sqrt{0.16} = 0.4 \text{ m s}^{-1}$$

$$= \frac{4}{10} \Rightarrow N = 4$$

38. $Z^2 = R^2 + X_C^2$
 $\Rightarrow X_C^2 = 1.25 R^2 - R^2$
 $= 0.25 R^2$
 $\Rightarrow X_C = 0.5 R$
 $\Rightarrow C = \frac{1}{X_C \omega} = \frac{1}{0.5 R \times 500} = \frac{1}{250 R}$

$$\tau = RC = \frac{1}{250} \text{ s} = 4 \text{ ms}$$

Section IV

39. Knowledge based.

40. Knowledge based.

PART III

41	42	43	44	45	46	47	48
B	D	A	A	B	C	D	C
49		50	51		52		
A, D		A	A, B, D		A, B, C, D		
53		54	55	56	57	58	
9		2	3*	0	2	9	

59	60
A – s	A – q
B – t	B – p
C – r	C – s
D – r	D – t*

Section I

41. Let α denote the common root

$$\begin{aligned} \alpha^2 + b\alpha - 1 &= 0 \\ \alpha^2 + \alpha + b &= 0 \\ b\alpha - 1 &= \alpha + b \\ \alpha(b - 1) &= b + 1 \\ \alpha &= \frac{b+1}{b-1} \\ (b+1)^2 + b(b^2 - 1) - (b-1)^2 &= 0 \\ 4b + b(b^2 - 1) &= 0 \\ 4 + b^2 &= 0 \\ b^2 &= -3 \\ b &= i\sqrt{3} \end{aligned}$$

42. Let the circle be

$$\begin{aligned} x^2 + y^2 + 2gx + 2fy + c &= \\ \text{Passed thro } (-1, 0) &\longrightarrow -2g + c = -1 \quad (1) \\ \text{Passes thro } (0, 2) &\longrightarrow 4f + c = -4 \quad (2) \\ \sqrt{g^2 + f^2} - c &= g \\ f^2 - c &= 0 \\ f^2 &= c \\ 4f + f^2 &= -4 \\ (f + 2)^2 &= 0 \Rightarrow f = -2 \\ \Rightarrow c &= -4 - 4f = 4 \\ 2g &= 5, g = \frac{5}{2} \\ \text{Circles is } x^2 + y^2 + 5x - 4y + 4 &= 0 \\ (-4, 0) &\text{ satisfies the equation} \end{aligned}$$

43. fogogo $f(x)$
= fogog(x^2)

$$\begin{aligned} &= \text{fog}(\sin(x)^2) \\ &= f(\sin(\sin(x^2))) \\ &= \sin^2(\sin(x^2)) \\ \text{gogof}(x) &= \text{gog}(x^2) \\ &= g(\sin(x)^2) \\ &= \sin(\sin(x^2)) \\ \therefore \sin^2(\sin(x^2)) &= \sin(\sin(x^2)) \\ \Rightarrow \sin(\sin(x^2))(\sin(\sin(x^2)) - 1) &= 0 \\ \Rightarrow \sin(\sin(x^2)) = 0 \text{ or } \sin(\sin(x^2)) &= 1 \\ \Rightarrow \sin(x^2) = 0 \text{ or } \sin(x^2) &= 1 \\ \Rightarrow x^2 = n\pi \\ \therefore x &= \pm \sqrt{n\pi} \quad n = \{0, 1, 2, \dots\} \end{aligned}$$

44. for non-singular matrices, $\begin{vmatrix} 1 & a & b \\ \omega & 1 & c \\ \omega^2 & \omega & 1 \end{vmatrix} \neq 0$

$$\begin{aligned} \Rightarrow 1 - c\omega - a\omega - ac\omega^2 &\neq 0 \\ (1 - a\omega)(1 - c\omega) &\neq 0 \\ \Rightarrow a \neq \frac{1}{\omega} = \omega^2 \text{ and } c &\neq \frac{1}{\omega} = \omega^2 \\ \therefore a = c = \omega \text{ and } b &= \omega \text{ or } \omega^2 \\ \text{Hence there are two such matrices.} \end{aligned}$$

45. Let the point be ' θ '

$$\begin{aligned} \text{Normal at } \theta \text{ is} \\ \frac{ax}{\sec \theta} + \frac{by}{\tan \theta} &= a^2 + b^2 \\ \text{Normal passes thro } (9, 0) \\ \frac{9a}{\sec \theta} &= a^2 + b^2 \quad (1) \\ a \sec \theta &= 6 \end{aligned}$$

$$\sec \theta = \frac{6}{a}$$

(1) reduces

$$9a \times \frac{a}{6} = a^2 + b^2$$

$$\frac{3a^2}{2} = a^2 + b^2$$

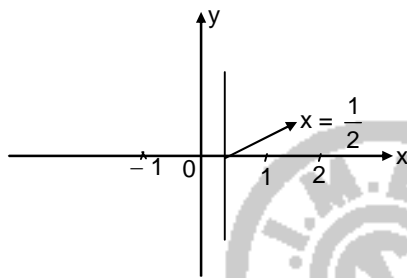
$$= a^2 + a^2(e^2 - 1)$$

$$\frac{3}{2} = 1 + e^2 - 1$$

$$= e^2$$

$$e = \sqrt{\frac{3}{2}}$$

46.



$$f(x) = f(1-x)$$

\Rightarrow curve is symmetrical about $x = \frac{1}{2}$

$$R_1 = \int_1^2 xf(x) dx$$

$$= \int_1^2 (-1+2-x)f(-1+2-x) dx$$

$$\int_1^2 (1-x)f(1-x) dx$$

$$= \int_{-1}^2 (1-x)f(x) dx$$

$$\int_{-1}^2 f(x) dx - \int_{-1}^2 xf(x) dx$$

$$= R_2 - R_1$$

$$2R_1 = R_2$$

47. Which is of the form 1^α

$$\lim_{x \rightarrow 0} (f(x)-1)g(x)$$

$$= e^{(1+x \log(1+b^2)-1) \frac{1}{x}}$$

$$= e^{\frac{x \log(1+b^2)}{x}}$$

$$= e^{\log(1+b^2)}$$

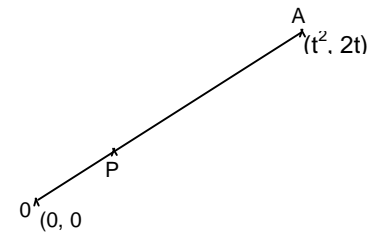
$$\therefore 1 + b^2 = 2b \sin^2 \theta$$

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

Since $b > 0$

$$\therefore \theta = \pm \frac{\pi}{2}$$

48.



$$\frac{OP}{PA} = \frac{1}{3}$$

Let P be (x, y)

$$X = \frac{t^2}{4}, Y = \frac{2t}{4}$$

Locus of P is

$$4X = 4Y^2$$

$$\Rightarrow Y^2 = X$$

Section II

$$49. P(E \cap \bar{F}) + P(F \cap \bar{E}) = \frac{11}{25}$$

$$\text{Also } P(\bar{E} \cap \bar{F}) = \frac{2}{25}$$

$$\text{But } P(E \cap \bar{F}) = P(\bar{E} \cap \bar{F}) = P(\overline{E \cup F})$$

$$\therefore P(E \cap F) = 1 - \frac{2}{25} = \frac{23}{25}$$

$$P(E \cup F) = 1 - \frac{2}{25} = \frac{23}{25}$$

$$P(E \cup F) = P(E \cap \bar{F}) + P(F \cap \bar{E}) + P(E \cap F)$$

(refer figure)

$$\therefore \frac{23}{25} = \frac{11}{25} + P(E \cap F)$$

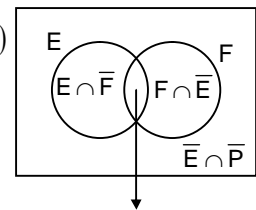
$$\therefore P(E \cap F) = \frac{12}{25} = P(E) \times P(F)$$

From the options

$$P(E) = \frac{3}{5} \text{ and } P(F) = \frac{4}{5}$$

or

$$P(E) = \frac{4}{5} \text{ and } P(F) = \frac{3}{5}$$



$$50. f(x) = \frac{b-x}{1-bx}$$

$$f: (0, 1) \rightarrow \mathbb{R}$$

In the given range $f(x)$ is not one-to-one, and hence

$f^{-1}(x)$ does not exist.

51. Normal at 't' is

$$y + xt = 2t + t^3$$

$$6 + 9t = 2t + t^3$$

$$t^3 - 7t - 6 = 0$$

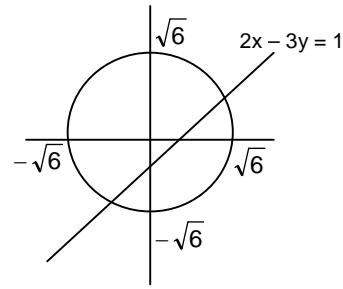
$$t = -1, t = -2, t = 3$$

Normal are

$$y - x = -3,$$

And $y + 3x = 33$

And $y - 2x = -12$



52. $f\left(-\frac{\pi^-}{2}\right) = 0$

$$f\left(\frac{-\pi^+}{2}\right) = -\cos\left(\frac{-\pi}{2}\right) = 0$$

(A) is true

$f(x)$ is continuous at $x = 0$

$$f'(0^-) = 0$$

$$f'(0^+) = 1$$

(B) is true

$F(x)$ is continuous at $x = 1$

$$f'(1) = 1$$

$$f'(1^+) = 1$$

$f(x)$ is differentiable at $x = 1$.

(c) is true.

$$\frac{22}{14} = \frac{11}{7} = 1$$

$$x = \frac{-3}{2} \text{ lies in } \left(-\infty, \frac{-\pi}{2}\right)$$

$\Rightarrow f(x)$ is differentiable there, since $f(x)$ is a linear function in that interval

(D) is true.

All points $\in S$ lies inside the circle, except $\left(\frac{5}{2}, \frac{3}{4}\right)$ and $\left(\frac{1}{8}, \frac{1}{4}\right)$ satisfies the inequality

$$2x - 3y - 1 < 0.$$

\therefore The remaining 2 points lie on the smaller intersection.

55. *Assuming $\omega = e^{\frac{i2\pi}{3}}$

$$1 + \omega + \omega^2 = 0$$

$$|x|^2 + |y|^2 + |z|^2$$

$$= (a + b + c)(\bar{a} + \bar{b} + \bar{c})$$

$$+ (a + b\omega + c\omega^2)(\bar{a} + \bar{b}\omega^2 + \bar{c}\omega)$$

$$+ (a + b\omega^2 + c\omega)(\bar{a} + \bar{b}\omega + \bar{c}\omega^2)$$

$$= 3(|a|^2 + |b|^2 + |c|^2)$$

$$\therefore \frac{|x|^2 + |y|^2 + |z|^2}{|a|^2 + |b|^2 + |c|^2} = 3$$

56. I. $F = e^{g(x)}$

\therefore Differential Equation is

$$ye^{g(x)} = g(x)g'(x)e^{g(x)}$$

Let $g(x) = t$

$$ye^t = \int te^t dt$$

$$ye^t = te^t - \int 1 \cdot e^t dt$$

$$= te^t - e^t + c$$

$$= (t - 1)e^t + c$$

$$\therefore y = (t - 1) + ce^{-t}$$

$$\therefore y(x) = (g(x) - 1) + ce^{-g(x)}$$

$$x = 0 \Rightarrow y = 0$$

$$\therefore c = 1$$

$$y(x) = (g(x) - 1) + e^{-g(x)}$$

$$\therefore y(2) = (g(2) - 1) + e^{-g(2)}$$

$$= 0 - 1 + 1 = 0$$

57. $x^4 - 4x^3 + 12x^2 + x - 1 = 0$

$$f(0) < 0, f(1) > 0$$

\therefore one root in $(0, 1)$

$$f'(x) = 4x^3 - 12x^2 + 24x + 1$$

$$f''(x) = 12(x^2 - 2x + 2) > 0$$

Section III

53. $M = \begin{pmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{pmatrix}$

$$M \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} = \begin{pmatrix} -1 \\ 2 \\ 3 \end{pmatrix} \Rightarrow a_2 = -1; b_2 = 2; c_2 = 3$$

$$M \begin{pmatrix} 1 \\ -1 \\ 0 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix} \Rightarrow a_1 + 1 = 1 \Rightarrow a_1 = 0$$

$$c_1 - 3 = -1 \Rightarrow c_1 = 2$$

$$M \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 12 \end{pmatrix} \Rightarrow 2 + 3 + c_3 = 12$$

$$\Rightarrow c_3 = 7.$$

$$A_1 + b_2 + c_3 = 0 + 2 + 7 = 9$$

54. Origin lies on the side $2x - 3y - 1 < 0$

The smaller intersection is on $2x - 3y - 1 > 0$

$\Rightarrow f^1(x)$ is increasing
 \therefore it has exactly one root
 $\Rightarrow f(x)$ may have almost 2 distinct roots
 Since real roots are even in number
 $f(x)$ has 2 distinct real roots

58. $(\bar{r}-\bar{c}) \times \bar{b} = 0$
 $\bar{r} = \bar{c} + m\bar{b}$
 $0 = \bar{r} \cdot \bar{a} = \bar{c} \cdot \bar{a} + m \bar{b} \cdot \bar{a}$
 $= -4 + m, \quad m = 4$
 $\bar{r} = \bar{c} + 4\bar{b}$
 $\bar{r} \cdot \bar{b} = \bar{c} \cdot \bar{b} + 4\bar{b}^2$
 $= 1 + 8 = 9$
 $\in (-\infty, -1] \cup [1, \infty)$

Section IV

59. (a) $\operatorname{Re} \left(\frac{2iz}{1-z^2} \right)$
 $\operatorname{Re} \left[\frac{2i}{z-z} \right]$
 $= \operatorname{Re} \left(\frac{2i}{z-z} \right)$
 $= \operatorname{Re} \frac{1}{(-\operatorname{Im} z)}$
 $= \frac{1}{-\operatorname{Im} z}$

(b) Put $y = 3^{x-1}$
 $\frac{8}{3}y > 1 - y^2 \leq 1$
 $\Rightarrow \left| \frac{8}{3}xy \right| \leq |1 - xy^2|$
 $\Rightarrow \frac{8}{3}y \leq 1 - y^2 \quad \text{if } 1 - y^2 \geq 0$
 $3y^2 + 8y - 3 \leq 0 \quad \text{i.e. } y \in [-1, 1]$
 $3y^2 + 8y - y - 3 \leq 0$
 $(3y - 1)(y + 3) \leq 0 \quad y \in \left[-3, \frac{1}{3}\right]$
 $y \in \left[0, \frac{1}{3}\right] = 3^{-1} \leq \frac{1}{3}$
 $x \leq 0$
 $\frac{8}{3}y \leq y^2 - 1 \quad \text{if } 1 - y^2 \leq 0$
 $3y^2 - 8y - 3 \geq 0$
 $3y^2 - 9y + y - 3 \geq 0$
 $(3y + 1)(y - 3) \geq 0 \quad y \geq 3$
 $\Rightarrow 3^{x-1} \geq 3$

$x \geq 2 \quad (r, t)$
 $\therefore x \in (-\infty, 0] \cup [2, \infty)$

(c) $\frac{1}{\cos^3 \theta} \begin{vmatrix} \cos \theta & \sin \theta & \cos \theta \\ -\sin \theta & \cos \theta & \sin \theta \\ -\cos \theta & -\sin \theta & \cos \theta \end{vmatrix}$
 $= \frac{1}{\cos^3 \theta} \begin{vmatrix} 0 & 0 & 2 \cos \theta \\ -\sin \theta & \cos \theta & \sin \theta \\ -\cos \theta & -\sin \theta & \cos \theta \end{vmatrix}$
 $= \frac{2 \cos \theta}{\cos^3 \theta} = 2 \sec^2 \theta \in [2, \infty)$

(d) $x^{\frac{3}{2}}(3x - 10)$
 $= 3x^{\frac{5}{2}} - 10x^{\frac{3}{2}}$
 $f'(x) = \frac{15}{2}x^{\frac{3}{2}} - 15\sqrt{x}$
 $= 15\sqrt{x} \left(\frac{x}{2} - 1 \right) \geq 0$
 If $x \geq 2$.

60. (a) $\cos \theta = \frac{-1+3}{4} = \frac{1}{2}$
 $\therefore \theta = \frac{\pi}{3}$
 \therefore required angle is $\pi - \frac{\pi}{3} = \frac{2\pi}{3}$

(b) $\int_a^x (f(x) - 3x) dx = a^2 - x^2$
 $f(x) - 3x = -2x \Rightarrow f(x) = x$
 $\therefore f\left(\frac{\pi}{6}\right) = \frac{\pi}{6}$

(c) $\frac{\pi}{\log 3} \log [\sec \pi x + \tan \pi x] \Big|_{\frac{\pi}{6}}^{\frac{5\pi}{6}} = \pi$

(d) $\left| \operatorname{Arg} \left(\frac{1}{z-1} \right) \right| = |\operatorname{Arg}(z-1)|$
 Maximum value = $\frac{\pi}{2}$, but it is never attained*.