HIGHER

2.6 Transformations of Graphs of Functions: Test Pack

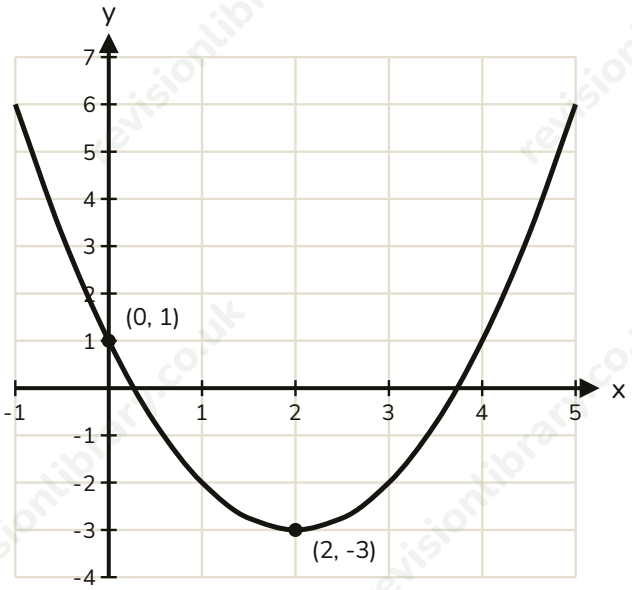
Total Marks

EDEXCEL 4MA1 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

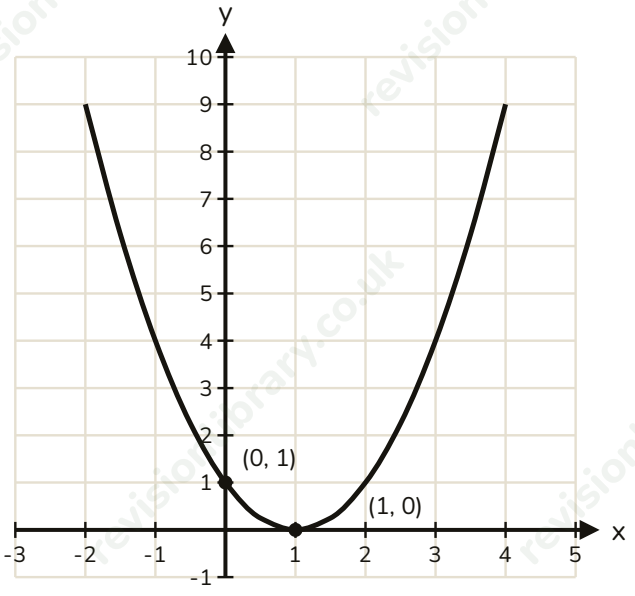
1 The graph of y = f(x) is a parabola with vertex at (2, -3) and passes through (0, 1). Sketch the graph of y = f(x) + 4 on the same axes and label the new vertex coordinate.



(Total for Question 1 is 1 mark)

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2 The graph of y = f(x) is a parabola with vertex at (1, 0) and passes through (0, 1). Sketch the graph of y = 2 - f(x) on the same axes and label the new vertex coordinate.



(Total for Question 2 is 2 marks)

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3 The graph of y = f(x) has a maximum at (-1, 4). State the coordinates of this maximum after the transformation y = f(3x). Explain briefly.

(Total for Question 3 is 2 marks)

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4 The graph of y = f(x) is transformed to give the graph of y = 2f(x - 1).
Given that $f(x) = x^3 - 6x^2 + 2$, find the equation of the transformed graph in the form y = ... , with the right-hand side expanded and simplified.

(Total for Question 4 is 3 marks)

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5 The graph of $y = f(x)$ is transformed to give the graph of $y = f(x) + 7$.
Describe fully the single transformation that does this.

(Total for Question 5 is 2 marks)

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6 The graph of $y = \cos(4x) + 3$ is drawn for $0 \leq x \leq 360$ (x in degrees).
Write down (a) the maximum value of y, (b) the minimum value of y, (c) the period of the graph in degrees.

(Total for Question 6 is 3 marks)

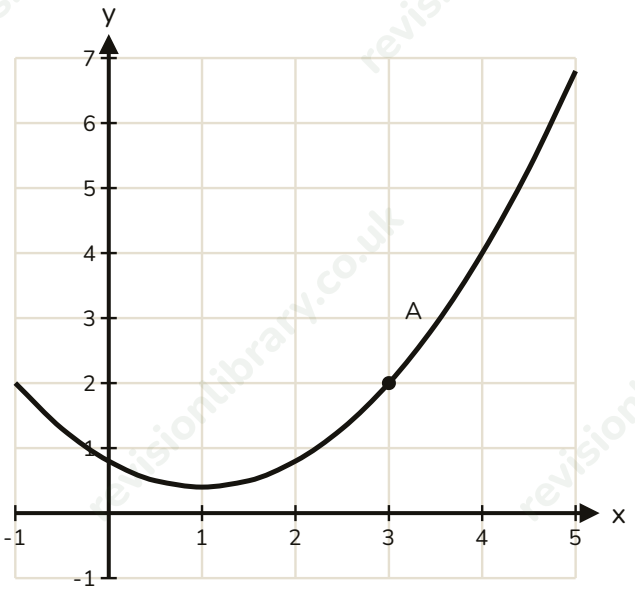
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7 The graph of $y = 2\cos(3(x - 45)) - 1$ is drawn for $x \geq 0$ (x in degrees).
Find the coordinates of the first maximum point of the graph for $x > 0$.

(Total for Question 7 is 4 marks)

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8 The graph of y = f(x) is shown and has a labelled point A at (3, 2). Describe the single transformation that maps the graph of y = f(x) onto the graph of y = 2 f(x). Also write down the coordinates of the image of A.



(Total for Question 8 is 2 marks)

9 The graph of y = 2sin(2x) is drawn for $0 \leq x \leq 360$ (x in degrees).
Write down (a) the maximum value of y, (b) the minimum value of y, (c) the period of the graph in degrees.

(Total for Question 9 is 3 marks)

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10 The graph of y = f(x) is transformed to give the graph of y = f(-x).
Given that $f(x) = 3x^2 + 3x - 5$, find the equation of the transformed graph in the form y = ... , with the right-hand side expanded and simplified.

(Total for Question 10 is 3 marks)

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11 The graph of $y = 4\cos(x) - 1$ is drawn for $0 \leq x \leq 360$ (x in degrees).
Write down (a) the maximum value of y, (b) the minimum value of y, (c) the period of the graph in degrees.

(Total for Question 11 is 3 marks)

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12 The graph of $y = 2x^2$ is translated by the vector [2; 2].
Find the equation of the new graph. Give your answer in the form y = ... , expanded and simplified.

(Total for Question 12 is 3 marks)

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13 Point C is on the graph of y = f(x) at C = (1, -4). State the image of C under the transformation y = -f(x) + 1. Give a brief reason.

(Total for Question 13 is 2 marks)

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14 A point D on y = f(x) is at D = (2, -1). Find the image of D under the transformation y = 0.5 f(x + 2) - 3. Give a brief explanation of each step.

(Total for Question 14 is 3 marks)

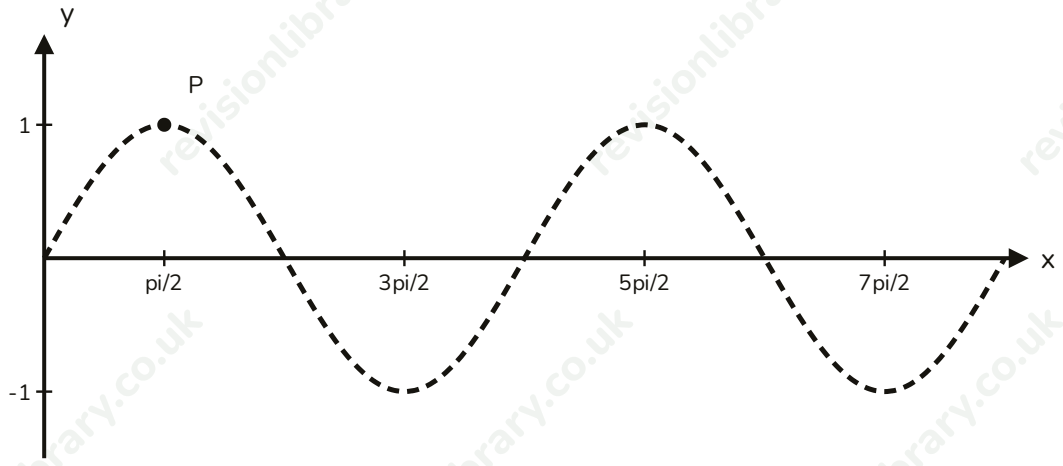
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15 The graph of y = f(x) has a labelled point E at (4, -1). State the image of E under the single transformation that maps y = f(x) to y = 3 f(x - 2) + 5. Give a brief reason.

(Total for Question 15 is 3 marks)

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16 A trig graph y = f(x) = sin x has a maximum at P at x = π/2 with coordinates (π/2, 1). Sketch y = sin(x/2) on the same axes for 0 ≤ x ≤ 4pi and write down the x-coordinate of the first maximum to the right of x = 0.



(Total for Question 16 is 3 marks)

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Mark scheme · 2.6 Transformations of Graphs of Functions: Test Pack

Question 1

sketch shows parabola shifted vertically up by 4 with correct orientation and position, and new vertex labelled (2, 1) cao **B1**

Answer: New vertex (2, 1)

Question 2

sketch shows reflection in x-axis of original parabola and a translation up by 2 units, preserving shape **M1**

new vertex labelled at (1, 2) cao **A1**

Answer: New vertex at (1, 2)

Question 3

recognition that x-coordinate changes by factor 1/3 for points not at x = 0, or that maxima x coordinate becomes -1/3 **M1**

coordinates (-1/3, 4) cao **A1**

Answer: (-1/3, 4)

Question 4

replaces x by x - 1 in f(x) **M1**

expands brackets and collects like terms (applying any multiplier and constant) **M1**

$y = 2x^3 - 18x^2 + 30x - 10$ cao **A1**

Answer: $y = 2x^3 - 18x^2 + 30x - 10$

Question 5

adding a constant outside f translates the graph vertically **M1**

Translation by the vector [0; 7] **A1**

Answer: Translation by the vector [0; 7]

Question 6

maximum value = 1 + (3) = 4 **B1**

minimum value = -1 + (3) = 2 **B1**

period = 360/4 = 90 degrees **B1**

Answer: (a) 4; (b) 2; (c) 90 degrees

Question 7

maximum of cos occurs when its argument is 0 degrees (plus multiples of 360) **M1**

solves 3(x - 45) = 0 + 360n for the smallest positive x **M1**

x = 45 **A1**

y = 1, so the point is (45, 1) **A1**

Answer: (45, 1)

Question 8

correct description: stretch vertically by a factor of 2 with respect to the x-axis, oe **M1**

coordinates of image given as (3, 4) cao **A1**

Answer: Stretch vertically by factor 2 in the y-direction; A maps to (3, 4)

Question 9

maximum value = 2 + (0) = 2 **B1**

minimum value = -2 + (0) = -2 **B1**

period = 360/2 = 180 degrees **B1**

Answer: (a) 2; (b) -2; (c) 180 degrees

Question 10

replaces x by -x in f(x) **M1**

expands brackets and collects like terms (applying any multiplier and constant) **M1**

$y = 3x^2 - 3x - 5$ cao **A1**

Answer: $y = 3x^2 - 3x - 5$

Question 11

maximum value = 4 + (-1) = 3 **B1**

minimum value = -4 + (-1) = -5 **B1**

period = 360 degrees **B1**

Answer: (a) 3; (b) -5; (c) 360 degrees

Question 12

a translation of [2; 2] replaces x by (x - (2)) and adds 2 to y **M1**

writes y = f(x - (2)) + 2 with $f(x) = 2x^2$ and expands **M1**

$y = 2x^2 - 8x + 10$ cao **A1**

Answer: $y = 2x^2 - 8x + 10$

Question 13

correct image coordinates (1, 5) stated **M1**

brief reason: reflect in x-axis then translate up 1 so y = -(-4) + 1 = 5, oe **A1**

Answer: (1, 5)

Question 14

correctly applies horizontal translation: x comes from solving x + 2 = 2 so original x for image is 0, or explains point mapping: point (2, -1) on f corresponds to x = 2, so for f(x + 2) the same y occurs at x = 0 **M1**

applies vertical scale and translation: y = 0.5*(-1) - 3 = -0.5 - 3 **M1**

final coordinates (0, -3.5) cao **A1**

Answer: (0, -3.5)

Question 15

recognises horizontal shift right by 2: x = 4 becomes x = 6 **M1**

applies vertical stretch factor 3 then translation up 5: y = -1 -> 3 * (-1) + 5 = 2 **M1**

final image (6, 2) cao **A1**

Answer: (6, 2)

Question 16

sketch shows horizontal stretch by factor 2 with doubled period, peaks at correct relative positions, and correct amplitude 1 **M1**

student shows at least one maximum at x = π with correct labelling or peak location ft their sketch **M1**

first maximum to the right of 0 stated as x = π cao **A1**

Answer: First maximum at x = π

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