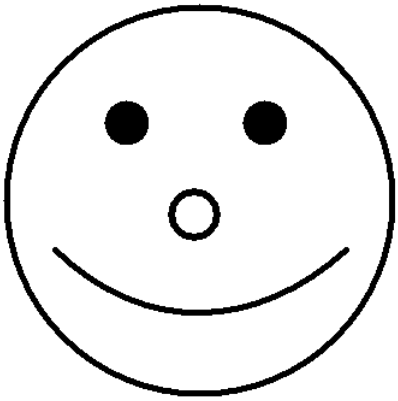
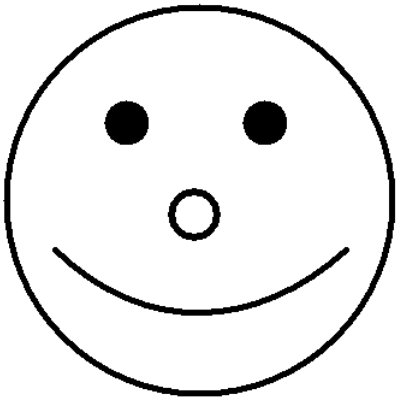
Question 1 **10 marks**

The MUMS committee has baked a lovely cake for Han. On the cake is a smiley face drawn in black icing (including the outer ring). If Han can only cut the cake with two straight cuts, and without moving chunks between cuts, what is the largest number of separate pieces of black icing that he can make?



Question 1 **10 marks**

The MUMS committee has baked a lovely cake for Han. On the cake is a smiley face drawn in black icing (including the outer ring). If Han can only cut the cake with two straight cuts, and without moving chunks between cuts, what is the largest number of separate pieces of black icing that he can make?



Question 2 **10 marks**

What is the midpoint between $\frac{1}{8}$ and $\frac{7}{12}$?

Question 2 **10 marks**

What is the midpoint between $\frac{1}{8}$ and $\frac{7}{12}$?

Question 3 **10 marks**

If 12% of x is 7, what is x% of 12?

Question 3 **10 marks**

If 12% of x is 7, what is x% of 12?

Question 4 **10 marks**

As the saying goes, "an apple a day keeps the doctor away". Your particular doctor takes this adage a little seriously, and vows to pay you a visit if you don't eat an apple on any given day. If you have 2008 apples, and eat one per day, beginning today, on what day of the week will your doctor first visit?

Question 4 **10 marks**

As the saying goes, "an apple a day keeps the doctor away". Your particular doctor takes this adage a little seriously, and vows to pay you a visit if you don't eat an apple on any given day. If you have 2008 apples, and eat one per day, beginning today, on what day of the week will your doctor first visit?

Question 5 **CHANGE RUNNER NOW** **10 marks**

If we add x to the numerator and denominator of both $\frac{2}{3}$ and $\frac{20}{23}$, the resulting fractions are equal. What is the value of x?

Question 5 **CHANGE RUNNER NOW** **10 marks**

If we add x to the numerator and denominator of both $\frac{2}{3}$ and $\frac{20}{23}$, the resulting fractions are equal. What is the value of x?

Question 6 **10 marks**

A number is formed by four digits followed by the digit 7. A second number is formed by the same four digits (in the same order) preceded by the digit 7. If the midpoint of these two numbers is 70000, then what is the first number?

Question 6 **10 marks**

A number is formed by four digits followed by the digit 7. A second number is formed by the same four digits (in the same order) preceded by the digit 7. If the midpoint of these two numbers is 70000, then what is the first number?

Question 7 **10 marks**

Julia has two show bags, each with 3 snakes and 3 jelly beans. In how many ways can she eat one lolly from each bag, such that she eats at least one snake?

Question 7 **10 marks**

Julia has two show bags, each with 3 snakes and 3 jelly beans. In how many ways can she eat one lolly from each bag, such that she eats at least one snake?

Question 8 **10 marks**

A perfectly circular pizza is cut into three sectors, with respective perimeters 5, 6 and 7 cm. What is the radius of this pizza?

Question 8 **10 marks**

A perfectly circular pizza is cut into three sectors, with respective perimeters 5, 6 and 7 cm. What is the radius of this pizza?

Question 9 **10 marks**

If a, b are not 0 and $a^2 + b^2 = 4ab$, what is the value of $\frac{(a-b)^2}{(a+b)^2}$?

Question 9 **10 marks**

If a, b are not 0 and $a^2 + b^2 = 4ab$, what is the value of $\frac{(a-b)^2}{(a+b)^2}$?

Question 10 **CHANGE RUNNER NOW** **10 marks**

Which two-digit number is equal to double of the product of its digits?

Question 10 **CHANGE RUNNER NOW** **10 marks**

Which two-digit number is equal to double of the product of its digits?

Question 11 **20 marks**

Sam is throwing a barbeque. Lamb chops cost $5 each and weigh 160g. Sausages cost $3 each and weigh 100g. Steaks cost $7 each and weigh 240g. What is the maximum weight of meat Sam can buy, if he has $53 to spend?

Question 11 **20 marks**

Sam is throwing a barbeque. Lamb chops cost $5 each and weigh 160g. Sausages cost $3 each and weigh 100g. Steaks cost $7 each and weigh 240g. What is the maximum weight of meat Sam can buy, if he has $53 to spend?

Question 12 **20 marks**

How many paths through *consecutive* letters in the grid below spell the word PATH (consecutive letters means adjacent either horizontally, vertically or diagonally)?

P	P	H	H
P	A	T	H
P	A	T	H
P	P	H	H

Question 12 **20 marks**

How many paths through *consecutive* letters in the grid below spell the word PATH (consecutive letters means adjacent either horizontally, vertically or diagonally)?

P	P	H	H
P	A	T	H
P	A	T	H
P	P	H	H

Question 13 **20 marks**

If $a + b = -3$ and $ab = 1$, find $\sqrt{\frac{a}{b}} + \sqrt{\frac{b}{a}}$.

Question 13 **20 marks**

If $a + b = -3$ and $ab = 1$, find $\sqrt{\frac{a}{b}} + \sqrt{\frac{b}{a}}$.

Question 14 **20 marks**

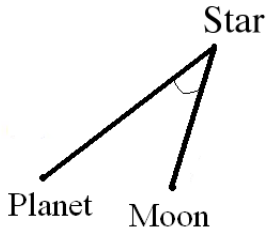
Three dice are rolled and their sum is 7. What is the probability that two of the dice show the same number?

Question 14 **20 marks**

Three dice are rolled and their sum is 7. What is the probability that two of the dice show the same number?

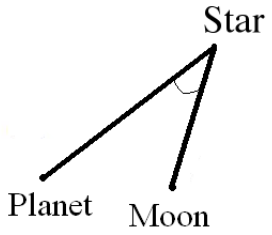
Question 15 **CHANGE RUNNER NOW** **20 marks**

In the MUMS solar system, there is only one planet and one star. Yi planet revolves around Kwok star in a circle with radius $6\sqrt{3}$. Yi planet has its own moon, Adib moon, which revolves around it with a radius of $3\sqrt{3}$. Recently, Adib moon captured a comet which started to orbit it. Chris comet orbits Adib moon with a radius of 1. However, the attraction of Kwok star is so great that if Chris comet comes within a radius of 8 of the star, it will be pulled away from Adib moon and burnt to a crisp by Kwok star's scorching rays. What is the maximum angle moon-star-planet in which this spectacular event can occur?



Question 15 **CHANGE RUNNER NOW** **20 marks**

In the MUMS solar system, there is only one planet and one star. Yi planet revolves around Kwok star in a circle with radius $6\sqrt{3}$. Yi planet has its own moon, Adib moon, which revolves around it with a radius of $3\sqrt{3}$. Recently, Adib moon captured a comet which started to orbit it. Chris comet orbits Adib moon with a radius of 1. However, the attraction of Kwok star is so great that if Chris comet comes within a radius of 8 of the star, it will be pulled away from Adib moon and burnt to a crisp by Kwok star's scorching rays. What is the maximum angle moon-star-planet in which this spectacular event can occur?



Question 16 **20 marks**

What is the sum of all positive integers less than 1000 whose digits are all even?

Question 16 **20 marks**

What is the sum of all positive integers less than 1000 whose digits are all even?

Question 17 **20 marks**

What is the value of $\sqrt{3+2\sqrt{2}}+\sqrt{3-2\sqrt{2}}$?

Question 17 **20 marks**

What is the value of $\sqrt{3+2\sqrt{2}}+\sqrt{3-2\sqrt{2}}$?

Question 18 **20 marks**

DB is a chord of a circle. E lies on DB such that DE = 3 and EB = 5. Let O be the centre of the circle. Join OE and extend OE past E to cut the circle at C. Given EC = 1, find the radius of the circle.

Question 18 **20 marks**

DB is a chord of a circle. E lies on DB such that DE = 3 and EB = 5. Let O be the centre of the circle. Join OE and extend OE past E to cut the circle at C. Given EC = 1, find the radius of the circle.

Question 19 **20 marks**

Let ABCD be a quadrilateral, and M the midpoint of AB, such that $AD = 4$, $BC = 8$ and $\angle DAB = \angle ABC = \angle DMC = 90^o$. Find the length of CD.

Question 19 **20 marks**

Let ABCD be a quadrilateral, and M the midpoint of AB, such that $AD = 4$, $BC = 8$ and $\angle DAB = \angle ABC = \angle DMC = 90^o$. Find the length of CD.

Question 20 **CHANGE RUNNER NOW** **20 marks**

Two brothers, each aged between 10 and 90, combined their ages by writing them down one after the other to create a four digit number, and discovered this number to be the square of an integer. Nine years later they repeated the process (combining their ages in the same order) and found that the combination was a square of another integer. What is the sum of their original ages?

Question 20 **CHANGE RUNNER NOW** **20 marks**

Two brothers, each aged between 10 and 90, combined their ages by writing them down one after the other to create a four digit number, and discovered this number to be the square of an integer. Nine years later they repeated the process (combining their ages in the same order) and found that the combination was a square of another integer. What is the sum of their original ages?

Question 21 **30 marks**

From the year 1 A.D. until now (inclusive), how many years have contained at least one two but no threes?

Question 21 **30 marks**

From the year 1 A.D. until now (inclusive), how many years have contained at least one two but no threes?

Question 22 **30 marks**

If $x + y = 9$, what is the minimum possible value of $\sqrt{x^2 + 9} + \sqrt{y^2 + 1}$?

Question 22 **30 marks**

If $x + y = 9$, what is the minimum possible value of $\sqrt{x^2 + 9} + \sqrt{y^2 + 1}$?

Question 23 **30 marks**

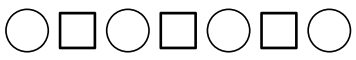
On a regular 12-hour analogue clock, as the minutes hand turns, so too does the hour hand rotate at a constant rate. Let any position that can be reached naturally be called *legitimate*. How many distinct legitimate positions remain legitimate when the hour hand is switched with the minute hand?

Question 23 **30 marks**

On a regular 12-hour analogue clock, as the minutes hand turns, so too does the hour hand rotate at a constant rate. Let any position that can be reached naturally be called *legitimate*. How many distinct legitimate positions remain legitimate when the hour hand is switched with the minute hand?

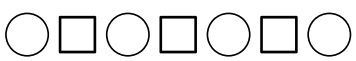
Question 24 **30 marks**

Put the numbers 1, 3, 4, 6, in each circle (each exactly once) and an operator (+, -, $\times, \div$) in each square (not necessarily exactly once), as well as any required parentheses, to make the expression equal to 24.



Question 24 **30 marks**

Put the numbers 1, 3, 4, 6, in each circle (each exactly once) and an operator (+, -, $\times, \div$) in each square (not necessarily exactly once), as well as any required parentheses, to make the expression equal to 24.



Question 25 **30 marks**

A shop sells doughnuts in boxes of 30, 35 or 42. For example, you can buy 70 doughnuts by buying 2 boxes of 35, or 72 by buying a box of 30 and a box of 42. However, there is no combination that gives 71 doughnuts. What is the largest number of doughnuts that cannot be bought?

Question 25 **30 marks**

A shop sells doughnuts in boxes of 30, 35 or 42. For example, you can buy 70 doughnuts by buying 2 boxes of 35, or 72 by buying a box of 30 and a box of 42. However, there is no combination that gives 71 doughnuts. What is the largest number of doughnuts that cannot be bought?