1 **a** $2x < 6$
$x < 3$

b $3x \geq 21$
$x \geq 7$

c $2x > 8$
$x > 4$

d $3x \leq 36$
$x \leq 12$

e $5x \geq -15$
$x \geq -3$

f $\frac{1}{3}x < 1$
$x < 3$

g $9x \geq 54$
$x \geq 6$

h $3x < -4$
$x < -\frac{4}{3}$

i $x < 14$

j $4x \leq -10$
$x \leq -\frac{5}{2}$

k $2 < 3x$
$x > \frac{2}{3}$

l $5 \geq \frac{1}{2}x$
$x \leq 10$

2 **a** $y > 7$

b $4p \leq 2$
$p \leq \frac{1}{2}$

c $6 < 2x$
$x > 3$

d $2a \geq 4$
$a \geq 2$

e $15 < 3u$
$u > 5$

f $2b \geq 9$
$b \geq \frac{9}{2}$

g $3x < -18$
$x < -6$

h $y \geq -13$

i $-20 \leq 4p$
$p \geq -5$

j $r - 2 > 6$
$r > 8$

k $3 - 6t \leq t - 4$
$7 \leq 7t$
$t \geq 1$

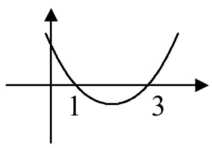
l $6 + 2x \geq 24 - 4x$
$6x \geq 18$
$x \geq 3$

m $7y + 21 - 6y + 2 < 0$
$y < -23$

n $20 - 8x > 21 - 6x$
$-1 > 2x$
$x < -\frac{1}{2}$

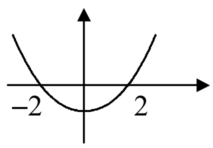
o $12u - 3 - 5u + 15 < 9$
$7u < -3$
$u < -\frac{3}{7}$

3 **a** $(x - 1)(x - 3) < 0$



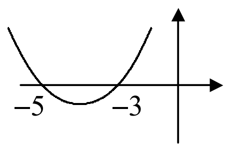
$\therefore 1 < x < 3$

b $(x + 2)(x - 2) \leq 0$



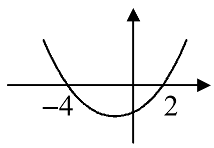
$\therefore -2 \leq x \leq 2$

c $(x + 5)(x + 3) < 0$



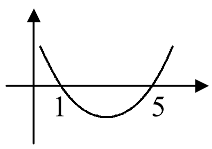
$\therefore -5 < x < -3$

d $x^2 + 2x - 8 \leq 0$
$(x + 4)(x - 2) \leq 0$



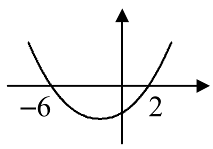
$\therefore -4 \leq x \leq 2$

e $(x - 1)(x - 5) > 0$



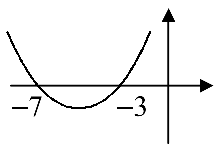
$\therefore x < 1$ or $x > 5$

f $x^2 + 4x - 12 > 0$
$(x + 6)(x - 2) > 0$



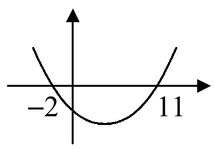
$\therefore x < -6$ or $x > 2$

g $(x + 7)(x + 3) \geq 0$



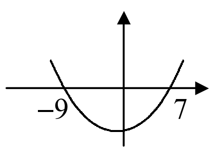
$\therefore x \leq -7$ or $x \geq -3$

h $x^2 - 9x - 22 < 0$
$(x + 2)(x - 11) < 0$



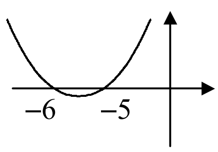
$\therefore -2 < x < 11$

i $x^2 + 2x - 63 \geq 0$
$(x + 9)(x - 7) \geq 0$



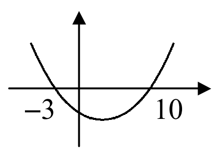
$\therefore x \leq -9$ or $x \geq 7$

j $(x + 6)(x + 5) > 0$



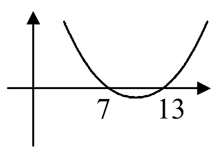
$\therefore x < -6$ or $x > -5$

k $x^2 - 7x - 30 < 0$
$(x + 3)(x - 10) < 0$



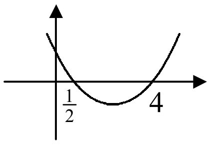
$\therefore -3 < x < 10$

l $x^2 - 20x + 91 \geq 0$
$(x - 7)(x - 13) \geq 0$



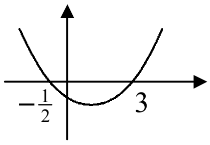
$\therefore x \leq 7$ or $x \geq 13$

4 **a** $(2x - 1)(x - 4) \leq 0$



$\therefore \frac{1}{2} \leq x \leq 4$

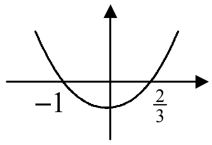
b $(2r + 1)(r - 3) < 0$



$\therefore -\frac{1}{2} < r < 3$

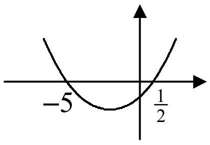
c $3p^2 + p - 2 \leq 0$

$(3p - 2)(p + 1) \leq 0$



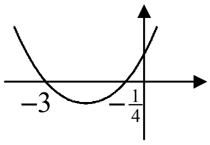
$\therefore -1 \leq p \leq \frac{2}{3}$

d $(2y - 1)(y + 5) > 0$



$\therefore y < -5$ or $y > \frac{1}{2}$

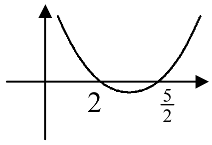
e $(4m + 1)(m + 3) < 0$



$\therefore -3 < m < -\frac{1}{4}$

f $2x^2 - 9x + 10 \geq 0$

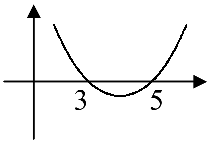
$(2x - 5)(x - 2) \geq 0$



$\therefore x \leq 2$ or $x \geq \frac{5}{2}$

g $a^2 - 8a + 15 < 0$

$(a - 3)(a - 5) < 0$

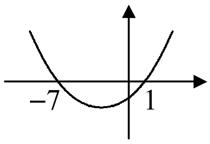


$\therefore 3 < a < 5$

h $x^2 + 4x \leq 7 - 2x$

$x^2 + 6x - 7 \leq 0$

$(x + 7)(x - 1) \leq 0$

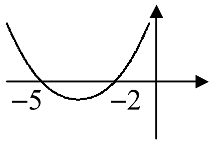


$\therefore -7 \leq x \leq 1$

i $y^2 + 9y > 2y - 10$

$y^2 + 7y + 10 > 0$

$(y + 5)(y + 2) > 0$

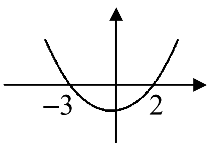


$\therefore y < -5$ or $y > -2$

j $2x^2 + x > x^2 + 6$

$x^2 + x - 6 > 0$

$(x + 3)(x - 2) < 0$

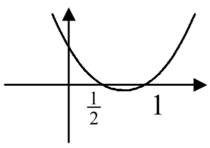


$\therefore -3 < x < -2$

k $5u - 6u^2 < 3 - 4u$

$2u^2 - 3u + 1 > 0$

$(2u - 1)(u - 1) > 0$

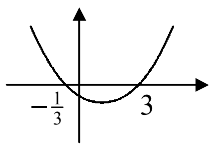


$\therefore u < \frac{1}{2}$ or $u > 1$

l $2t + 3 \geq 3t^2 - 6t$

$3t^2 - 8t - 3 \leq 0$

$(3t + 1)(t - 3) \leq 0$

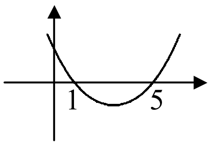


$\therefore -\frac{1}{3} \leq t \leq 3$

m $y^2 - 4y + 4 \leq 2y - 1$

$y^2 - 6y + 5 \leq 0$

$(y - 1)(y - 5) \leq 0$

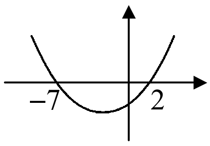


$\therefore 1 \leq y \leq 5$

n $p^2 + 5p + 6 \geq 20$

$p^2 + 5p - 14 \geq 0$

$(p + 7)(p - 2) \geq 0$

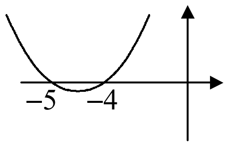


$\therefore p \leq -7$ or $p \geq 2$

o $26 + 4x < 6 - 5x - x^2$

$x^2 + 9x + 20 < 0$

$(x + 5)(x + 4) < 0$



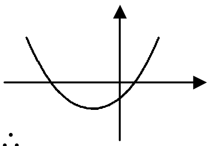
$\therefore -5 < x < -4$

5 **a** for critical values

$x = \frac{-2 \pm \sqrt{4+4}}{2}$

$x = \frac{-2 \pm 2\sqrt{2}}{2}$

$x = -1 \pm \sqrt{2}$



$\therefore$

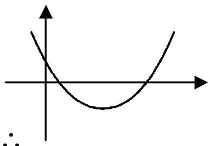
$-1-\sqrt{2} < x < -1+\sqrt{2}$

b for critical values

$x = \frac{6 \pm \sqrt{36-16}}{2}$

$x = \frac{6 \pm 2\sqrt{5}}{2}$

$x = 3 \pm \sqrt{5}$



$\therefore$

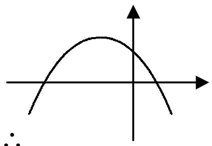
$x < 3-\sqrt{5}$ or $x > 3+\sqrt{5}$

c for critical values

$x = \frac{6 \pm \sqrt{36+44}}{-2}$

$x = \frac{6 \pm 4\sqrt{5}}{-2}$

$x = -3 \pm 2\sqrt{5}$



$\therefore$

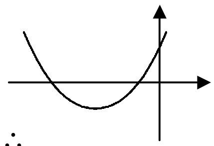
$-3-2\sqrt{5} < x < -3+2\sqrt{5}$

d for critical values

$x = \frac{-4 \pm \sqrt{16-4}}{2}$

$x = \frac{-4 \pm 2\sqrt{3}}{2}$

$x = -2 \pm \sqrt{3}$



$\therefore$

$x \leq -2-\sqrt{3}$ or $x \geq -2+\sqrt{3}$

6 **a** equal roots

$\therefore\ b^2 - 4ac = 0$

$36 - 4k = 0$

$k = 9$

b real and distinct roots

$\therefore\ b^2 - 4ac > 0$

$4 - 4k > 0$

$4 > 4k$

$k < 1$

c no real roots

$\therefore\ b^2 - 4ac < 0$

$9 - 4k < 0$

$9 < 4k$

$k > \frac{9}{4}$

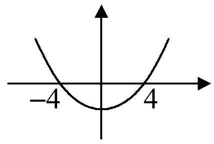
d real roots

$\therefore\ b^2 - 4ac \geq 0$

$k^2 - 16 \geq 0$

$(k + 4)(k - 4) \geq 0$

$k \leq -4$ or $k \geq 4$



e equal roots

$\therefore\ b^2 - 4ac = 0$

$1 + 4k = 0$

$k = -\frac{1}{4}$

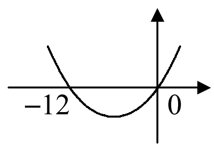
f no real roots

$\therefore\ b^2 - 4ac < 0$

$k^2 + 12k < 0$

$k(k + 12) < 0$

$-12 < k < 0$



g real and distinct roots

$\therefore\ b^2 - 4ac > 0$

$4 - 4(k - 2) > 0$

$12 > 4k$

$k < 3$

h equal roots

$\therefore\ b^2 - 4ac = 0$

$k^2 - 8k = 0$

$k(k - 8) = 0$

$k = 0$ or 8

i no real roots

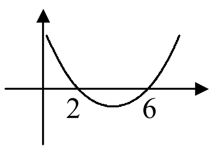
$\therefore\ b^2 - 4ac < 0$

$k^2 - 4(2k - 3) < 0$

$k^2 - 8k + 12 < 0$

$(k - 2)(k - 6) < 0$

$2 < k < 6$



j real roots

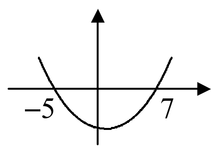
$\therefore\ b^2 - 4ac \geq 0$

$(k - 1)^2 - 36 \geq 0$

$k^2 - 2k - 35 \geq 0$

$(k + 5)(k - 7) \geq 0$

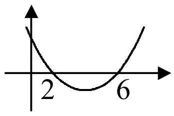
$k \leq -5$ or $k \geq 7$



1 **a** $4 > \frac{3}{2}y$

$y < \frac{8}{3}$

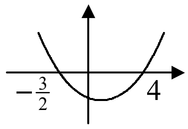
b $(x - 2)(x - 6) \geq 0$



$\therefore\ x \leq 2$ or $x \geq 6$

2 $2n^2 - 5n - 12 < 0$

$(2n + 3)(n - 4) < 0$



$-\frac{3}{2} < n < 4$

n integer $\therefore\ n = -1, 0, 1, 2, 3$

3 **a** $(x + 8) \geq 1.5 \times x$

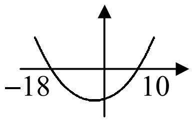
$8 \geq 0.5x$

$x \leq 16$

b $x(x + 8) \geq 180$

$x^2 + 8x - 180 \geq 0$

$(x + 18)(x - 10) \geq 0$



$x \leq -18$ or $x \geq 10$

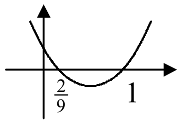
but $x > 0$ (width > 0)

and $x \leq 16$ $\therefore$ $10 \leq x \leq 16$

4 $9x^2 - 6x + 1 < 5x - 1$

$9x^2 - 11x + 2 < 0$

$(9x - 2)(x - 1) < 0$



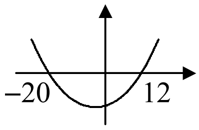
$\frac{2}{9} < x < 1$

5 $x = y + 8$

sub. $y(y + 8) \leq 240$

$y^2 + 8y - 240 \leq 0$

$(y + 20)(y - 12) \leq 0$



$-20 \leq y \leq 12$

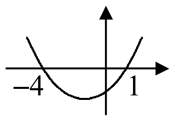
$x + y = y + 8 + y = 2y + 8$

$\therefore$ max value of $(x + y) = 2(12) + 8 = 32$

6 $3t^2 - 11t - 4 \geq 2t^2 - 14t$

$t^2 + 3t - 4 \geq 0$

$(t + 4)(t - 1) \geq 0$



$t \leq -4$ or $t \geq 1$

7 **a** $2x^2 + 2x - kx + 8 = 0$

real and distinct roots

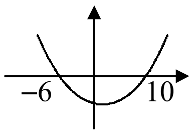
$\therefore\ b^2 - 4ac > 0$

$(2 - k)^2 - 64 > 0$

$4 - 4k + k^2 - 64 > 0$

$k^2 - 4k - 60 > 0$

b $(k + 6)(k - 10) > 0$



$k < -6$ or $k > 10$

8 let height be h $\therefore\ h^2 = (3r - 4)^2 - r^2$

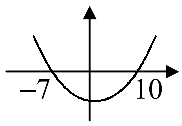
but $h \leq 24$

$\therefore\ h^2 \leq 24^2$

$(3r - 4)^2 - r^2 \leq 576$

$r^2 - 3r - 70 \leq 0$

$(r + 7)(r - 10) \leq 0$



$-7 \leq r \leq 10$

$\therefore$ maximum value of $r = 10$