

Section 2: Inequalities

Solutions to Exercise level 2

1. (i) $5(x-3) \leq 2(2x+3)$

$$5x - 15 \leq 4x + 6$$

$$x - 15 \leq 6$$

$$x \leq 21$$

(ii) $2(1-x) > 3x+4$

$$2 - 2x > 3x + 4$$

$$2 > 5x + 4$$

$$-2 > 5x$$

$$-\frac{2}{5} > x$$

$$x < -\frac{2}{5}$$

(iii) $4(2x+5) \geq 3(3x-1)$

$$8x + 20 \geq 9x - 3$$

$$20 \geq x - 3$$

$$23 \geq x$$

$$x \leq 23$$

(iv) $\frac{2x+1}{3} > \frac{x-4}{2}$

$$2(2x+1) > 3(x-4)$$

$$4x + 2 > 3x - 12$$

$$x + 2 > -12$$

$$x > -14$$

(v) $-\frac{1}{2}(4+3x) \geq 2x-1$

$$4 + 3x \leq -4x + 2$$

$$7x \leq -2$$

$$x \leq -\frac{2}{7}$$

(vi) $\frac{x-1}{3} > -\frac{3-x}{2}$

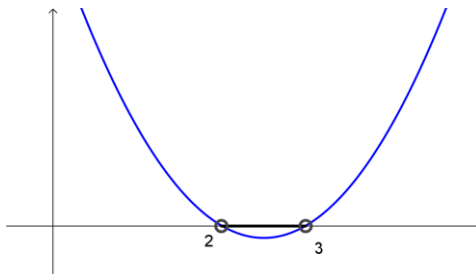
$$2x - 2 > -9 + 3x$$

$$-x > -7$$

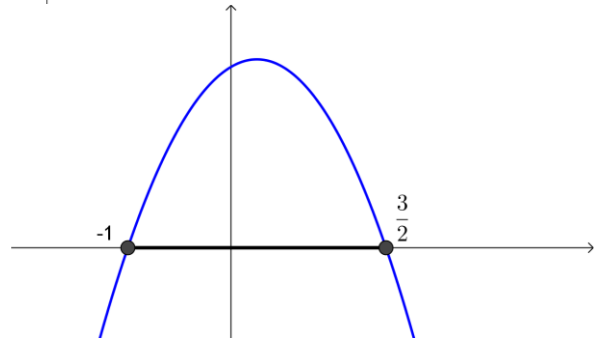
$$x < 7$$

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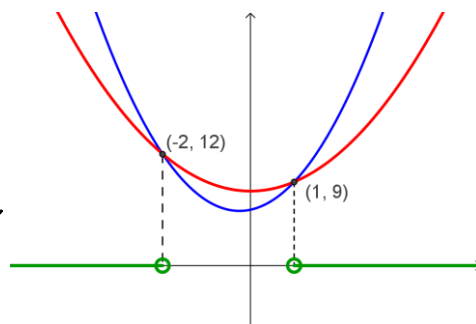
2. (i) $x^2 - 5x + 6 = 0$
 $(x-2)(x-3) = 0$
 From graph, solution is $2 < x < 3$



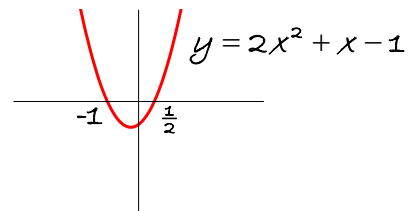
- (ii) $-2x^2 + x + 3 = 0$
 $2x^2 - x - 3 = 0$
 $(2x-3)(x+1) = 0$
 From graph, solution is $-1 \leq x \leq \frac{3}{2}$



- (iii) $x^2 + 8 = 2x^2 + x + 6$
 $x^2 + x - 2 = 0$
 $(x-1)(x+2) = 0$
 So intersections are $(1, 9)$ and $(-2, 12)$,
 From graph, solution is $x < -2$ or $x > 1$



3. (i) $1 - x - 2x^2 \geq 0$
 $2x^2 + x - 1 \leq 0$
 $(2x-1)(x+1) \leq 0$
 From graph, $-1 \leq x \leq \frac{1}{2}$



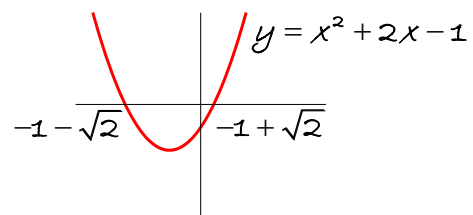
- (ii) $x^2 + 2x - 1 < 0$ cannot be factorised, so use quadratic formula to solve the equation $x^2 + 2x - 1 = 0$:

$$a=1, b=2, c=-1$$

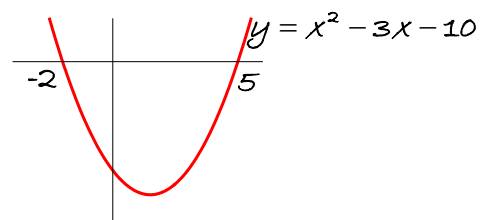
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times -1}}{2}$$

$$= \frac{-2 \pm \sqrt{8}}{2} = \frac{-2 \pm 2\sqrt{2}}{2} = -1 \pm \sqrt{2}$$

From graph, $-1 - \sqrt{2} < x < -1 + \sqrt{2}$



- (iii) $x^2 \geq 3x + 10$
 $x^2 - 3x - 10 \geq 0$
 $(x-5)(x+2) \geq 0$
 From graph, $x \leq -2$ or $x \geq 5$



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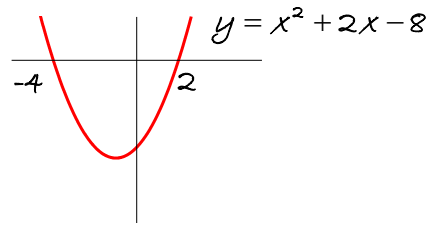
(iv) $x(x+3) > x+8$

$$x^2 + 3x > x + 8$$

$$x^2 + 2x - 8 > 0$$

$$(x+4)(x-2) > 0$$

From graph, $x < -4$ or $x > 2$



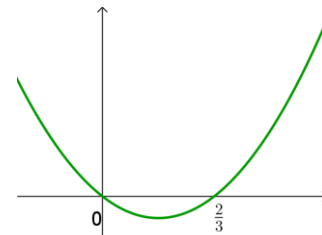
4. (i) $\frac{2}{x} \geq 3$

Multiplying through by x^2 : $2x \geq 3x^2$ $x \neq 0$

$$3x^2 - 2x \leq 0$$

$$x(3x - 2) \leq 0$$

$$0 < x \leq \frac{2}{3}$$



0 must be excluded from the solution set, so $<$ rather than \leq is used here

(ii) $\frac{x-2}{x+1} < 1$

Multiplying through by $(x+1)^2$:

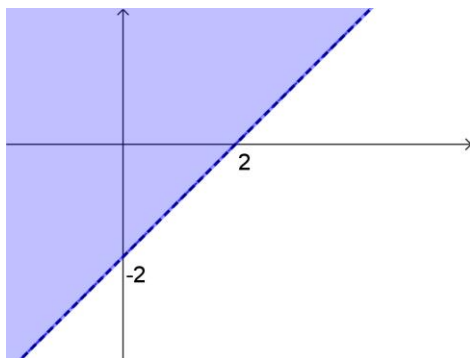
$$(x+1)(x-2) < (x+1)^2 \quad x \neq -1$$

$$x^2 - x - 2 < x^2 + 2x + 1$$

$$3x > -3$$

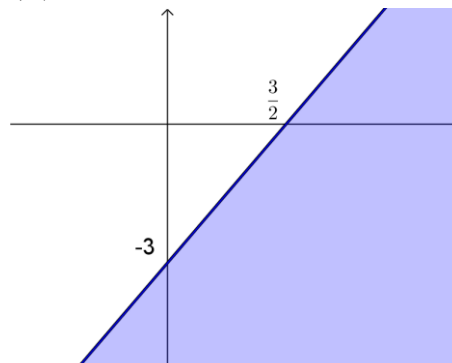
$$x > -1$$

5. (i)



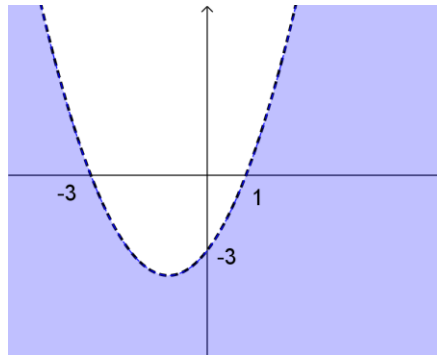
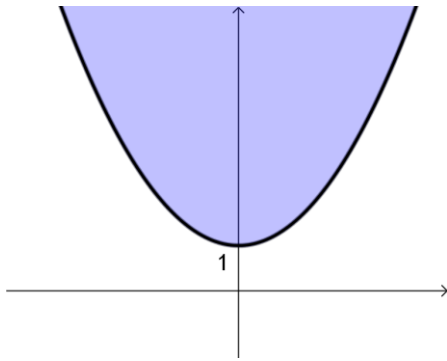
(iii)

(ii)



(iv)

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6. There are no real roots if the discriminant is less than zero.

(i) $x^2 - 5x + k = 0$

$$a = 1, b = -5, c = k$$

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

$$(-5)^2 - 4 \times 1 \times k < 0$$

$$25 - 4k < 0$$

$$25 < 4k$$

$$4k > 25$$

$$k > \frac{25}{4}$$

(ii) $x^2 + kx + k + 3 = 0$

$$a = 1, b = k, c = k + 3$$

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

$$k^2 - 4 \times 1 \times (k + 3) < 0$$

$$k^2 - 4k - 12 < 0$$

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

From graph, $-2 < k < 6$.

