1. For each parabola, identify:
i) the coordinates of the vertex
ii) the y-intercept and its symmetry point
iii) the direction of opening
iv) whether it has a maximum or minimum value, what that value is and when it occurs

a) $y = 3(x + 7)^2$ b) $y = -2(x - 3)^2 + 4$ c) $y = -\left(x - \frac{1}{2}\right)^2 - \frac{3}{4}$

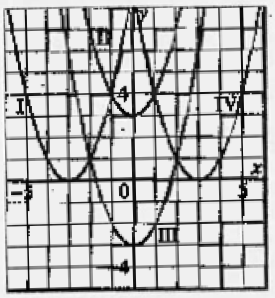
Graph the parabolas for equations a & b from above.

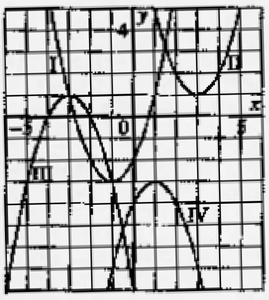
2. For each parabola:
I) State the coordinates of the vertex.
II) State whether the parabola opens up or down.
III) Describe the transformations needed to change the graph of $y = x^2$ to the given parabola.
iv) Describe the shape, relative to $y = x^2$.
v) State the step pattern.

a) $y = -(x - 3)^2 + 5$ b) $y = 3(x - 6)^2 - 20$ c) $y = \frac{1}{2}(x + 1)^2 + 2$

Graph the parabolas for equations a & c from above.

3. Match each equation with the appropriate graph (below left).
a) $y = (x - 3)^2$ b) $y = x^2 - 3$ c) $y = x^2 + 3$ d) $y = (x + 3)^2$





4. Match each equation with the appropriate graph (above right).
a) $y = (x - 3)^2 + 1$ b) $y = -(x + 3)^2 + 1$
c) $y = -(x - 1)^2 - 3$ d) $y = (x + 1)^2 - 3$

5. Write an equation for the quadratic function that fits each description.
a) Its graph can be obtained by translating the graph of $y = x^2$ four units to the left and three units downward.
b) It has the same shape as $y = x^2$ but it opens downward and its vertex is at (5, 0).

6. Describe how to transform the graph of $y = x^2$ to produce the graph of each function.
a) $y = 5x^2$ b) $y = (x - 3)^2 + 2$ c) $y = -x^2 - 4$
d) $y = -2(x + 5)^2$ e) $y = -(x + 2)^2 - 2$ f) $y = 0.5(x - 4)^2 - 6$

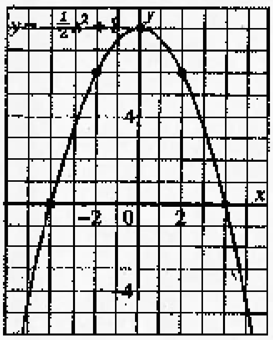
7. Write the equation of the image graph after $y = x^2$ has undergone each transformation.
a) Translate 2 units left and 3 units up.
b) Stretch by a factor of 2, then translate 1 unit right.
c) Reflect in the x-axis, then translate 4 units down.

8. Write the equation of each parabola.
a) vertex (0, 0) with $a = -1$
b) vertex (4, 0) with $a = \frac{1}{2}$
c) vertex (4, −1) with $a = 2$
d) vertex (−4, 1) with $a = -2$

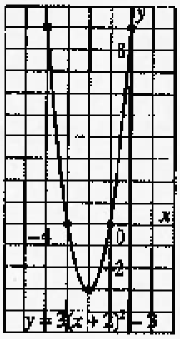
9. For each quadratic function, identify:

i) the coordinates of the vertex
ii) the equation of the axis of symmetry
iii) the x- and y-intercepts
iv) the maximum or minimum value

a)



b)



10. Expand and simplify.

a) $(x+3)(x-2)$
b) $(x+5)(x-8)$
c) $(2x+3)(5x-1)$
d) $(2x+3)^2$
e) $(3x-1)(8x-7)$
f) $(15-x)(5+x)$
g) $2(x+3)+x(x+5)$
h) $y=-(x+1)^2+8$
i) $y=5(x-3)^2-5$
j) $y=(x+2)^2+10$
k) $y=\frac{1}{3}(x-6)^2+13$

11. Determine whether the equations in each pair are equivalent.

a) $y=2(x-3)^2-7$
$y=2x^2-12x+11$

b) $y=(x-5)^2-25$
$y=x^2-10x$

c) $y=-2(x-20)^2+800$
$y=-2x^2+80x$

12. **Tennis** In tennis a lob shot is used when your opponent is close to the net. A good lob shot should float the ball over your opponent's head and land in the back of the court. An example of a lob shot can be modelled by the equation $y=-0.14(x-2)^2+5$, measured in metres, and seconds.

a) How long, after being hit, does the ball reach its maximum height?
b) What is the maximum height of the ball?
c) From what height was the ball hit?
d) What is the height of the ball 3 seconds after being hit?

13. **Energy use** The amount of energy used by a household varies throughout the day. The energy consumption can be approximated by the quadratic function $y=-0.2083(x-12)^2+50$. x is the time, in hours, on the 24-h clock and y is the amount of energy used, in kilowatts (kW).

a) At what time does the peak energy usage occur in this household?
b) How much energy is used at the peak time?
c) How much energy is used at 18:00?

Answers:

1.a) (-7,0); (0,147)&(-14,147); up; min of 0 @ x=-7 b) (3,4); (0,-14)&(6,-14); down; max of 4 @ x=3 c) (½, -3/4); (0,-1)&(1,-1); down; max of -3/4 @ x=1/2

2.a) (3,5); down; HT right 3, reflection in x-axis, VT up 5; same; -1,-3,-5 b) (6,-20); up; HT right 6, VS by factor of 3, VT down 20; narrower; 3, 9, 15
c) (-1,2); up; HT left 1, VS by factor of ½, VT up 2; wider; 0.5, 1.5, 2.5

3. a) iv b) iii c) ii d) i 4. a) ii b) iii c) iv d) I 5.a) $y=(x+4)^2-3$ b) $y=-(x-5)^2$

6.a) VS by factor of 5 b) HT right 3, VT up 2 c) reflection in x-axis, VT down 4 d) HT left 5, VS by factor of 2 and reflection in x-axis
e) HT left 2, reflection in x-axis, VT down 2 f) HT right 4, VS by factor of 0.5, VT down 6

7. a) $y=(x+2)^2+3$ b) $y=2(x-1)^2$ c) $y=-x^2-4$ 8.a) $y=-x^2$ b) $y=\frac{1}{2}(x-4)^2$ c) $y=2(x-4)^2-1$ d) $y=-2(x+4)^2+1$

9.a) (0,8); x=0; x-int @ -4 & 4, y-int=8; max of 8 b) (-2,-3); x=-2; x-int @ -3 & -1, y-int=9; min of -3

10a) x^2+x-6 b) $x^2-3x-40$ c) $10x^2+13x-3$ d) $4x^2+12x+9$ e) $24x^2-29x+7$ f) $-x^2+10x+75$

g) x^2+7x+6 h) $y=-x^2-2x+7$ i) $y=5x^2-30x+40$ j) $y=x^2+4x+14$ k) $y=\frac{1}{3}x^2-4x+25$

11a) yes c) yes 12a) 2 s b) 5 m c) 4.44 m d) 4.86 m 13a) 12:00 b) 50 c) 42.5 kW