# Final Exam Model Paper 2

MODEL PAPER

Full marks 75 · 3 hours

Name _____ Class _____ Roll no. ____ Date _____ Marks _____ / 75

**All questions are compulsory. Time: 3 hours.**

A practice paper by Science Playground, made to CDC's Specification Grid 2082, Optional Mathematics, Grades 9–10; not an official CDC or exam board paper. Mark it yourself online: the QR code below opens the paper with its answers.

A full practice run of the Grade 9 final exam in Optional Mathematics: 75 marks in 3 hours, 17 questions, every one compulsory, in three groups. Group A is one question of 11 multiple-choice items; groups B and C have questions of two to four parts, with the marks of each part in brackets. Show your working on paper as in the exam hall, then tap your choice in group A, open each other part's answer and give yourself the marks its scheme allows. You need graph paper for Question 10.

## Group A Objective questions — 11 marks

### Question 1 — 11 × 1 = 11

**Choose the correct option for each of the following questions.**

**A.** What is the rationalizing factor of $3+\sqrt{2}$?

(i) $3+\sqrt{2}$
(ii) $3-\sqrt{2}$
(iii) $\sqrt{2}$
(iv) $-3-\sqrt{2}$

**B.** What is the remainder when $x^3+2x^2-5$ is divided by $(x-2)$?

(i) 11 (ii) -5 (iii) 3 (iv) 13

**C.** Which of these is equal to 1 radian?

(i) $\left(\frac{180}{\pi}\right)^\circ$
(ii) $\left(\frac{\pi}{180}\right)^\circ$
(iii) $180^\circ$
(iv) $\left(\frac{90}{\pi}\right)^\circ$

**D.** What is the value of $\sin 120^\circ$?

(i) $\frac{\sqrt{3}}{2}$
(ii) $-\frac{\sqrt{3}}{2}$
(iii) $\frac{1}{2}$
(iv) $-\frac{1}{2}$

**E.** Which of these is **not** a trigonometric identity?

(i) $\sin^2\theta+\cos^2\theta=1$
(ii) $1+\tan^2\theta=\sec^2\theta$
(iii) $\sin\theta+\cos\theta=1$
(iv) $\cot\theta=\frac{\cos\theta}{\sin\theta}$

**F.** An enlargement with center O and scale factor −1 has the same effect as which transformation?

(i) a reflection in the X-axis
(ii) a reflection in the line $y=x$
(iii) a rotation through 180∘ about the origin
(iv) a rotation through +90∘ about the origin

**G.** What is the x-intercept of the line $2x - 3y = 12$?

(i) 6 (ii) -4 (iii) 4 (iv) -6

**H.** What is the slope of the line through $(x_1, y_1)$ and $(x_2, y_2)$?

(i) $\frac{y_2 - y_1}{x_2 - x_1}$
(ii) $\frac{x_2 - x_1}{y_2 - y_1}$
(iii) $\frac{y_2 + y_1}{x_2 + x_1}$
(iv) $(y_2 - y_1)(x_2 - x_1)$

**I.** A vector $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$ starts at the point $(1, 2)$. Where does it end?

(i) $(4, -2)$ (ii) $(2, -6)$ (iii) $(-2, 6)$ (iv) $(3, -4)$

**J.** The lower and upper quartiles of a set of data are 20 and 50. What is its quartile deviation?

(i) 15 (ii) 30 (iii) 35 (iv) 0.43

**K.** The $n$th term of a sequence is $\frac{n}{n+1}$. What does it head for as $n \to \infty$?

(i) 0 (ii) 1
(iii) $\frac{1}{2}$ (iv) $\infty$

## Group B Within one content area — 40 marks

### Question 2 — 4 marks

**In the set $A = \{1, 2, 3\}$, the relation "is less than or equal to" is**

$$R = \{(1,1), (1,2), (1,3), (2,2), (2,3), (3,3)\}.$$

**a.** Define a reflexive relation. **[1]**

**b.** Yasmin says that $R$ is both reflexive and symmetric. Check both, and say whether she is right. **[2]**

**c.** Write the inverse relation $R^{-1}$, and say in words what it means. **[1]**

### Question 3 — 3 marks

**Bhim writes two matrices and tells his friends that they are equal:**

$$M = \begin{pmatrix} a+1 & 4 \\ 4 & 7 \end{pmatrix}, \qquad N = \begin{pmatrix} 5 & 4 \\ b-2 & 7 \end{pmatrix}.$$

**a.** Is $M$ a symmetric matrix? Give a reason. **[1]**

**b.** If $M = N$, what type of matrix is $N - M$? Give a reason. **[1]**

**c.** Find the values of $a$ and $b$. **[1]**

### Question 4 — 3 marks

**A rectangular vegetable plot in a school garden is $\frac{4}{\sqrt{5} - \sqrt{3}}$ meters long.**

**a.** Write the rationalizing factor of $\sqrt{5} - \sqrt{3}$. **[1]**

**b.** Rationalize the denominator and simplify the length. About how long is the plot? **[2]**

### Question 5 — 2 marks

**A trigonometric expression $\tan 135^\circ + \cos 240^\circ$ is given.**

**a.** Use $\tan(180^\circ - \theta) = -\tan\theta$ to write $\tan 135^\circ$ as a trigonometric ratio of an acute angle, and find its value. **[1]**

**b.** Find the angle between -90° and 0° whose tangent is equal to $\tan 135^\circ$. **[1]**

## Question 6 — 4 marks

**A trigonometric expression $\frac{1+\tan^2\theta}{1+\cot^2\theta}$ is given.**

**a.** Write $\cot\theta$ in terms of $\sin\theta$ and $\cos\theta$. **[1]**

**b.** Write the value of $\operatorname{cosec}^2\theta - \cot^2\theta$. **[1]**

**c.** Prove that $\frac{1+\tan^2\theta}{1+\cot^2\theta} = \tan^2\theta$. **[2]**

## Question 7 — 3 marks

**The roof of a house in Jumla rises 7 dm for every 24 dm along the ground. It makes an angle $\theta$ with the ground, so $\tan\theta = \frac{7}{24}$.**

**a.** Find the values of $\sin\theta$ and $\cos\theta$. **[2]**

**b.** Find the value of $25(\sin\theta + \cos\theta)$. **[1]**

## Question 8 — 3 marks

**A straight irrigation canal on a farm map passes through the point $(3,\,4)$ and cuts off equal intercepts on the two axes.**

**a.** Write the double-intercept form of the equation of a straight line. **[1]**

**b.** Find the equation of the canal. **[2]**

## Question 9 — 4 marks

**On a plan (1 unit = 1 m), a lamp is at $A(0,\,3)$ and the ground is the X-axis.**

**a.** A point P moves so that it is always as far from the lamp A as from the ground. Find the equation of its locus. **[2]**

**b.** In what ratio does the X-axis divide the line segment joining $C(2,\,-3)$ and $D(5,\,6)$? Find the point of division. **[2]**

## Question 10 — 4 marks

**Triangle ABC has vertices $A(1,\,-1)$, $B(4,\,0)$ and $C(2,\,1)$. It is reflected in the line $y = 2$.**

**a.** Write the image of a point $(x,\,y)$ under a reflection in the line $y = b$. **[1]**

**b.** Find the coordinates of $A'$, $B'$ and $C'$. **[1]**

**c.** Draw $\triangle ABC$ and its image on the same graph. **[2]**

## Question 11 — 3 marks

**The graph shows a vector $\vec{m}$.**

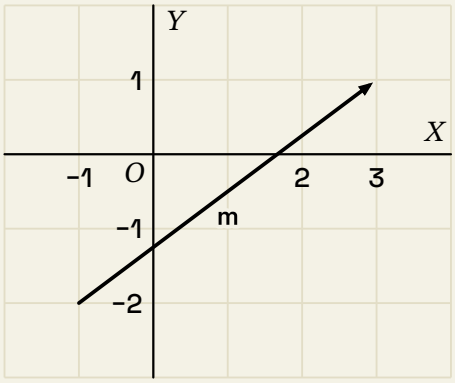



**Figure 2** The vector $\vec{m}$, from $(-1, -2)$ to $(3, 1)$.

**a.** Write $\vec{m}$ in column vector form. **[1]**

**b.** Find the unit vector in the direction of $\vec{m}$. **[1]**

**c.** Kushal says that $-\vec{m}$ has the same magnitude and the same direction as $\vec{m}$, because the minus sign only changes the numbers. Is he right? Give a reason. **[1]**

## Question 12 — 3 marks

**A survey of 30 households in a ward of Lalitpur counted the children in each.**

| Number of children ($x$) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| Number of households ($f$) | 3 | 8 | 13 | 4 | 2 |

**a.** Write the formula for the position of the first quartile ($Q_1$) in a discrete series. **[1]**

**b.** Find the first quartile. **[1]**

**c.** Sneha says: "The number of children goes from 0 to 4, so the upper quartile must be 3, three-quarters of the way along." Is she right? Give a reason. **[1]**

## Question 13 — 4 marks

**A function $f(x) = \frac{x^2-9}{x-3}$ is given.**

**a.** What is meant by $x \to 3^+$? **[1]**

**b.** Lakpa says that $f(x)$ and $g(x) = x + 3$ are the same function, because $\frac{x^2-9}{x-3} = \frac{(x-3)(x+3)}{x-3} = x + 3$. Is he right? Give a reason. **[1]**

**c.** Complete the table and find $\lim_{x \to 3} f(x)$. **[1]**

| $x$ | 2.9 | 2.99 | 2.999 | 3.001 | 3.01 | 3.1 |
|---|---|---|---|---|---|---|
| $f(x)$ | | | | | | |

**d.** Why can't the limit be found just by putting $x = 3$ in $f(x)$? **[1]**

# Group C Across content areas — 24 marks

## Question 14 — 6 marks

**A point P divides the line segment joining $A(-2, 6)$ and $B(4, 0)$ internally in the ratio $k$:1, where $k > 0$.**

**a.** Show that the coordinates of P are $\left(\frac{4k-2}{k+1}, \frac{6}{k+1}\right)$. **[2]**

**b.** What point does P head for as $k \to \infty$? **[1]**

**c.** Find the equation of the line AB. **[1]**

**d.** For $k = \sqrt{2}$, write the coordinates of P with rational denominators, and show that P lies on AB. **[2]**

## Question 15 — 6 marks

**A school's maths club makes a data set from the function $f(x) = x^2$ on the domain $A = \{-2, -1, 0, 1, 2\}$: its five outputs.**

**a.** Write $f$ as a set of ordered pairs and write its range. **[2]**

**b.** Taken as a function from $A$ to $B = \{0, 1, 2, 3, 4\}$, is $f$ onto? Give a reason. **[1]**

**c.** Find the standard deviation of the five outputs 4, 1, 0, 1, 4. **[3]**

## Question 16 — 6 marks

**A potter's wheel in Bhaktapur has a radius of 21 cm. In one second it turns through $150^{\text{g}}$. (Take $\pi = \frac{22}{7}$.)**

**a.** Convert $150^{\text{g}}$ into degrees and into radians. **[2]**

**b.** How far does a point on the rim travel in one second? Through how many degrees does the wheel turn while a point on its rim travels 66 cm? **[2]**

**c.** Sujata says that $\sin 150^{\text{g}}$ and $\sin 150^{\circ}$ are equal, because the number is the same. Is she right? Give a reason. **[1]**

**d.** The wheel keeps turning at the same speed for $t$ seconds. Does the distance a point on its rim has travelled have a limit as $t \to \infty$? Give a reason. **[1]**

## Question 17 — 6 marks

**Pasang turns $\triangle ABC$ with $A(1, 2)$, $B(3, 2)$, $C(3, 5)$ about a fixed point, and gets $\triangle A'B'C'$ with $A'(0, 1)$, $B'(0, 3)$, $C'(-3, 3)$.**

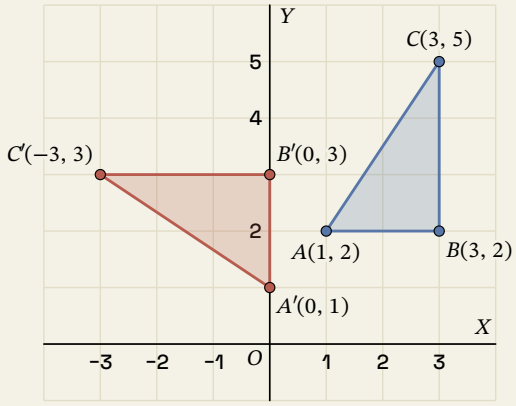



**Figure 4** $\triangle ABC$ **(blue) and its image** $\triangle A'B'C'$ **(red) after a rotation.**

**a.** Pasang says: "A rotation changes the direction of a side but not its length." Check this with $\overrightarrow{AB}$ and $\overrightarrow{A'B'}$. **[1]**

**b.** Find $\overrightarrow{BC}$ and $\overrightarrow{B'C'}$ and their magnitudes. **[2]**

**c.** Find the center, the angle and the direction of the rotation. **[3]**


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