JZ Maths

TMUA TOPIC TEST

Transformations Part A Topic Test

Time limit: 40 minutes

Calculators: not permitted

Format: 10 multiple-choice questions

This is a TMUA-style topic test: a timed set of TMUA-style questions, with a particular focus on a given topic. You can also sit this test online at jzmaths.com, where the result will count towards your mastery score.

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Question 1

Let $f(t) = t^4 - 2t^3 + P(t)$, where P is a polynomial of degree at most 2. Define $g(x) = 3 - 2f(2 - x)$. What is the coefficient of x^3 in $g(x)$?

A 6

B -6

C 12

D -12

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Question 2

Starting with an arbitrary curve, consider the following two sequences. Sequence P reflects the curve in $x = 3$, stretches it horizontally by scale factor $1/2$, reflects it in $y = -2$, and then stretches it vertically by scale factor 3. Sequence Q stretches the curve horizontally by scale factor $1/2$, reflects it in $x = a$, stretches it vertically by scale factor 3, and then reflects it in $y = b$. For which pair (a, b) do the two sequences always produce the same final curve?

A $(a, b) = \left(6, -\frac{3}{2}\right)$

B $(a, b) = \left(\frac{3}{2}, 6\right)$

C $(a, b) = \left(-\frac{3}{2}, -6\right)$

D $(a, b) = \left(\frac{3}{2}, -6\right)$

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Question 3

Starting with the graph of $y = f(x)$, each option describes a sequence of transformations. Treat f as an arbitrary function with no special symmetry or periodicity. Which option produces a resulting function that is different from the functions produced by every one of the other five options?

A Translate horizontally by $+2$ units; stretch horizontally by scale factor $\frac{1}{3}$; stretch vertically by scale factor 2; reflect in the line $y = \frac{5}{2}$.

B Reflect in the x-axis; stretch vertically by scale factor 2; translate vertically by $+5$ units; stretch horizontally by scale factor $\frac{1}{3}$; translate horizontally by $+\frac{2}{3}$ units.

C Stretch horizontally by scale factor $\frac{1}{3}$; translate horizontally by $+\frac{2}{3}$ units; reflect in the x-axis; stretch vertically by scale factor 2; translate vertically by $+5$ units.

D Translate horizontally by -2 units; stretch horizontally by scale factor $\frac{1}{3}$; stretch vertically by scale factor 2; reflect in the line $y = \frac{5}{2}$.

E Stretch horizontally by scale factor $\frac{1}{3}$; translate horizontally by $-\frac{2}{3}$ units; reflect in the x-axis; stretch vertically by scale factor 2; translate vertically by $+5$ units.

F Translate horizontally by $+2$ units; stretch horizontally by scale factor $\frac{1}{3}$; reflect in the line $y = \frac{5}{2}$; stretch vertically by scale factor 2.

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Question 4

The circle $x^2 + y^2 = 1$ is first stretched horizontally by scale factor 2, then reflected in the line $x = 3$, then stretched vertically by scale factor 3, and finally reflected in the line $y = 1$. Which equation represents the resulting curve?

A $\dfrac{(x-6)^2}{4} + \dfrac{(y-2)^2}{9} = 1$

B $\dfrac{(x-3)^2}{4} + \dfrac{(y-1)^2}{9} = 1$

C $\dfrac{(x-6)^2}{9} + \dfrac{(y-2)^2}{4} = 1$

D $\dfrac{(x+6)^2}{4} + \dfrac{(y+2)^2}{9} = 1$

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Question 5

Let f be a function whose derivative exists for all real x, with $f(2) = 3$ and $f'(2) = -1$. Starting with $y = f(x)$, reflect the graph in the line $x = 1$, stretch it horizontally by scale factor 2, reflect it in the line $y = 4$, and then stretch it vertically by scale factor $1/2$. What is the equation of the tangent to the resulting graph at the image of $(2, 3)$?

A $y = -\frac{1}{4}x + \frac{5}{2}$

B $y = \frac{1}{4}x + \frac{5}{2}$

C $y = -4x + \frac{5}{2}$

D $y = -\frac{1}{4}x + \frac{3}{2}$

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Question 6

Let $f(x) = \log_4 x$. Sequence P translates the graph horizontally by $+1$, stretches it horizontally by scale factor 2, translates it vertically by $+1$, and then stretches it vertically by scale factor 2, producing $y = g(x)$. Sequence Q stretches the graph horizontally by scale factor 2, translates it horizontally by $+1$, stretches it vertically by scale factor 2, and then translates it vertically by $+1$, producing $y = h(x)$. What is the set of x-coordinates of the points at which the two final graphs intersect?

A $\emptyset$

B $\left\{\frac{7}{3}\right\}$

C $\{3\}$

D $\{2\}$

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Question 7

Starting with $y = \sin x$, Sequence P translates the graph horizontally by $+\pi/3$, stretches it horizontally by scale factor $1/2$, reflects it in the y-axis, and translates it vertically by $+1$. Sequence Q reflects the graph in the x-axis, stretches it horizontally by scale factor $1/2$, translates it horizontally by $+a$, and translates it vertically by $+1$. For which value of a in the interval $0 \leq a < \pi$ do the two sequences produce the same final graph?

A $\dfrac{\pi}{6}$

B $\dfrac{\pi}{3}$

C $\dfrac{2\pi}{3}$

D $\dfrac{5\pi}{6}$

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Question 8

Let f have period 3 and satisfy $\int_0^3 f(x)\,dx = 5$. Sequence P translates $y = f(x)$ horizontally by $+3$, stretches it horizontally by scale factor $1/2$, translates it vertically by $+2$, and stretches it vertically by scale factor 3, producing $y = g(x)$. Sequence Q performs each horizontal pair and each vertical pair in the reverse order, producing $y = h(x)$. What is

$$\frac{\int_0^{3/2} g(x)\,dx}{\int_0^{3/2} h(x)\,dx}?$$

A 1

B $\dfrac{7}{11}$

C $\dfrac{3}{2}$

D $\dfrac{11}{7}$

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Question 9

Starting with $y = f(x)$, where f has no special symmetry or periodicity, the following four transformations are each applied exactly once in a uniformly random order: translate horizontally by $+1$; stretch horizontally by scale factor $1/2$; translate vertically by $+3$; stretch vertically by scale factor 2. What is the probability that the final graph has equation $y = 2f(2x - 1) + 3$?

A $\frac{1}{6}$

B $\frac{1}{3}$

C $\frac{1}{4}$

D $\frac{1}{2}$

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Question 10

A transformation T acts on a function h by

$$T(h(x)) = 3 - 2h(2x - 1).$$

Starting with f, the same transformation is applied n times, where n is a positive integer. Which expression represents the resulting function $T^n f$?

A $1 + (-2)^n \left(f(1 + 2^n(x - 1)) - 1\right)$

B $1 + 2^n \left(f(1 + (-2)^n(x - 1)) - 1\right)$

C $3^n - 2^n f(2^n x - n)$

D $1 + (-2)^n \left(f(1 + 2^{-n}(x - 1)) - 1\right)$

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